PROJECT DOCUMENT BINDER

Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation Project

List of Project Documents

Remedial Design/Remedial Action Work Plan Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation	February 2013
Remedial Design/Remedial Action Field Sampling Plan, February 2013	February 2013
Remedial Design/Remedial Action Quality Assurance Project Plan	February 2013
Remedial Design/Remedial Action Waste Management Plan	February 2013
Remedial Design/Remedial Action Accident Prevention Plan/Site Safety and Health Plan	February 2013
Final Status Survey Plan for FUSRAP Areas at the Iowa Army Ammunition Plant, (FINAL),	February 2013
Final Soil Sorting Pilot Study Test Report	October 2014

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial
Action Program

1. DISTRIBUTION

All Document Holders

2. DOCUMENT TITLE

Final Remedial Design/Remedial Action Work Plan, Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation (Project Document Binder)

3. DESCRIPTION OF CHANGE

As part of the Remedial Action activities identified for the IAAAP OU-8 Remedial Action, a pilot study was conducted to determine the feasibility and effectiveness of using a radiological sorting technique to separate contaminated soil and reduce the overall soil quantity that will be transported and disposed of, in order to meet the established remediation goals.

The pilot test was conducted in accordance with an established test plan with the results documented in the ***Final Soil Sorting Pilot Study Test Report Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation***.

This test report is being added to the project RAWP project documents

4. DOCUMENT CHANGE INSTRUCTIONS

1. Insert the attached “List of Project Documents” in the front of the project document binder.

2. Place the tabbed dividers and Soil Sorting Pilot Study Test Report in the binder located after the Final Status Survey Plan for the FUSRAP Areas at the Iowa Army Ammunition Plant.

3. Place this DCN behind the new List of Project Documents.

FINAL

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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FINAL

REMEDIAL DESIGN/REMEDIAL ACTION WORK PLAN IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

Prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:

North Wind Services, LLC
Under Contract No. W912P9-12-D-0510

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirement
APP	Accident Prevention Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
cm^2	square centimeters
cpm	counts per minute
DCGL	derived concentration guideline level
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DQO	data quality objective
dpm	disintegrations per minute
DU	depleted uranium
EMC	elevated measurement comparison
EPA	Environmental Protection Agency
FFA	Federal Facilities Agreement
FS	Firing Site
FSA	Firing Sites Area
FSP	Field Sampling Plan
FSS	Final Status Survey
FSSP	Final Status Survey Plan
ft	feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPS	global positioning system
HEPA	high-efficiency particulate air
HVAC	heating, ventilation, and air conditioning
IAAAP	Iowa Army Ammunition Plant
in.	inch
m	meter
m^2	square meters

m^3	cubic meters
mg/Kg	milligram per kilogram
MARSSIM	Multi-Agency Radiation Site Survey and Investigation Manual
mrem/yr	millirem per year
NCP	National Contingency Plan
NNSS	Nevada Nuclear Security Site
NRC	Nuclear Regulatory Commission
O&M	operations and maintenance
OSHA	Occupational Safety and Health Act
OU	operable unit
pCi/g	pico Curies per gram
PPE	personal protective equipment
PRG	preliminary remediation goal
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	Remedial Action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RG	remediation goal
RI	remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SGS	Segmented Gate System
SSHP	Site Safety and Health Plan
TSDF	treatment, storage, and/or disposal facility
USACE	United States Army Corps of Engineers
WAC	waste acceptance criteria
WMP	Waste Management Plan
WTS-SOP	Water Treatment System – Standard Operating Procedure
yd^2	square yards
yd^3	cubic yards

Remedial Design/Remedial Action Work Plan
Iowa Army Ammunition Plant Operable Unit 8,
Depleted Uranium Contaminated Soil and Structure Remediation
Middleton, Iowa

1. INTRODUCTION

This Remedial Design/Remedial Action (RD/RA) Work Plan has been prepared in accordance with the Iowa Army Ammunition Plant (IAAAP) Federal Facilities Agreement (FFA; EPA, 2006a) by the United States Army Corps of Engineers (USACE), St. Louis District Formerly Utilized Sites Remedial Action Program (FUSRAP) Project Office. This Work Plan describes an RA that addresses depleted uranium (DU) contaminated soil and structures resulting from U.S. Atomic Energy Commission (AEC) operations previously conducted at IAAAP (Figure 1-1) in Middletown, Iowa. This RA is the final remedy for the FUSRAP areas of IAAAP, designated as Operable Unit (OU)-8 (Figure 1-2). This Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RA will proceed in accordance with the signed OU-8 Record of Decision (ROD; USACE, 2011a) that presents the selected remedy for remediation of soil and structures in designated areas at IAAAP. The specific areas at IAAAP where the selected remedy applies include Line 1 structures; the Firing Sites Area (FSA); Yards C, G, and L; and Warehouse 3-01.

1.1 Remedial Action Summary

The selected remedy was chosen in accordance with CERCLA (42 USC § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] §300.430(a)(1)(iii)(A)). This decision is based on the Administrative Record file located at the Burlington, Iowa Public Library and at the USACE, St. Louis District FUSRAP Project Office.

No principal threat wastes, as defined by the NCP, are present at the FUSRAP areas of IAAAP. The principal contaminant of concern for the FUSRAP areas is DU. The selected remedy for DU-contaminated soil is removal by excavation and physical treatment prior to off-site disposal. Additionally, DU will be removed from structures using decontamination and/or component removal and off-site disposal.

The main components of the selected remedy for soil (ROD – Alternative 4) include:

- Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) at Firing Sites 1 and 2 (FS-1, FS-2); Firing Sites 3, 4, and 5 (FS-3, FS-4, FS-5); the Firing Site 6 Area (FS-6); and the Firing Site 12 Area (FS-12). Excavation will not be conducted at Yards C, G, and L or Firing Site 14 (FS-14).

- Physical treatment of DU and DU-contaminated soil excavated from FS-1 and FS-2; FS-3, FS-4, and FS-5; FS-6; and FS-12 via soil sorting.

- Materials exceeding the DU RG will be disposed of at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate.

- Site restoration, including backfilling, grading, and re-vegetation.

- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.

- Five-year reviews for FUSRAP areas where contaminants remain above levels acceptable for unlimited use and unrestricted exposure to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use will be verified during each 5-year review.

The main components of the selected remedy for structures (ROD – Alternative S3) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures.

- Disposal of DU-contaminated materials at a properly permitted off-site facility.

- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.

- Five-year reviews for structures if they exceed levels appropriate for unlimited use and unrestricted exposure to ensure continued protectiveness of human health under industrial land use. Industrial land use will be verified during each 5-year review.

1.2 Summary of the Work Plan

This RD/RA Work Plan outlines a comprehensive process that follows the governing CERCLA and FFA requirements for implementing the selected remedy at OU-8 (Figure 1-3). The Work Plan is the primary guidance document used by the project team to execute the selected remedy. In addition, several supporting documents provide a detailed description of the RA and discuss processes and activities to achieve site closure. These documents include a Field Sampling Plan (FSP; USACE, 2013a), a Quality Assurance Project Plan (QAPP; USACE, 2013b), a Waste Management Plan (WMP; USACE, 2013c), an Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP; USACE, 2013d), and a Final Status Survey Plan (FSSP) for the FUSRAP Areas at IAAAP (USACE, 2013e). The relationship of the RD/RA Work Plan and these supporting documents is shown in Figure 1-4.

This Work Plan includes a discussion of the basis, build-up, and overview of the proposed RD for the selected remedy. The associated RD drawings are presented in Appendix A. The supporting documentation provides technical methods, procedures, and protocols for implementing the requirements defined in the Work Plan.

This Work Plan is comprised of the following additional sections.

- <u>Section 2, Remedial Action Objectives</u>. Remedial action objectives (RAOs) and RGs, as defined in the 2011 ROD (USACE, 2011a), to specify expected remedy performance during remedy execution, operations, and closeout. These RAOs and RGs provide the foundation for the approach used in designing and implementing the selected remedy.

- <u>Section 3, Statutory Determinations and Applicable or Relevant and Appropriate Requirements</u>. Under CERCLA, Section 121(b), and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (ARARs), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

- Section 4, Remedial Design. This section describes the remedial activities and processes to be implemented in conjunction with the RD presented in this Work Plan. The RD includes a discussion of the conceptual site model, technical and functional requirements, alternative evaluation, and a description of the design.

  - Conceptual Site Model. This section includes information derived from the Remedial and Supplemental Investigations (USACE, 2008; 2011b) used to summarize the known nature and extent of contamination for each of the areas being addressed under this RA. This is a brief discussion of the nature of the problem for each OU-08 site addressed by the selected remedy.

  - Technical and Functional Requirements. This section includes a description of the problem statement and technical basis necessary to develop the technical and functional requirements for the selected remedy. These requirements identify the compliance and performance requirements guiding the design of the selected remedy, and establish the monitoring parameters that are necessary to evaluate that the RA is or will achieve the RAOs. The technical and functional requirements document for this project (USACE, 2013f) is included as Appendix B.

  - Alternatives Evaluation. This section includes a description of the technology reviews and evaluation used for the selection process of the proposed soil processing system.

  - Remedial Design. This section includes a description of the design preparation process, design overview, a brief description of the proposed process systems, and descriptions and capabilities of support structures, appurtenance, and ancillary equipment.

Section 5, Remedial Action Description. This section presents a description and discussion detailing all activities associated with the execution of the RA. These activities begin with the approval of this Work Plan and conclude with acceptance of the RA Completion Report. This section includes a discussion of field planning and procurement activities, a discussion of the RA at each area and site of OU-8, and provides a road map integrating the supporting documents during the execution of this work.

  - Field Planning and Procurement. This work element includes the work to be performed immediately following approval of the Work Plan by USACE and regulatory agencies. This will include planning and preparation for field activities, including application and attainment of necessary permits; procurement activities for services, subcontractors, and materials; submittal of cut sheets, vendor information, and other pre-construction submittal requirements; and finalization of work execution plans and schedules.

  - Remedial Action Construction/Implementation. This work element begins with mobilization and includes site preparation activities, a pilot test, full-scale RA field work, and concludes with de-mobilization activities. The discussion identifies and defines activities, processes, hold-points, and the inspection, performance, and compliance requirements necessary to ensure that the RA meets the safety, quality, and regulatory requirements specified in this Work Plan and that are necessary to achieve the RAOs and RGs.

- Section 6, Performance and Compliance Monitoring. This section provides an overview of the performance and compliance monitoring strategy for this action. The overall monitoring strategy for the project is described and discussed in terms of the data objective to be attained, including clean-up performance, process verification, process compliance monitoring, waste acceptance, and site closure. The project FSP provides specific details on sample and data management requirements and field execution methods and procedures, respectively. The QAPP provides the field team instructions and implementation details for quality assurance/quality control (QA/QC) measures associated with the execution of this work.

- Section 7, Waste Management. The WMP section summarizes the waste management strategy for this RA. This includes identification of the anticipated waste streams and the basis for identifying and choosing an appropriate waste disposal facility for a given waste stream. This section of the Work Plan identifies the regulatory statutes and requirements that this action will follow for handling these waste streams. The project WMP provides specific instructions for managing, handling, transporting, and disposing waste generated as part of this action.

- Section 8, Accident Prevention. This section presents the APP/SSHP governing this RA. The APP/SSHP provides specific details on the site safety and health requirements, including personal protective equipment (PPE), personal and area monitoring, hazard mitigation measures, and emergency response procedures.

- Section 9, Remedial Action Cost and Schedule. This section discusses the RA cost estimate, implementation schedule, and identifies regulatory deliverables associated with this RA.

- Section 10, References. This section includes citations for documents referenced in this Work Plan.

The post-ROD RA process and associated documents needed to implement the RA and to demonstrate RA completion, as well as post-RA reviews, are illustrated on Figure 1-3.

2. REMEDIAL ACTION OBJECTIVES

RAOs and RGs are defined in the ROD (USACE, 2011a) to specify expected remedy performance during remedy execution, operations, and closeout. RAOs are specific goals for protection of human health and the environment that were developed to guide the identification of ARARs, and the development of RGs. RGs for soil and structural surface concentrations were developed that, if met, would not result in adverse human health and environmental impacts under the exposure scenarios evaluated in the Baseline Risk Assessment.

2.1 Remedial Action Objectives Defined in the 2011 Record of Decision

The following RAOs were developed based on the current and expected future industrial/military land use of IAAAP, in conjunction with human health dose and risk estimated for the IAAAP site worker and construction worker at the FUSRAP areas:

- Prevent ingestion, dust inhalation, and external gamma radiation exposures to isotopes of DU in the FSA soil that could otherwise result in cumulative carcinogenic risks exceeding 1.0E-04 and radiological doses exceeding 25 millirem per year (mrem/yr) for receptors under the current (industrial) and expected future industrial land use scenarios.

- Prevent radiation exposure from DU particles embedded in and/or adhered to structural surfaces or components of the Line 1 buildings that could otherwise result in cumulative carcinogenic risks exceeding 1.0E-04 and total effective does equivalent exceeding 25 mrem/yr.

2.2 Remediation Goals

RGs, also known as derived concentration guideline levels (DCGLs) (EPA, 2000a), were developed for protection of human health. These criteria are based upon potential industrial site worker exposures to residual DU in soil at the FSA and on the surfaces of FUSRAP structures at FS-12 and at Line 1 upon completion of RAs. Radiation dose and excess carcinogenic risk to site workers and construction workers were considered. The soil RG and structure RG are both based on 1E-4 excess carcinogenic risk to site workers.

- The soil RG is 150 pico Curies (pCi) of U-238 activity per gram of soil, and

- The RG for structures is 23,000 disintegrations per minute (dpm) gross alpha and beta activity per 100 square centimeters (cm^2) of surface area.

USACE will utilize the Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM), a consensus document collaboratively developed by the Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC) to demonstrate compliance with the stated DCGLs (EPA, 2000a). MARSSIM defines two potential DCGLs based on the area of contamination:

1. If the residual radioactivity is evenly distributed over a large area, MARSSIM looks at the average activity over the entire area being evaluated. The DCGL is derived based on an average concentration over a large area.

2. If the residual radioactivity appears as small areas of elevated activity within a larger area, typically smaller than the area between measurement locations, MARSSIM considers the result of individual measurements. The DCGL used for the elevated measurement comparison (EMC) is derived separately for these small areas (EPA, 2000a).

The RA addressing residual FUSRAP-related DU at IAAAP will remove contamination such that residual radioactivity in soils and on the surfaces of structures is compliant with each of the stated DCGLs.

It should be noted that chemical toxicity was not the basis for the development of DU soil RGs. This is primarily because most of the DU present in soil exists as fragments that are not readily bioavailable for human exposures via the usual chemical exposure pathways (i.e., ingestion, dermal contact, and inhalation of particulates or volatilized contaminants). Additionally, the radiologically risk-based soil RG is more stringent than any RG that would be derived based on the chemical toxicity of DU. To demonstrate this, the RG of 150 pCi/g from the FS Report (USACE, 2011b) was converted to an equivalent mass concentration in accordance with EPA's, Soil Screening Guidance for Radionuclides: Technical Background Document, Appendix B (EPA, 2000b). When calculated, the mass equivalent of the radiologically risk-based RG is 447 milligrams per kilogram (mg/Kg). In contrast, EPA's preliminary remediation goal (PRG), which is protective of noncarcinogenic effects resulting from industrial worker exposures to the chemical form of uranium (i.e., via soil ingestion, dermal contact, and dust inhalation), is 3,100 mg/Kg. EPA's industrial worker PRG is derived using similar exposure assumptions as those used for the IAAAP site worker scenario, and is derived based on a target hazard index of 1.0. In summary, the mass equivalent to the radiological PRG derived in the IAAAP FS Report is approximately seven times more health-conservative than EPA's PRG for the chemical form of uranium. The associated calculations are shown in Appendix D, Response to EPA Comment #4.

3. STATUTORY DETERMINATIONS AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Under CERCLA, Section 121(b), and the NCP, the lead agency must select remedies that are protective of human health and the environment, comply with ARARs, are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatments that permanently and significantly reduce the volume, toxicity, or mobility of hazardous waste as a principal element and a bias against offsite disposal of untreated wastes. Section 2.12 of the ROD (USACE, 2011a) discusses how the selected remedy meets these statutory requirements. The following sections provide an overview of this discussion.

3.1 Protection of Human Health and the Environment

The selected remedy will protect human health and the environment through excavation of DU-contaminated soil and decontamination/removal of DU-contaminated structures. Soils and structural materials that do not meet the RGs will be placed in a properly permitted off-site disposal facility that will provide protective management and appropriate monitoring of the potential release of any contaminants. Short-term risk to the community and workers conducting excavation, transportation, and disposal activities will be managed using appropriate personal protection and safety measures. Continued industrial land use will assure continued protectiveness by preventing inappropriate use of the site, and will be verified through the 5-year review process.

3.2 Compliance with ARARs

Implementation of the selected remedy will comply with the substantive portion of all specific ARARs. Table 3-1 summarizes the ARARs identified in the ROD that are applicable to the selected remedy. Under the selected remedy, DU-contaminated soil and structures will be remediated to the specified RGs listed in the ARARs. The RGs are fully protective of human health and the environment and achieve residual conditions consistent with industrial use. Industrial use is supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.

3.3 Five-Year Review Requirements

The NCP (40 CFR Section 300.430(f)(4)(ii)) states that if the selected remedy "results in hazardous substances, pollutants, or contamination remaining on-site above levels that allow for unlimited use and unrestricted exposure," then a 5-year review of the remedy is required. USACE will be responsible for reviews at the FUSRAP areas until transfer to DOE. As stated in the FFA (EPA, 2006a), USACE and DOE will review the RA "no less often than every 5 years after initiation of such RA to ensure that human health and the environment are being protected." The 2006 FFA requires that USACE perform any reviews that take place prior to and up to 2 years after USACE approval of the RA Completion Report. DOE will perform any 5-year reviews thereafter.

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4. REMEDIAL DESIGN

This section discusses the basis for and key aspects of the RD. The RD package is provided in Appendix A and consists of the design drawings that describe the proposed approach and components needed for completion of the RA.

This section includes the conceptual site model, overviews the technical and functional requirements that provide the basis for the RA design, describes the alternatives considered for soil sorting and processing, and describes the approach selected for design and implementation.

4.1 Conceptual Site Model

Remedial actions for OU-8 will be conducted to remediate DU-contaminated soil and miscellaneous structures at four firing sites, and to decontaminate or replace DU-contaminated components located in two structures within the Line 1 portion of IAAAP (Table 4-1). The general location of these areas is shown in Figure 1-2 and is labeled as the FSA and Line 1. This section provides a conceptual site model for each of the areas that are addressed in the RA. Information provided in this section was derived from the OU-8 Feasibility Study (USACE, 2011b).

The soil remediation areas are shown in Figure 4-1.

4.1.1 Firing Site 12 – Soil

FS-12 covers the areas affected by activities completed at FS-9, FS-10, FS-11, and FS-12. Remediating DU-contaminated soil at FS-12 is the major portion of the OU-8 RA. FS-12 consists of a cleared area where grasses, shrubs, and isolated small trees are present, along with a surrounding densely forested area (Figure 4-2). An area with a radius of approximately 175 meters (m) (574 feet [ft]) was surveyed using a hand-held gamma radiation detector to locate the presence of DU-contaminated soil. Elevated gamma count rates indicate that DU-contaminated soil is present with significant quantities of detectable DU at concentrations greater than 1.5 times the naturally occurring background concentrations. Naturally occurring background gamma radioactivity levels in this area are typically in the range of 10,000 to 12,000 counts per minute (cpm). Site survey maps (Figures 4-2, 4-3, and 4-4) show the extent of DU radiological measurements, including points where the initial walkover site survey data indicated gamma radiation measurements exceeding 16,000 cpm, 50,000 cpm, and 100,000 cpm, respectively, and show 100-m (328-ft) and 175-m (574-ft) radius circles in relation to the FS-12 discharge location.

In addition to the DU-contaminated soil, a drum of DU fragments collected during site investigations at FS-12 and other firing sites is currently stored adjacent to the former control building at FS-12 for disposal as part of the RA.

The gamma walkover survey data support the following conclusions:

1. There is a highly contaminated area (i.e., an area with a high frequency of points with an elevated count rate) inside the existing tree line, with the highest concentration in a roughly triangular area that extends from slightly north of the firing location through the southeast and southwest quadrants.

2. Elevated count rate points extend into the forested area, nominally 100 m (328 ft) to 175 m (574 ft) from the firing location. Elevated count rate points are present in all directions, with a greater frequency in the southern quadrant. However, there is a lower density of points in the northwest section which may be a result of incomplete survey coverage due to limited access caused by dense vegetation.

4.1.2 Firing Sites 1 and 2 – Soil

In June 2011, a small soil area at the former location of soil sample IAAP96848 was investigated by USACE to support a driveway expansion project at the FS-1 and FS-2 area. The investigation found that the small area exhibited gamma count rates that were approximately double the count rate of the immediately surrounding area. The elevated location included count rates greater than 16,000 cpm, with some of the count rates measuring around 25,000 cpm. A small volume of soil less than 0.8 cubic meters (m^3) (1 cubic yard [yd^3]) was removed and placed in a drum at FS-12 to be disposed during the RA at FS-12. After removal of the soil, a gamma walkover survey of the excavated surface indicated that gamma count rates were approximately the same as those of the surrounding area. A biased sample (IAAP137384) was also collected from the excavation surface after the RA occurred, and associated uranium results from this sample were well below the RG of 150 pCi/g.

In addition, 40 new soil samples were obtained at 20 systematic sampling locations spread across the FS-1 and FS-2 area. Two samples were collected from each location, one near the surface at 0 to 15 centimeters (cm) (0 to 6 inches [in.]) and another between 15 and 60 cm (6 to 24 in.) below the ground surface. Samples from 10 of the sampling locations were collected near the location of the elevated concentration area in accordance with a Class 1 MARSSIM survey. The remaining 10 sampling locations were collected over the remaining FS-1 and FS-2 area in accordance with a Class 2 MARSSIM survey. The sample locations are shown in Figure 4-5. None of the additional soil samples at the FS-1 and FS-2 area yielded results exceeding the RG. Therefore, no additional remediation is planned for the FS-1 and FS-2 area.

The results of the walkover survey and soil sampling from the systematic locations will be presented in the OU-8 RA Closure Report at the completion of the OU-8 RA.

4.1.3 Firing Sites 3, 4, and 5 – Soil

One location of an elevated gamma count rate was identified immediately adjacent to the loading dock at FS-5 (Figure 4-6). The elevated gamma count rates measured during the gamma walkover survey ranged from greater than 16,000 cpm to approximately 185,000 cpm. This elevated gamma count rate was attributed in the IAAAP Remedial Investigation (RI; USACE, 2008) to “an apparent DU object, approximately 10 to 13 cm (4 to 5 in.) in diameter, approximately 7 to 10 cm (3 to 4 in.) below the ground surface.” Oxidized uranium leached from the object into the underlying soil; however, the area affected by the DU object is limited to approximately 2 square meters (m^2) (2.4 square yards [yd^2]). The DU object and contaminated soil were left in place. Soil samples were analyzed for metals and explosives but none were present above screening levels.

Contamination at FS-3, FS-4, and FS-5 is limited to a 2-m^2 (2.4 yd^2) area contaminated with DU.

4.1.4 Firing Site 6 Area – Soil

One location with an elevated gamma count rate was identified (approximately 150,000 cpm) near the northeast corner of the intersection of the main firing sites roadway and the access road that connects FS-6 with FS-12 (Figure 4-7). An isolated DU fragment was identified and was covered with approximately 7 cm (3 in.) of soil. The DU fragment was later removed. Soil beneath the DU fragment was discolored by yellow uranium oxidation products and had elevated radiological counts. One soil sample had uranium activity that exceeded the RG. Eight of 36 soil samples exceeded screening levels for explosives (2,4,6 trinitrotoluene and Royal Demolition Explosive), and nine of 29 samples exceeded screening levels for metals (aluminum and chromium). Explosives contaminated soil is limited to the area in and around the concrete structure and road junction, which is in the same area where the DU fragment was located. Although the DU fragment was removed, the associated DU-contaminated soil was not removed.

A second area of DU-contaminated soil was identified during a previous investigation of the FS-6 area that took place in the year 2000. That area was further investigated during the 2006–2007 RI field activities; however, the area with the elevated gamma count rate associated with that contaminated soil could not be identified. Based on the inability to relocate that area, no RA will be taken in regard to the previous detection.

Contamination at FS-6 is limited to one area (assumed to be 1 m^2 [1.2 yd^2]) that is contaminated with oxidized uranium leached from the DU fragment that was previously removed. The DU-contaminated soil may also be contaminated with explosives. Although soil at other locations in the FS-6 area may have concentrations of explosives or metals above screening levels, remediating soil that is not DU contaminated is not in the scope of this RA.

4.1.5 Firing Site 12 – Structures

Two structures at FS-12 are addressed in the RA: a bunker located adjacent to FS-9 and the FS-12 Control Building.

Material described in the RI as “sludge” in the basement of the bunker had uranium activity of approximately 427 pCi/g, which exceeds the soil RG (150 pCi/g). The areal extent and thickness of this material is unknown. Although the material is described as sludge, it is assumed to be soil that was washed into the basement.

Based on RI data, no interior surfaces of the bunker exceed the structure surface RG (23,000 dpm/100 cm^2). However, the surfaces covered by sludge could not be surveyed during previous investigations.

The FS-12 Control Building contains furnishings (e.g., furniture and equipment) that have not been surveyed.

4.1.6 Line 1 – Building 1-63-6

The buildings identified for the Line 1 portion of IAAAP are shown in Figure 4-8. An as-built drawing shows the generic floor plan and section for the six 1-63 buildings (Figure 4-9). The drawing is the mirror image of the floor plan of Building 1-63-6.

Survey data for total alpha and beta radiation collected during a supplemental investigation (USACE, 2011b, Appendix A) indicate that an air filter has radiation levels up to 25,566 dpm/100 cm^2, which exceed the structure RG of 23,000 dpm/100 cm^2 (Figure 4-10). Other radiation levels measured in the vicinity of the air filter were elevated (approximately 12,000 to 19,000 dpm/100 cm^2) but were below the RG. Figure 4-11 is a photograph of the air filter and vicinity. No other surveyed surfaces in this building were close to the RG. Contamination in Building 1-63-6 is limited to the air filter and potentially the nearby portion of the heating, ventilation, and air conditioning (HVAC) system.

4.1.7 Line 1 – Building 1-11

An as-built drawing (Figure 4-12) shows the floor plan of the western portion of Building 1-11. Survey data for total alpha and beta radiation collected during a supplemental investigation (USACE, 2011b, Appendix A) indicate that a section of an 3.4-m × 18.3-m (11-ft x 60-ft) floor grate covering the production pit has radiation levels up to 76,037 dpm/100 cm^2, which is approximately three times the RG. Radiation levels at three locations exceed the RG, while radiation levels at other locations on the grate and at the floor near the grate were elevated (up to approximately 18,000 dpm/100 cm^2) but were below the RG. Survey readings elsewhere in the building were well below the RG. Figure 4-13 shows 2007 radiological survey locations, and Figure 4-14 shows the portions of the grate that had elevated gamma count rates measured in 2009. Data for both surveys are presented in the Feasibility Study Report (USACE, 2011b). Contamination in Building 1-11 is limited to a section of the floor grate and potentially nearby portions of the floor grate and floor. Figure 4-15 is a photograph that shows the grate over the production pit and stairways at each end of the pit.

4.2 Technical and Functional Requirements

This section provides a summary of the primary remediation requirements, as specified in the ROD (USACE, 2011a). Other applicable requirements that address site development, facility operations, applicable codes and standards, and industrial standard engineering practices are identified in the project technical and functional requirements document (USACE, 2013f).

4.2.1 Record of Decision ARARS

Table 3-1 of this Work Plan lists the ARARs and associated implementation determinations identified in the ROD. The RD documents will address these requirements and ensure compliance is incorporated into the project work activities. The ARARs are summarized as follows:

- NRC criteria for license termination at 10 CFR 20.1403(b) and (c) provide the basis for site-specific RGs. The industrial use scenario RG for soil is 150 pCi/g, and the RG for structure surfaces is 23,000 dpm/100 cm^2.

- The Endangered Species Act at 16 USC § 1538 (a)(1) prohibits taking of an endangered species. The Indiana bat is an endangered species that may be found as a transient species within the FUSRAP areas of IAAAP. Therefore, RA activities must be executed in ways that avoid or minimize adverse effects on this species. These measures consist primarily of not felling trees larger than 6 in. (15 cm) in diameter during the frost-free season unless a particular tree has been inspected by a biologist to confirm that it does not have characteristics favored by the Indiana bat as a maternal roosting site.

- The Radiation Protection Program at 10 CFR 20, Subpart B, impose constraints on air emissions of radioactive material, which apply to generating dust while excavating or handling DU-contaminated soil or sediment.

4.2.2 Firing Site Area Soils Remediation

For planning purposes, the estimated volumes of soil exceeding the RG are presented in Table 4-2. For locations where isolated DU-contaminated soil was found, soil volumes requiring excavation were estimated to be 0.8 m^3 (1 yd^3) at each of the firing site groupings.

The total soil volume estimated for the FS-12 area consists of 100% of the soil to a depth of 30 cm (1 ft) and 25% of the soil between 30 and 60 cm (1 and 2 ft) within a 100-m (328-ft) radius of the testing pad at Ground Zero. For distances greater than 100 m (328 ft) from the testing pad (up to a 175-m [574-ft] radius), the total volume includes an estimate of 5% of the soil to a depth of 30 cm (1 ft). It is possible that more DU-contaminated soil will be discovered farther than 175 m (574 ft) from the FS-12 Control Building, and therefore that additional soil may be excavated. However, it is expected that this additional soil volume will be much smaller than the estimated volume within 175 m (574 ft) of Ground Zero.

For planning purposes, and as outlined in the Feasibility Study (USACE, 2011b), an ex-situ expansion factor of 30% is assumed for the excavated materials. Applying this expansion factor, it is estimated that a total of 16,838 m^3 (22,023 yd^3) of soil will be processed during the RA. It may be possible to substantially reduce the soil volume that requires off-site disposal as DU-contaminated waste by processing it through an automated radiological monitoring and soil sorting system.

4.2.3 Physical Treatment

Physical treatment is a large component of this RA and for soils; remediation will be accomplished by several methods. Soils contaminated with DU materials identified in the field through walkover surveys, and areas with DU contamination, are staked or otherwise delineated from the non-contaminated soil surrounding it. When large DU fragments or pieces are found, they will be collected, stored, and staged in an appropriate fashion prior to final waste packaging, shipment, and disposal.

An automated soil surveying and sorting system may be utilized to more efficiently sort the soil excavated from the firing sites in efforts to significantly reduce the total quantity of DU-contaminated soils that must be sent off-site for disposal. The system uses radiological monitors and manual separation or automatic conveyor systems to separate the DU-contaminated soil from within the excavated soil. This system would segregate soil into two streams: (1) soil that is above the RG, and (2) soil that is below the RG.

The primary goal for the sorting system is to reduce the amount of soil that must be disposed at an off-site facility. This system may be used if it can be shown that the increased cost of performing the sorting activities is offset by the cost saving achieved in the resulting soil packaging and transportation of contaminated soils.

4.2.4 Other Firing Sites Remediation

At other firing sites, the major requirements are to locate previously-identified DU-contaminated soil and excavate DU-contaminated soil that exceeds the RG. Contaminated soil excavated from other firing sites will be taken to FS-12 and processed, packaged, and disposed of with FS-12 soils.

4.2.5 Firing Site 12 Structures Remediation

At the FS-12 bunker, DU-contaminated sediment will be removed from the basement and exposed surfaces will be surveyed and decontaminated, if necessary, so that the surfaces of the structure meet the structural RG.

At the Firing Site Control Building, furnishings (e.g., furniture and equipment) will be surveyed to determine radiation levels at the surface and will be disposed or released based on those levels.

4.2.6 Line 1 Building Structural Components

Building 1-63-6 air filter remediation consists of the following:

- Replace the HVAC system air filter that exceeds the structural RG, survey the adjacent vicinity of the ductwork, and decontaminate, as necessary, to meet the structures RG; and
- Package and transport contaminated debris to an off-site facility for disposal.

Building 1-11 floor grate remediation consists of the following:

- Decontaminate or replace sections of a floor grate that exceed the structural RG, survey the adjacent area, and decontaminate, as necessary, to meet the structural RG; and
- Package and transport contaminated debris to an off-site facility for disposal.

4.2.7 Water Management

During project execution, components will be put in place to capture potentially contaminated stormwater runoff from the general excavation area. Any contained water will be evaluated, sampled, and/or treated, as necessary, in accordance with the USACE IAAP Water Treatment System - Standard Operating Procedure (WTS-SOP), Current Version.

Consistent with the EPA Storm Water Pollution Prevention Plan guidance, a 2-year, 24-hour design storm will be used to calculate the required storage volumes. Adequate capacity to retain this volume of storm water will be available onsite.

4.2.8 Performance and Confirmation Monitoring

Performance surveys will be conducted during remediation to guide remedial activities and to provide a basis for ceasing remedial activities. Post-remediation surveys will be conducted to confirm that RGs for soil and structures have been attained. These survey and monitoring activities are described in more detail below:

- Walkover surveys will be conducted in the forested area, after removing underbrush to improve access, to identify DU-contaminated soil. This will be conducted in the annular ring between 100 m (328 ft) and 175 m (574 ft) from the site center. This survey will be used to identify areas that require remediation. The requirements are to (a) identify DU-contaminated soil that exceeds the RG; and (b) document the location of those fragments/contaminated soil using a global positioning system (GPS).

- Performance monitoring during soil excavation will be performed using hand-held survey instruments. Survey instruments used to guide soil remediation must be able to identify soil that contains DU above the soil RG. The screening criteria will be determined during initial field activities at the site (in accordance with the FSP) and are illustrated in Appendix A of the FSP.

- The final evaluation of attaining the soil RG (i.e., a confirmatory survey) where contaminated soil was remediated using bulk excavation at FS-12 will be conducted in accordance with the FSSP (USACE, 2013e), which is attached as part of this RD/RA package.

- Performance monitoring during structures remediation can be conducted using a hand-held gamma survey instrument. Instruments that measure alpha/beta/gamma radiation on surfaces will be used to confirm that surfaces meet the structures RG.

- The final evaluation of attaining the structural RG (i.e., a confirmatory survey) will be conducted in accordance with FSSP.

4.3 Process Design Alternatives

The selected remedy in the ROD (USACE, 2011a) included the removal of DU-contaminated soil by excavation, treatment using physical treatment technologies (e.g., soil sorting and radiological scanning), and off-site disposal.

The implementation of this remedy may include the performance of an on-site pilot-scale demonstration of physical treatment technology (e.g., a radiological soil sorting system) prior to initiation of full-scale remediation. A pilot test, if implemented, would be used to determine the cost effectiveness of implementing a soil sorting process and to better refine the design and operation parameters of the soil remediation process. Other areas that could be further evaluated in a pilot-scale demonstration may include waste stream identification and characterization and further evaluation of localized excavation methods to be used in the dense brush and tree areas.

Separation techniques reviewed during this evaluation included DU fragment separation and DU-contaminated soil sorting methods using radiological surveying and physical sorting approaches for the DU-contaminated soil. As addressed in the ROD, many techniques evaluated in the Feasibility Study (USACE, 2011b) were dismissed as possible remediation methods that could be used for the IAAAP site remediation due to the generation of secondary waste streams.

The separation techniques evaluated for this project included particle size or sieve screening, gravimetric separation, and radiological monitoring and segregation in which soil is separated based on radiation levels.

4.3.1 DU Fragment Separation

During the design alternatives evaluation, two methods of separating DU fragments from the soil media were considered: (1) density classification and (2) screening/size separation. These are described briefly in the following sections.

4.3.1.1 Density Classification

The density classification method evaluated is an air entrainment process that creates a fluidized bed that allows the heavier, or denser, materials to settle to the bottom layer of materials as it flows over an oscillating conveyor deck. These systems are typically recommended and used for applications requiring only a two-part separation into light and heavy fractions, where the latter is a minor constituent in a closely sized dry granular mixture, and the density difference between the two components is approximately 1.5:1 or more. Under these conditions, the separator exhibits very high separation efficiencies at high rates of throughput. DU particles are approximately seven times as dense as typical soil forming minerals, and therefore density-based separation could be very effective if soil properties are favorable. Standard equipment includes an integrally mounted exhaust hood that encloses the chamber for dust control, V-belt drive and guard, and independent air intake filter housing with easy-to-clean filter housings. The air stream and associated filter housing may be a potential secondary waste stream generated from the process.

Test separations are the only practical means for predicting separator performance. Where this method would most likely be able to separate measurable DU fragments from the soils as compared to typical screening techniques, it is unclear how the small DU particles could be separated because of their ability to stick to the clay soils without impacting the material density. It is unlikely that a consistent radiological concentration separation could be effectively performed using this method.

4.3.1.2 Screening/Size Separation

Standard particle size based screening techniques can easily be employed to separate DU particles from the soil media. This type of system uses conveyors, screens, and vibration equipment to separate materials by size using standard sieves and screens. This process is routinely used and readily available in the sand and gravel mining and rock quarrying industries.

This process can be very effective in separating the majority of the DU fragments from the soil if there is a significant difference between the size of the DU fragments and the soil materials. This process is primarily dependent on the soil properties, with the two primary characteristics being the size of the DU particles relative to the soil particles and the cohesive properties of the soil. In high clay content materials such as the fine-textured soil at IAAAP, there could be the potential for the soil to form aggregates that are so large that they do not pass through the screening equipment. In that case, physical screening based on particle size would not be effective for separating DU particles from soil particles. By utilizing a rotating screen, the majority of the processed materials are reduced in size by using gravitational impacts to break up large clods or aggregates.

This process can be used as both a stand-alone fragment separation approach and as a pre-processing step to remove large materials prior to additional separation processes.

4.3.2 DU-contaminated Soil Separation

Manual and automated soil separation techniques were identified. Manual separation involves labor intensive methods to locate, remove, and segregate DU-material. Automated separation involves utilization of industrial soil sorting technologies combined with radiological measurement devises. Based on internet searches, past agency reports, and telephone contacts, three companies were identified that currently market soil-sorting systems that utilize radiological measurements as the separation criteria. Eberline Services, Inc. owns and markets the Segmented Gate System (SGS). This system represents the basic system used during the early field demonstrations performed in the late 1990s. This technology was first developed by Thermo NUtech (Oak Ridge, TN) and was later acquired by Eberline. The second vendor is ISO-PACIFIC Nuclear Assay Systems, which owns and markets the S3 Real-Time Segregation System for Depleted Uranium. The third system is owned by AMEC and is identified as the Orion ScanSort system.

4.3.2.1 Soil Survey and Segregation

DU-contaminated soil separation and removal can be achieved via soil survey and segregation techniques in the field. The basic operation involves conducting a walk-over survey and manual removal and segregation. Although labor intensive, this method may be the most effective way of remediating certain areas at OU-8.

4.3.2.2 Eberline Services Segmented Gate System

The SGS is an automated characterization and sorting technology that measures the radioactivity of soil as it passes over a conveyor belt and automatically separates the soil fraction that exceeds the established cleanup standards. This system has been used for many years to process over 171,300 m^3 (224,000 yd^3) of contaminated soil at a number of different locations across the country. The system is typically coupled with a screen plant, or other sorting technology, that is used to control the size of materials that are processed through the sorting conveyor. A screed controls the thickness of the soil layer deposited on the conveyor approximately 5 cm (2 in.) thick. The detector array is housed in a shielded box, whose height above the conveyor can be adjusted for varying soil layer thicknesses. At the end of the conveyor is a holding area for soil that has passed underneath the detector array until a sorting decision is made.

This system has not been used for many years. As a result, this system would require the time and cost needed to refurbish the system and ensure that it is in proper operating condition. In addition, it is highly unlikely that it could be available for use in the timeframe designated for this project.

4.3.2.3 ISO-PACIFIC S3

The ISO-PACIFIC S3 is a slow-moving conveyor belt equipped with laboratory-grade detection capability, coupled to precise, well-controlled, and automated particle diversion mechanisms. Contaminated soil is excavated and fed into the S3. The soil is deposited on a conveyor belt using an adjustable screed to control the thickness and width of the soil layer. Soil is then conveyed below the detector array in a thin layer whose depth and density is matched to the photon emission and attenuation characteristics of the contaminant of concern. The soil is conveyed at a preselected speed underneath the detector array, ranging from 2 cm (1 in.) to 7 cm (3 in.) thick. The array is linked to the control computer, which toggles electrically operated diversion chutes located at the end of the sorting conveyor. DU particles are diverted to the contaminated material conveyor, and this belt subsequently discharges the particles to a container or stockpile for further processing or final disposition. The soil below the RG falls directly onto the ‘clean’ conveyor, which transports it to a stacking conveyor.

For DU detection, the S3 uses an array of 11 collimated Alpha Spectra 12.7-cm (5-in.) diameter field instrument scintillation detectors (for detection of low energy radiation sodium iodide) controlled by a Ludlum Model 4612 Single Channel Analyzer.

This system also incorporates a reversible diversion conveyor that can be used to effectively measure and separate materials that are wet and have sticky, high clay content characteristics. With this feature, the probability of being able to meet and/or exceed the separation goals is much higher than with other systems that do not have a similar feature.

This sorting system, which is based on the SGS used in past cleanup activities, has been upgraded and improved to utilize better detectors, automated analytical software, and automatic controls to better address the different types of materials and circumstances that are encountered at remediation sites. The S3 system was completed in late 2010 and has not been deployed to date.

4.3.2.4 AMEC – Orion ScanSort

ScanSort is a conveyor-based system that accurately surveys, monitors, and sorts scanned material into “above criteria” and “below criteria” discharge piles. It is truck transportable and compact and can be operated safely by as few as two trained staff.

Technologies unique to ScanSort include custom scanning spectroscopy detectors, monitoring and reporting software, and a reversing conveyor. Depending upon the type of material and the detection criteria, ScanSort can process and segregate up to 200 tons of soil per hour. This system has been used successfully over the past 2 years for three large cleanup projects. Each project achieves a volume reduction of greater than 95%. ScanSort also produces data of NRC and EPA Final Status Survey (FSS) quality.

The advertised benefits of ScanSort, relative to other conveyor-based systems, are as follows:

- Superior material handling with 100% density calibration;
- Scanning spectroscopy enables higher production rates;
- All-weather scanning and sorting of wet or dry material; and
- Processes soil, crushed stone and concrete, and slurry.

4.3.3 DU Fragment Disposal Options

Options for metallic DU disposition include disposal and recycling; however, based on the origin and makeup of the DU fragments, there were no companies or processes identified that would be willing to pursue any recycling or remanufacturing activities for the IAAAP DU materials. There are a number of disposal options for metallic DU, several are discussed below:

1. <u>Disposal at the Nevada Nuclear Security Site (NNSS).</u> The NNSS can accept low-level radioactive waste from DOE activities and classified waste from DOD activities. NNSS personnel indicated that all DU is assumed to be a result of DOE activities, and hence the waste from IAAAP would qualify

for disposal at NNSS. The waste types from IAAAP that can be disposed at NNSS include soil, debris, and metallic DU.

2. Treatment and disposal by Perma-Fix. Perma-Fix has a certified waste program that will allow it to dispose waste at NNSS, as well as other facilities. The waste materials are treated and processed as needed with the final disposal location being selected based on the most economical disposal location.

3. Disposal at the Energy Solutions Clive, UT facility. The Metallic DU can be treated by combining with other debris, which may allow the disposal of the DU fragments at the Clive, UT facility.

4.3.4 Alternatives Evaluation

Table 4-3 provides a general summary addressing each of the process alternatives.

The base case alternative will be excavation and disposal of all excavated soil without any removal of DU particles or sorting to reduce the volume of material disposed. However, the radiological soil surveying and segregation approach may be considerably cheaper than the base case alternative if the cost savings due to reducing the amount of material disposed are greater than the cost of soil sorting.

In the projects recently completed by AMEC, the project break-even point occurred when between 3,820 and 7,640 m^3 (5,000 and 10,000 yd^3) of soil were processed. In these cases, the project was achieving greater than 95% volume reduction in the processed soils. If this is the case and a similar soil volume reduction can be achieved at IAAAP, then the IAAAP RA project can likely achieve significant project cost reduction relative to the baseline alternative. If the achievable volume reduction is only in the 20 to 50% range, the break-even point may not be achieved. The actual soil sorting efficiencies should be further analyzed during field pilot tests in order to provide a basis for evaluating the cost-benefit ratio of soil sorting.

If DU fragment separation is performed, there will be additional costs incurred for separate handling, packaging, and disposal operations, along with a higher unit cost for disposal of the DU fragments. Due to the nature of radioactive material, it is assumed that DU separation by itself will not be sufficient to eliminate all the radioactive material from the soil waste stream. Because of the increased cost, there is no benefit to performing DU separation without also sorting soil and reducing the volume of contaminated soil that has to be disposed.

Based on discussions with two soil sorting companies, both indicate that they fully anticipate being able to achieve volume reductions in the 85 to 90% range, and therefore warranting the performance of the pilot tests. These reductions are expected even with the identified clay content and moisture related to the site soil characteristics. In addition to the efficiency evaluation, the pilot test would also be used to calibrate the system to the site-specific radiation levels and to perform confirmation analysis that may be used for the sorting system setup and control. The soil sorting process would also include the appropriate pre-sorting and screening for large objects needed to ensure that the excavated materials can be processed through the sorting equipment.

4.3.5 Material Process Recommendation

Based on this evaluation, it is recommend to pursue the use of a radiological soil monitoring and sorting system. It is highly likely that this process would provide significant savings to the project even when considering the added cost for equipment and the additional cost of a second DU fragment waste stream.

Further cost reviews may be performed after the project design is complete and when competitive prices and more project specific approaches from both ISO-PACIFIC and AMEC are available.

If the pilot test results show that the volume reduction needed to reduce the overall project cost is not achievable, then the project could proceed with the removal action using the excavation and direct disposal alternative.

4.3.6 Pilot Studies

Three additional information needs have been identified that could be addressed during the pilot study:

1. Site-specific soil and fragment characterization,
2. DU and radiological measurements needed to determine separation equipment settings, and
3. Demonstration of excavation and DU removal techniques.

These three items are described further in the following sections.

4.3.6.1 Site-Specific Soil and Fragment Characterization

Additional information is needed to further characterize and identify the actual subsurface extent and dispersion of the DU fragments. The pilot study activities would evaluate the size of the fragments, the radiation levels associated with the fragments, the particle size of soil, and the size of rocks and other debris that are typically contained in the soils at this site. This information could then be used to size any process screening components and help ensure that any resulting waste streams can be disposed within the regulations applicable to the associated facility waste acceptance criteria (WAC).

4.3.6.2 DU and Radiological Measurements Needed to Determine Separation Equipment Settings

In order to support the use of a radiological monitoring and sorting system for soil segregation, key site-specific information is needed to develop the applicable process control setting and controls of the process equipment.

Specifically, the segregation systems base the decision of above- or below-threshold criteria on the average concentration of a standard volume (e.g., 1 m^3, all of which has been analyzed for activity concentration using laboratory-quality analysis to identify key radionuclide activity concentrations). Using the radiological monitoring/sorting system, these decisions would be made based on gross gamma surveys (no nuclide-specific information) and an occasional grab sample for off-site laboratory analysis for verification of proper system operations. To make sure that correct control criteria are used in the field, the set points for the scan surveys may be lowered to levels that will result in confidence levels of less than 5% false positives within the soils determined to be below the RG. During the pilot studies, efforts can be taken to ensure that materials are targeted that represent both the average and maximum DU soil concentrations. By having this data well established, controls can be incorporated to ensure all processed materials designated as being below the RGs conservatively meet the soil RG set in the ROD (USACE, 2011a).

4.3.6.3 Demonstration of Excavation and DU Removal Techniques

The last area of investigation that should be addressed in the pilot studies is related to the excavation methods that may be employed for the fragments and contaminated soil located in the wooded areas. Even though this is not directly related to the separation issues, it is an area where higher efficiencies and lower costs may be achieved by the project if the most efficient removal methods are utilized. These actual methods will be identified in more detail during the development of the pilot study test plan but may include methods such as manual digging, clearing, and grubbing with small equipment and high-efficiency particulate air (HEPA) vacuum excavation.

4.4 Firing Site 12 Soil Remediation Design

The project design components consist of materials and equipment that may be used to process the contaminated soils with the primary components divided into three major areas: (1) soil excavation, (2) soil processing system, and (3) soil packaging and transportation. The proposed equipment and process layout is shown in Appendix A.

The activities and design elements include:

- Vegetation removal to support additional walkover surveys,
- Setup and location of the soil processing areas,
- Connection and utilization of electrical power, and
- Identifying a location for railcar loading (if rail transport is selected during the pre-construction planning and procurement phase).

The general approach to the remediation will be to begin remediation activities at the outer limits of the contamination areas and work toward the center, and/or work the general excavation from the highest elevation to the lowest elevation. This approach will minimize the possibility of contaminated storm water or other materials from re-contaminating or impacting areas already completed. The general flow for contaminated soils and materials will go from excavation, to sorting, to packaging, to transportation, and then to disposal.

4.4.1 Soil Excavation

The project approach for excavation is to identify areas within the project area that have high densities of DU materials. These high-density areas will utilize mass soil excavation techniques where all soils in the specified area will be excavated until the DU soil RG is attained. The design has identified two mass excavation areas: one area with the very high density of DU-contaminated soil and a second area that has a slightly lower measured DU-contamination. In both cases, excavation will be conducted in 13- to 25-cm (5- to 10-in.) “lifts.” Following the removal of a “lift,” a walkover radiological survey will be conducted to determine the effectiveness of DU soil removal during the excavation. If additional DU contaminated soil is identified, then additional excavation will be performed. This approach will be used until radiological survey levels are observed that support the closure of the excavated areas.

Stormwater management controls will be put in place to prevent stormwater runoff from flowing from contaminated areas to cleared areas.

Excavation will be performed using standard soil removal practices utilizing scrapers, front-end loaders, and/or other equipment, as determined during the field activities. Prior to the start of soil removal, the areas may be mowed and tilled to allow as much excavated material (including plant debris) to be processed through the soil sorting equipment without generating a high quantity of large size materials (i.e., sod, roots, and other plant material). It is not intended that equipment will be purchased for the project.

It is anticipated that equipment will be supplied by contractors or will be rented. Examples of excavation equipment that may be required include:

- Tractor and grass shredder,
- Tractor and roto-tiller,
- Brush and small tree shredder,
- Scraper,
- Backhoe, and
- Front-end loader.

The approach to the soil excavation is presented in Drawings C-3 and C-4 of the DU-contaminated soil and structures RD package included in Appendix A.

In addition to the general mass soil removal, there will be a significant effort to identify and remove DU-contaminated soil outside the areas where mass excavation is used. Soil from these areas will be manually excavated, as needed, and then packaged and transported to the soil sorting area for processing. These locations will be primarily identified using the past sodium iodide walkover surveys that were completed during the RI (USACE, 2008) and Feasibility Study (USACE, 2011b). There are, however, areas that will require additional site walkover surveys to determine the extent of contamination and to identify all DU sources in the areas. Drawing C-2 of the design package identifies areas where additional site walkover data are needed. These areas consist of two areas within the original 175-m (574-ft) radius that were not well characterized because of dense or thick underbrush within the area. These areas may be thinned and surveyed prior to completion of the excavation. Three additional areas have been identified for site walkover surveys that are outside the 175-m (574-ft) radius boundary. These areas were selected based on the presence of multiple locations showing high gamma count rate observations at or near the boundary of the previously surveyed area. Otherwise, it is assumed that all other areas outside the 175-m (574-ft) radius have soil that is below the DU RG, and these areas will proceed directly to a FSS.

4.4.2 Soil Radiological Sorting System

The primary intent and purpose of the soil radiological sorting system is to sort and divert the soil with DU contamination greater than 150 pCi/g. This system may include material screening to remove oversize particles, soil sorting based on the level of radioactivity emitted, and material packaging. The system will include a screening method in which all large particles and materials will be removed or broken up to allow material processing through the soil sorting equipment. Soil coming off the sorting equipment will be directly packaged into waste containers or staged for return to the excavated areas as backfill. The general layout and approach to the process system are described in Drawings P-1, P-2, and P-3 of the design package (Appendix A).

4.4.2.1 Size Separation

If the radiological sorting system is used, standard particle size based screening techniques will be incorporated to separate large, miscellaneous items from the soil media. This type of screening can be completed using conveyors, rotary screens, and vibration equipment with size specific standard sieves and screens.

As shown in the design drawings, a rotary screen has been initially selected for this function. This process will separate larger materials from the soils to allow processing of the remaining soils through the automated soil sorting system. The specific size and configuration will be selected to match the process material constraints of the soil sorting equipment. The process system is intended to process as much material through the soil sorting equipment as possible. It is anticipated that the screen would have a throughput capacity of 100 tons per hour or more. This may be achieved using equipment such as the 612W Trommel Screen manufactured by Screen Machine Industry. It is also anticipated that the separated materials could be re-introduced back into the DU-contaminated soil waste stream for packaging and disposal.

4.4.2.2 Soil Sorting Equipment

The soil sorting equipment, if used, will include radiological monitoring of the soil as it moves across sodium iodide detectors. The sorting system will then automatically sort and separate the DU-contaminated soil and materials from soils below the RG based on measured and verified process set points.

Based on discussions with two soil sorting companies, both indicate that they fully anticipate being able to achieve contaminated soil volume reductions in the 85 to 90% range. These reductions are expected to be achievable even with the identified clay content and moisture in the site soil. The use of this equipment may include pre-operational testing, or a pilot test, that would help evaluate the overall separation efficiency and include calibration of the system to the site-specific radiation levels and RGs.

Based on information obtained from multiple vendors, material feed rates may vary but could have process capacities of more than 100 tons per hour. The two primary vendors that have been identified for this work are AMEC (with the Orion Scan Sort system) and ISO-PACIFIC (with the S3 Nuclear Assay System).

4.4.2.3 Contaminated Soil Packaging and Transport

For planning and design purposes, the process system will need equipment to place the resulting contaminated soils into Department of Transportation (DOT)-approved waste containers (i.e., rail cars, intermodal containers, or SuperSacks). The design assumed the use of 15-m^3 (20-yd^3) roll-off containers, although final selection of the waste containers will be made during the pre-construction planning and procurement phase based on logistical considerations, availability, and cost. Using intermodal roll-off boxes, or SuperSacks, simplifies the process by allowing the soil that comes off the sorting equipment to be packaged onsite and not require any additional transfer of packaging before it is sent to the disposal facility. The filled containers will be staged at the firing site until ready to transport to rail cars near the area rail access. Boxes would then be transported using a roll-off truck and loaded onto the rail cars using a portable crane. SuperSacks would be loaded using a fork lift truck.

The waste containers assumed for the design are roll-off containers with a 15-m^3 (20-yd^3) capacity that can be lifted and secured on rail cars. A 40-ton crane will be sufficient for the loading operations.

4.5 Other Firing Sites Design

The other identified firing sites and structures with DU-contaminated soils have been evaluated and include very small quantities of DU-contaminated soils. These specific soils locations will be excavated with the resulting soils taken to the FS-12 areas, where they will be added to the overall soils waste processing stream and be packaged and disposed of along with the FS-12 excavated soils. There are no specific design components included for these other firing sites.

4.6 Line 1 and FS-12 Structures Remediation

The design package includes drawings that depict the location of the contaminants identified within the buildings that exceed the cleanup goals. These specific DU-contaminated locations will be decontaminated or removed and replaced, with the resulting DU-contaminated material taken to the FS-12 areas where it will be packaged and disposed of along with the other DU-contaminated materials. There are no design components associated with the cleanup of these facilities.

5. REMEDIAL ACTION DESCRIPTION

This section of the Work Plan discusses the execution of the RD and the proposed RA following approval of this Work Plan by the regulatory agencies. This is a chronological discussion of all activities that occur following Work Plan approval through the completion and approval of the RA Completion Report. The intent of this section is to provide a road map detailing the activities the remedial contractor will follow to illustrate to the USACE and agencies that this RA is being conducted in a manner that is compliant with the ROD (USACE, 2011a). This section also discusses the process to be followed by the remedial contractor and USACE to illustrate that the RA has met the RGs and RAOs, and can ultimately be deemed complete through the approval of the Remedial Action Completion Report by the agencies.

The discussion in this section of the Work Plan also serves as a road map to several supporting documents, including the QAPP, FSP, APP/SSHP, and WMP.

This section of the Work Plan discusses:

- Pre-construction Planning and Procurement;
- Mobilization and Site Preparation;
- RA Activities at each Firing Site and Line-1 Structure:
  - Excavation,
  - Decontamination or Replacement of Components,
  - Pilot Testing,
  - Waste Processing,
  - FSS and Monitoring,
  - Waste Transportation and Disposal,
  - Site Restoration.
- Pre-Final and Final Inspections;
- Demobilization;
- RA Completion Report; and
- Five-Year Reviews.

5.1 Pre-Construction Planning and Procurement

Prior to mobilization to the field, the contractor will conduct pre-construction planning and procurement activities. These activities include procurement, development and approval of pre-construction submittal items, attainment of permits, preparation of construction and operation plans, identification and assembly of the project team, and training.

5.1.1 Procurement

The contractor will begin the process of attaining materials, supplies, services, and subcontracts needed during the execution of the RA fieldwork.

5.1.2 Pre-construction Submittals

The contractor will attain and/or submit the information required by this Work Plan, design documents and specifications, or by contract to USACE for review and approval prior to the execution of RA field work.

5.1.3 Notifications and Permits

The contractor will prepare, submit, and attain the required permits and make the appropriate notifications, as required by this Work Plan, the RD, the contract, and/or as required by the facility.

5.1.4 Construction Plan and Operation Plans

The contractor shall prepare and submit for review and approval all required construction and operations plans required by this Work Plan and the RD.

5.1.5 Project Team

The contractor shall assemble, train, and prepare the project team for the execution of the RA. This shall include ensuring that project personnel are trained and briefed on the requirements of the SSHP, the Work Plan, the design, and associated documents.

5.2 Mobilization and Site Preparation

This task describes the work that the contractor shall perform prior to the initiation of RA field activities. Work will include installation of a construction field office; conducting site layout survey(s); establishment of work controls zones; installation of storm-water and sediment control prevention measures; preparation and installation of laydown, staging, and stockpile areas; and preparation of the waste container staging area.

5.2.1 Construction Field Office

The contractor’s field office will be set up and established at the FS-12 area, or other designated locations within the firing sites area. This office will be used to support administrative activities and store records for the on-site contractor field team, subcontractors, and the USACE fieldwork oversight personnel.

5.2.2 Initial Site Layout Survey

The contractor will have an initial site survey performed to define the site boundaries and initial construction features (i.e., the primary operation work pad, laydown areas, stockpile areas, and the location of storm water and sediment control measures).

5.2.3 Storm Water and Sediment Controls Measures

Prior to any physical disturbance to any project areas, the contractor will install the initial storm water and sediment control features identified in the RD.

5.2.4 Preparation and Installation of Work Pads, Laydown and Stockpile Areas

The contractor will conduct such work as necessary to install the process system laydown area(s), waste container staging and storage area(s), and the soil stockpile area(s). This work will include, but may not be limited to, site excavation, grading, and installation of an engineered work surface; installation of fences and access controls, signs, and placards; and step-in/step-out features.

5.2.5 Initiate Remedial Action

Upon completion of mobilization and site preparation activities, the contractor will conduct a review and assessment with USACE and project leadership to confirm that the contractor is prepared to conduct the RA. Following USACE approval, the contractor will initiate RA field activities.

5.3 Remedial Action Tasks and Activities

This section of the Work Plan describes the RA activities and interfaces that will take place during the OU-08 RA. This includes an activity process description at FS-12, the cleared and forested areas, FS-12 structures, the other firing sites, and the Line-1 structures remediation. The discussion for each of these areas describes the interface between the physical remediation activities and pilot testing, performance monitoring, waste processing and management activities, compliance monitoring (FSS), and site restoration activities.

OU-08 RA activities for the various areas will proceed largely on a concurrent path. The largest portion of fieldwork is during the FS-12 soil removal and disposal activities. FS-12 will be the base of operations for all OU-08 RA activities and will house the project office, waste and waste container storage and staging facilities, waste processing facilities, and waste transportation staging facilities. Depending on the disposal facility selected during the pre-construction planning and procurement phase, waste may be transported by public highways or by rail. If rail transportation is selected for waste shipping, then FS-12 will act as a waste packaging and staging area, and the Area-M railhead may be modified to stage waste containers prior to loading and shipping. In either case, waste generated at FS-12, as well as the other firing sites or Line-1 structures, will be processed through the FS-12 waste packaging and staging area.

Pilot tests may be conducted for evaluation of potential soil treatment technology(s). These tests could be performed during treatment system start-up operations. The pilot tests would be used to (1) test the efficiency and potentially optimize the operations of a proposed soil sorting process, and (2) evaluate potential technologies, methods, or processes to be used for remediation of FS-12. In support of any pilot tests, a pilot test work plan would be developed in conjunction with potential treatment technology vendors that will provide the details of the purpose, timing, and execution of the proposed pilot test.

5.3.1 Firing Site-12, DU-Contaminated Soil Remediation

As identified in Section 4 of this Work Plan, an area within 100 m (328 ft) of the FS-12 Control Building appears to have the heaviest concentration of DU contamination and is hereafter referred to as the 100-m (328-ft) area. The RD describes a process of sequential excavations for this area, which following completion will reduce the concentration of DU to below the RG of 150 pCi/g. The RA for this area, which covers approximately 35,300 m^2 (8.8 acres), requires the contractor to conduct a series of sequential excavations of segments or parcels in the targeted area, followed by performance monitoring and eventually an FSS. It is anticipated that these excavations will be a series of “lifts” (excavation limited to approximately 13 to 25 cm [5 to 10 in.]), with a concurrent walkover survey to determine if DU contamination remains in excavation area. This process continues until performance monitoring finds no remaining contamination at levels above the DU soil RG. Following completion of the excavation and performance survey, the excavation area will be subject to a MARSSIM FSS. The FSS will confirm that the excavation area has met the RG for soil. Section 6 of this Work Plan describes the performance survey process, and the FSSP included with this RD/RA package describes the FSS process.

Soils and debris removed during the excavation will be transported to a contaminated soil stockpile near the waste processing area. From there, this material may undergo additional processing prior to being packaged in waste containers. Section 5.3.5 describes the waste management process in more detail.

The design package provides a detailed description of the work process and areas within the FS-12 100-m (328-ft) area and forested area portions that are addressed by remedial activities. The activities for the 100-m (328-ft) and forested areas are summarized here and in the next section.

5.3.1.1 Firing Site-12 General Area Excavation Process

The excavation process for the FS-12 general area will proceed as follows:

1. The contractor will locate and mark the target excavation area in accordance with the RD.
2. The contractor will remove the specified layer of soil from the area and transport to the contaminated soil staging area for further processing and waste packaging (Section 5.3.5).
3. The contractor will conduct real-time excavation performance monitoring to confirm that the excavation(s) extend laterally and vertically beyond the extent of DU-contaminated soil. This will be an iterative approach in which excavation and performance monitoring will be repeated until monitoring results indicate that the DU-contaminated soil has been removed to the DU-contaminated soil RG.
4. After performance monitoring results show that the DU-contaminated soil has been excavated to below the DU soil RG, the contractor will notify the USACE, and the USACE will conduct (or have conducted) an FSS following the process described in the FSSP (USACE, 2013e). Excavations will remain open until laboratory results from the FSS show that they are below the soil RG.
5. If contamination above the soil RG is found following the completion of the FSS, then the contractor will be notified and further excavation will be conducted. Steps 1 through 4 will continue until the FSS finds no further contamination above the RG.
6. Following the conclusion of the successful FSS, the site will be declared to have been remediated to below the RG, released for site restoration activities (Section 5.3.6), and access controls put in place to prevent recontamination until all remaining FS-12 site restoration activities are complete.

5.3.2 Firing Site-12, Forest Area Remediation

As identified in Section 4 of this Work Plan, an area was identified outside of the 100-m (328-ft) soil remediation area that contains isolated locations of DU-contaminated soil. The RD describes a process of target excavations for this area, which following completion will reduce the concentration of DU in the forested area to below the RG of 150 pCi/g. The RA for this area covers approximately 70,235 m^2 (17.4 acres), with the possibility of incorporating additional targeted sections of the forest area.

As discussed in Section 4.4.1 of this Work Plan, three additional areas have been identified for site walkover surveys that are outside the 175-m (574-ft) radius boundary. These areas were selected based on the presence of multiple locations showing high gamma count rate observations at or near the boundary of the previously surveyed area. Otherwise, it is assumed that all other areas outside the 175-m (574-ft) boundary have soil that is below the DU RG, and these areas will proceed directly to an FSS.

The RI (USACE, 2008) was conducted using a walkover survey for most of the area beyond the 100-m (328-ft) soil remediation area described in Section 4.4.1, out to a radius of 175 m (574 ft). Most, if not all, of this area is forested or brush covered and, for the purposes of this Work Plan, is referred to as the forest area. There are several areas within the forest area that were not readily accessible to the RI field team, and limited walkover data exist for those areas. For these areas, the Work Plan specifies that brush and other deleterious materials that inhibited the RI field survey will be removed or cut back to facilitate a walkover survey. Once that survey is complete, the contractor will proceed to remediate DU-contaminated soils found in that area. To facilitate efficient and effective removal of forest area DU-contaminated soil, a pilot test may be conducted prior to full-scale remediation. This pilot test could evaluate soil and debris removal technologies to determine whether one proves to be more efficient or effective than the other.

As with the 100-m (328-ft) soil remediation area, remediation of the forested area will proceed through a series of steps that include locating and removing contaminated soil, performance monitoring, and conducting an FSS. Section 6 of this Work Plan describes the performance monitoring survey protocol and process. For the purposes of this Work Plan, the contractor will assume that the RI walkover survey data are accurate and illustrate the location of targeted areas requiring remediation, with the exception of the area defined in the design as needing additional characterization. Contaminated soil and debris will be placed into a contaminated material shipping container near the waste processing area and may undergo additional monitoring prior to transportation for disposal. Section 5.3.5 describes the waste management process in more detail.

5.3.2.1 Firing Site-12 Forested Area Excavation Process

The excavation process for the FS-12 forested area will proceed as follows:

1. The contractor will locate and define the forested areas that require additional characterization.

2. The contractor will remove and clear brush as required by the RD.

3. The contractor will complete a walkover survey, as described by Section 6 of this Work Plan and the FSP.

4. The contractor will then commence with full-scale remediation of the forested area.

5. The contractor will locate and mark the target excavation area in accordance with the RD.

6. The contractor will remove the soil and debris from the targeted area and transport them to the contaminated soil staging area for further processing and waste packaging (Section 5.3.5).

7. The contractor will conduct performance monitoring to confirm that the excavation(s) extend laterally and vertically beyond the extent of DU-contaminated soil. This will be an iterative approach in which excavation and performance monitoring will be repeated until performance monitoring results indicate that the remaining soil is below the DU-contaminated soil RG.

8. After performance monitoring results show that the DU-contaminated soil has been excavated to below the DU-contaminated soil RG, the contractor will notify the USACE, and the USACE will conduct (or have conducted) an FSS following the process described in the FSSP. Excavations will remain open until laboratory results from the FSS show that they are below the soil RG.

9. If contamination above the soil RG is found following the completion of the FSS, then the contractor will be notified and further excavation will be conducted. Steps 6 through 9 will be continued until the FSS demonstrates that the soil is below the RG.

10. Once the results of the FSS indicate that the site conditions are below the RG, then access controls will be put in place to maintain this condition until all remaining FS-12 site restoration activities have been completed.

5.3.3 Other Firing Site Soil Areas

As identified in Section 4 of this Work Plan, several firing sites (FS-1 and FS-2, FS-5, and FS-6) contain isolated pockets of DU-contaminated soil. The RD describes a process of using target excavations for these areas that will reduce the concentration of DU to below the RG of 150 pCi/g. The RA for these areas is limited to very small areas at each firing site.

As with the FS-12 contaminated soil areas, the contractor will perform a series of steps that include locating and removing contaminated soil, performance monitoring, and conducting an FSS. Section 6 of this Work Plan describes the performance monitoring survey protocol and process. For the purposes of this Work Plan, the contractor will assume that the RI walkover survey data are accurate and illustrate the location for targeted excavation. Contaminated soil and debris will be transported to a contaminated soil stockpile area near the waste processing area and may undergo additional processing prior to waste packaging and transportation. Section 5.3.5 describes the waste management process in more detail.

5.3.3.1 Other Firing Sites – DU-Contaminated Soil – Excavation Process

The excavation process for the other firing site soil areas will proceed as follows:

1. The contractor will locate and mark the target excavation area in accordance with the RD.

2. The contractor will remove the specified soil from the area and transport to the contaminated soil staging area for further processing and waste packaging (Section 5.3.5).

3. The contractor will conduct performance monitoring to confirm that the excavation(s) extend laterally and vertically beyond the extent of DU-contaminated soil. This will be an iterative approach in which excavation and performance monitoring will be repeated until performance monitoring results indicate that the soil is below the DU-contaminated soil RG.

4. After performance monitoring results show that the DU-contaminated soil has been excavated to below the DU-contaminated soil RG, the contractor will notify the USACE, and the USACE will conduct (or have conducted) an FSS following the process described in the FSSP. Excavations will remain open until laboratory results from the FSS show that they are below the soil RG.

5. If contamination is found following the completion of the FSS, then the contractor will be notified and further excavation will be conducted. Steps 1 through 4 will continue until the FSS finds no further contamination.

6. Following the conclusion of the successful FSS, the site will be declared complete, released for site restoration activities (Section 5.3.6), and access controls put in place to prevent recontamination until all remaining OU-08 site restoration activities are complete.

5.3.4 Structures Remediation

As identified in Section 4 of this Work Plan, several structures have been identified that have isolated DU surface contamination or were not surveyed during the RI. The structures remediation work will be conducted in two parts. First, additional radiological surveys will be conducted at two FS-12 structures: a bunker and the Firing Site Control Building. Second, localized decontamination of contaminated surfaces and/or removal and replacement of contaminated parts will be completed at the FS-12 structures and the Line 1 buildings. The RD describes a process for remediating these areas, which following completion will reduce the concentration of DU to below the RG of 23,000 dpm/100 cm^2. Any equipment, furniture, or miscellaneous items will be surveyed and released for unrestricted use if the materials meet the clearance requirements set in the *Army Radiation Safety Program*, Pamphlet 385-24.

5.3.4.1 Line – 1 and FS-12 Structures Remediation

Remediation for Line-1 and FS-12 structures will proceed as follows:

1. For the FS-12 structures, the contractor shall conduct an initial radiological survey of the identified structures and identify areas for radiological contamination with these structures. The survey will be conducted in accordance with the Radiation Control Plan and FSP.

2. In accordance with the RD, the contractor will locate and mark the area of contamination within the Line-1 and FS-12 structures.

3. The contractor will remove the surface contamination, or replace contaminated parts, and transport the contaminated material to the FS-12 staging area for further processing and waste packaging (Section 5.3.5).

4. The contractor will conduct performance monitoring to confirm that the contamination does not remain in the structures. This will be an iterative approach in which decontamination and performance monitoring will be repeated until real-time monitoring results indicate that the levels are below the structural RG.

5. After performance monitoring results show that surface contamination is below the structural RG, the contractor will notify the USACE, and the USACE will conduct (or have conducted) an FSS following the process described in the FSSP.

6. Following attainment of the RG, the structure(s) will be declared complete, released for site restoration activities (Section 5.3.6), and access controls put in place to prevent recontamination until all remaining OU-08 site restoration activities are complete.

5.3.5 Waste Management Process Execution and Interface

In accordance with the RD and this Work Plan, the contractor will install a process system work pad, material and supplies laydown area(s), and the soil stockpile area(s). The work includes installation of an engineered work surface, installation of fences and access controls, signs and placards, and radiological control step-in/step-out features. The contractor will also have installed storm water and sediment management systems, as required by the design. Throughout the life of this RA, the contractor will operate and maintain these features in accordance with the requirements of this plan and the RD.

Section 7 of this Work Plan, the WMP, and a contractor-provided Process System Operations and Maintenance (O&M) Plan will provide details on the O&M of waste management activities. In general, the contractor will maintain an integrated waste management processing and packaging system for this RA. The waste management system will include features and facilities to process and manage waste generated during the RA.

The waste management system includes the following features:

- Soil stockpile and staging areas (preprocessing);
- Waste processing area and system capable of soil sorting;
- Soil staging and storage area (post processing);
- Incoming waste container storage area;
- Contaminated soil staging and packaging area (post processing); and
- Outbound waste container storage area.

A pilot test may be conducted prior to implementing full-scale waste processing to test the efficiency and cost effectiveness of a soil and DU sorting technology. Prior to the conduct of any pilot test, a Pilot Test Plan would be prepared as part of the project field planning and procurement phase (Work Plan, Section 5.1). The Pilot Test Plan will include the details of any pilot test, including the identity of the source(s) and quantity of contaminated soil that will be used in the pilot test, and the performance sampling strategy. Prior to mobilizing and setting up the soil sorting technology, a sufficient amount of contaminated soil would be gathered and stockpiled. It is believed that the soil sorting process, if successful, could process contaminated soil and debris much quicker than soil excavation. The purpose of the pilot test would be to confirm the effectiveness of sorting on the site-specific soil and debris, determine an expected sorting efficiency, determine and optimize operational control parameters, conduct a project cost benefit analysis, and make a “go/no-go” decision on the use of the technology.

A soil sorting pilot test would consist of the following goals, objectives, and activities:

- Mobilize the soil sorting system to the site and set up on the work pad.
- Excavate and stockpile a defined quantity of highly contaminated soil and a defined quantity of medium contaminated soil.
- Run both soils through a sorting system and determine the ability of the system to discriminate between soil contaminated with DU above and below the soil RG.
- If the system passes the preliminary test, then process an additional 75 m^3 (100 yd^3) of soil from several known contaminated areas, and determine the effective sorting efficiency. This sorting efficiency would then be used to complete an overall project cost benefit analysis of using the sorting system during full-scale remediation.
- Conduct confirmatory sampling and analysis of post processing soil stockpiles piles to confirm that (a) the soil identified as below the soil RG continues to meet the DU RG, and (b) the contaminated pile continues to exceed the criteria.
- Evaluate the need for preprocess filtering or processing of incoming soil and debris.

5.3.5.1 Waste Management Process

The waste management process will proceed as follows:

1. The contractor shall submit a process system O&M Plan, which may include a Pilot Test Plan, during the pre-construction planning and procurement activities. The contractor will determine at that time the stockpiled soil quantities that may be needed prior to the initiation of a pilot test.

2. The contractor will set-up the contaminated soil and debris stockpile area in accordance with the RD; this will include the required access and administrative controls.

3. The contractor will initiate soil and debris excavation and structures remedial activities, as detailed in the RD and Section 5.3.1, and proceed to collect the contaminated soil and debris, as outlined in the O&M Plan.

4. Once sufficient type and quantity of contaminated soil has been collected, the contractor will mobilize the chosen soil sorting equipment and prepare for pilot test activities, as applicable.

5. Any pilot test results will be evaluated and a determination made as to whether to proceed with using additional soil sorting processes or opt for no additional processing and proceed directly to waste packaging and transportation.

6. If a soil sorting process system is selected for use, then the contractor will proceed with the setup and preparation of full-scale operations. If the soil sorting process system is not chosen, then the contractor will skip to Step 9.

7. The contractor will segregate the soil below the RG from contaminated soil (i.e., soil that has DU contamination above the RG).

8. Soil determined to be below the RG will be stockpiled in a controlled storage area for possible reuse during site restoration activities.

9. Contaminated soil and debris will be directed to the contaminated soil and debris area where it will be containerized and prepared for transportation and disposal.

10. The contractor will present a Waste Packaging, Shipping, and Disposal Plan as part of pre-construction planning and procurement activities. This plan will address the specific requirements and methods the contractor will follow to maintain and confirm compliance with the chosen Waste Disposal Facilities' WAC and the DOT requirements, including packaging, confirmation sampling, manifesting, and final disposal acceptance and certification.

11. During and following waste management activities, the contractor will maintain all records associated with waste management activities and include this record to USACE as part of the pre-final and final inspection and reporting process.

5.3.6 Site Restoration

The contractor will conduct such site restoration activities as are necessary throughout the RA. It is anticipated that site restoration will be conducted in incremental steps as discrete areas are declared complete. The RD provides the specific details for planned restoration activities that the contractor will implement. Work activities under this task will include:

- Site grading and soil backfill;
- Site seeding;
- Incremental removal of staging areas, stockpile areas, and process pads;
- Incremental removal of RA access control features;
- Installation of any institutional control features that might be deemed necessary; and
- Removal of any remaining project offices or other site utilities.

The schedule for conducting final site restoration activities and demobilization will depend upon USACE and agency concurrence that the RA is complete, and will be contingent on agency sign-off through the pre-final and final inspection process.

5.3.7 Pre-final and Final Inspections/Report

As the RA nears completion, USACE and the contractor shall schedule a meeting with the agencies to discuss the procedures and requirements for project completion and close-out.

Potential topics for discussion include:

- Final documentation submissions,
- Construction clean-up responsibilities,
- Demobilization activities,
- Pre-final inspection schedule, and
- Identification of any potential transfer of responsibilities.

5.3.7.1 Pre-final Inspection

The contractor and USACE will jointly inspect the site and determine if each element of work is complete and ready to accept. For this project, these inspections can be conducted routinely throughout the RA as an area of the site is deemed complete. The contractor will maintain a list of items that the inspection identifies as a defect or not complete (i.e., a punch list). The contractor will prepare a pre-final inspection report, including the punch list, as well as a schedule for completion of the outstanding items and a date for the final inspection.

A pre-final inspection report will be prepared to document the results of the pre-final inspection. The report will identify the open items from the inspection, the agreed upon action for closing the open items, and the scheduled closure date for each item. The pre-final inspection report will include the following:

- Completed pre-final inspection checklist,
- Identification of open items,
- Actions and schedules for closure of open items,

- Schedule for sequential demobilization from completed sites and areas, and
- Planned date for final inspection, if required.

The schedule for the pre-final inspection(s) and pre-final inspection(s) reports will be identified in a RA construction schedule prepared and submitted as part of the preconstruction planning and procurement process defined in Section 5.1.

5.3.7.2 Final Inspection

Work on the RA is complete when the remedy is deemed operational and functional, and all punch list tasks noted in the pre-final inspection report have been performed. If deemed necessary, the contractor and USACE will make a determination if sufficient work has been performed to seek a final inspection. The final inspection will include a review of the RD/RA Work Plan requirements, and reviewing the work that was performed and associated documentation to determine that all elements of the design and Work Plan are complete. Additionally, the agencies will focus their review and inspection on ascertaining that the remedy that has been implemented is in full compliance with the ROD (USACE, 2011a).

A final inspection report will be prepared to document the results of the RA at meeting all performance and compliance objectives identified in the RD/RA Work Plan and the ROD. The results will address:

- Results of the final inspection,
- Evaluation of the RA at meeting the performance and compliance objectives,
- Resolution of any outstanding items from the pre-final inspection,
- Explanation of any changes from the RD and Work Plan, and
- Concurrence that the RA execution phase is complete.

The schedule for the final inspection(s) and final inspection(s) reports will be identified in a RA construction schedule prepared and submitted as part of the preconstruction planning and procurement process defined in Section 5.1.

5.3.8 Demobilization

Site demobilization will occur after the majority of the construction work is complete. For this RA, this may occur sequentially as different areas of OU-08 are deemed complete. For FS-12, this may occur as different phases of the operational phase of the remedy are complete. Excavation, soil processing, waste packaging, waste transportation, site restoration, and waste disposal are largely sequential activities, and facilities, equipment, and controls for these elements of work will be de-mobilized as the work is completed.

Complete demobilization from the site will not occur until the final inspection report has been submitted and approved. Incremental demobilization will be completed as detailed and agreed to in the pre-final inspection report(s).

Demobilization activities will include:

- Removing equipment, materials, access controls, and other items no longer necessary to complete site activities;

- Decontaminating, as necessary, survey equipment, tools, and other items that contacted DU-contaminated material so they meet release criteria prior to being released from the site;
- Removing temporary building and structures;
- Completing necessary restoration activities;
- Removing site debris and temporary utilities; and
- Transferring all finalized documentation associated with the RA.

5.3.9 Remedial Action Completion Report

Within 60 days after the final inspection, the contractor will prepare and submit an RA report to USACE and the agencies. The report will be the official record of RA activities.

The RA report will contain:

- Introduction,
- Chronology of events,
- Performance standards and cleanup goals met,
- Description of the QA/QC procedures followed,
- Description of RA activities,
- Final inspection documentation,
- Information about site conditions and post-RA land use controls developed in accordance with Environmental Work Instruction E0-1-012, “Incorporating Land use Controls in Project Planning,”
- Discussion of O&M requirements (if any), and
- Summary of project costs.

The schedule for the RA Completion Report will be identified in an RA construction schedule prepared and submitted as part of the preconstruction planning and procurement process defined in Section 5.1.

5.3.10 Five-Year Review Requirements

The selected remedy results in hazardous substances, pollutants, or contaminants to remain on-site above levels that allow for unlimited use and unrestricted exposure. Therefore, CERCLA requires that the performance of the remedy be reviewed every 5 years. Details about the 5-year review process are provided in Section 3.3.

6. PERFORMANCE AND COMPLIANCE MONITORING

This section of the Work Plan identifies the planned performance and compliance monitoring activities developed to guide decision making during remediation and document achievement of RGs. Monitoring requirements are derived from the RAOs and the RGs defined in Section 3 of the Work Plan, the ROD, and through an activity-specific data quality objectives (DQOs) development process, as provided below. The DQOs identified below support the development of a monitoring strategy designed to assess progress toward, and completion of, the RAOs and RGs.

Data collected from performance and compliance monitoring events are necessary to assess performance of the remedy, determine the need for operational changes, support RA decision making, and support USACE and agency performance and compliance reviews.

This section of the Work Plan covers the following:

- DQOs,
- Monitoring strategy,
- Data collection,
- Sampling equipment and procedures, and
- Sample management and analysis.

6.1 Data Quality Objectives

This section summarizes the major DQOs for each portion of the OU-8 RA.

- **The DQOs related to remediating soils at FS-12 and other firing sites are:**
  - Delineate the extent of the DU-contaminated area at FS-12 outside of the 100-m (328-ft) radius.
  - Provide a means for real-time analysis of remaining DU-contamination following excavation.
  - Provide a means to confirm DU-contaminated soil and debris are remediated to below the RG.
- **The DQOs related to operational and startup (pilot) testing are:**
  - Determine if the sorting system is effective for processing site soil (i.e., the fine-textured soil with a significant clay content).
  - Determine the sensor system settings that segregate soil below the soil RG and soil that is above the RG, and optimize the settings to maximize the portion of soil that is below the RG.
  - Confirm (via lab analysis) that the soil deemed as below the soil RG by the soil sorting system has radiation levels below the soil RG.

- **The DQOs related to soil sorting during full-scale soil remediation are:**
  - Segregate soil into soil stockpiles (soil that is deemed below the RG) and contaminated soil stockpiles (soil that is deemed to be above the RG) based on measured radiation levels.
  - Confirm that the radioactivity level in the below RG soil stockpile remains below the soil RG.
- **The DQOs related to remediating structures at FS-12 are:**
  - Identify surfaces (e.g., walls, floors, etc.) that exceed the structural RG.
  - Confirm that structure surfaces meet the structural RG.
- **The DQOs related to remediating Line 1 Building components are:**
  - Identify sections of the Building 1-11 floor grate that exceed the structural RG.
  - Determine if the areas exposed by removing the floor grate exceed the structural RG.
  - Determine if HVAC ductwork exposed by removing the filter exceed the structural RG.
  - Confirm that structural surfaces meet the structural RG.
- **The DQOs related to waste management are as follows:**
  - Determine that DU-contaminated soil and debris meet the disposal facilities' WAC.
  - Confirm that inbound used waste containers (e.g., roll-off containers or railcars) do not have radioactive contamination (internal or external).
  - Confirm that outbound waste containers do not have radioactive contamination on exterior surfaces.
- **The DQOs related to contamination control are as follows:**
  - Confirm that inbound equipment and vehicles do not have radioactive contamination.
  - Confirm that personnel, equipment, and vehicles do not have radioactive contamination upon exiting the controlled work zone.
  - Determine if air quality resulting from remedial operations impacts human health and the environment.

6.2 Monitoring Strategy and Methods

This section describes the strategy for performance and compliance monitoring associated with firing sites soil remediation, FS-12 and Line 1 structures remediation, waste management, and contamination control. The project FSP and QAPP together provide specific details on sampling equipment, procedures, sample management and analysis, and data management and reporting related to the RA monitoring strategy.

6.2.1 Firing Sites Soil Remediation

The monitoring strategy for firing sites soils remediation includes three components: characterization, performance monitoring, and compliance monitoring.

6.2.1.1 Characterization Monitoring

Site characterization monitoring is only required for certain areas of FS-12; these areas are part of the northwestern segment where access limitations due to dense vegetation resulted in incomplete walkover survey coverage and areas beyond 175 m (574 ft) from the FS Ground Zero. Characterization monitoring conducted during the execution phase of the RA will identify DU-contaminated soil requiring remediation in certain uncharacterized portions of FS-12; the RD identifies these areas.

6.2.1.2 Performance Monitoring

Spatially located performance monitoring data will be collected to provide real-time guidance and information for decision making during excavation activities of all DU-contaminated soil. The method of monitoring is delineated in the FSP, and will be tailored to the area of the site under remediation.

As an example, in the 100-m (328-ft) area of FS-12, incremental lifts of soil will be removed and upon completion of each lift, a gamma walkover survey of the excavated area will be performed. Any areas where the gamma walkover survey indicates that soil concentrations exceed background, the soil RG will be marked and subject to additional excavation. During initial excavation activities, the data will be evaluated to determine how effective the chosen incremental lift was in removing DU-contaminated soil above the RG. Through this real-time evaluation process, lessons-learned will be applied to future decisions regarding the adequacy of the chosen lift in efficiently removing contaminated soil. The process of excavating and surveying will be continued until gamma walkover surveys indicate that DU is no longer present at levels above the RG. At that point, the excavated area will be designated as complete and will be ready for a confirmation survey to confirm that soil remaining in the area meets the RG.

In the less contaminated portions of FS-12 and at other firing sites, localized excavation will be used to remove contaminated material from discrete areas. In areas where localized excavation is used, performance monitoring will consist of surveying the sides and bottom of an excavation using a gamma survey instrument. If the gamma survey indicates contamination exceeds the soil RG, then the excavation will be expanded. The process of excavating and surveying will be continued until all of the contaminated material at that location has been removed. At that point, the excavated area will be designated as complete and will be ready for a confirmation survey to confirm that remediation of that area has been completed.

6.2.1.3 Confirmatory Monitoring

The confirmatory monitoring strategy for the contaminated soils at the FSAs will use the MARSSIM approach (EPA, 2000a) for the excavated areas. The FSSP included with this RD/RA package describes the FSS process.

The FSSP presents FSS methodology for the following:

- Land areas,
- Structures, and
- Processed soil destined for backfill.

Soil Sorting Performance Monitoring – The proposed soil sorting process utilizes radiation sensors that are components of the soil sorting system to classify soil as having radiation levels above or below the soil RG. As part of waste processing start-up activities, a pilot test may be conducted to evaluate the accuracy of the soil sorting radiation sensors. Prior to use of sensor data for confirmatory monitoring, data collection and calibration procedures would be developed and maintained for the sorting process.

Soil Sorting Operational Monitoring – During initial start-up, and potentially periodically during operations, soil sorting system compliance monitoring would be necessary to confirm that the radiation levels of the processed soil are, and remain below, the soil RG. Laboratory data will be used as a periodic check to verify that the operation of the sorting system continues to meet the remediation requirements.

6.2.2 Firing Sites and Line 1 Structures Remediation

Performance monitoring for FS-12 and Line 1 structures remediation will consist of conducting gamma surveys of surfaces to identify areas with elevated radiation levels. The survey data will be used to establish structural components that require decontaminating and/or removal in order to establish that these remedial activities are complete. At FS-12, results of gamma surveys of furnishings (e.g., office furniture) will be used as a basis for either free-release or disposal of those items. Any equipment, furniture or miscellaneous items will be surveyed and released for unrestricted use if the materials meet the clearance requirements set in the *Army Radiation Safety Program*, Pamphlet 385-24.

Once the contractor has determined that decontamination and/or removal has remediated areas of elevated DU-contamination, they will notify the USACE, who will have an FSS conducted on these structures in accordance with the attached FSSP to confirm and document completion.

6.2.3 Waste Management

During waste management activities, certain performance and compliance monitoring will be required to ensure that the waste is handled and managed in a fashion that is not detrimental to human health and environment, is compliant with NRC and DOT regulations, and meets the disposal facility’s WAC. Monitoring activities will include periodic soil and waste product sampling (to illustrate that contaminated waste meets a disposal facility’s WAC) and surface radiological surveys of incoming and outgoing waste containers.

The performance monitoring component of waste management consists of confirming that inbound waste containers do not have greater than the soil RG levels of radioactivity so that contamination from elsewhere is not brought to the OU-8 site. Every inbound reusable container will be surveyed and containers that are found to be free of contamination will be stored in a segregated area until needed for waste packaging. New, unused containers will not be surveyed prior to use.

Compliance monitoring consists of periodically collecting samples of waste, and laboratory analysis of those samples to confirm that the WAC constituent concentrations are below the limits established by the disposal facility. The WAC constituents to be analyzed are those that, based on process knowledge and historical site characterization data, have a reasonable potential of being present in DU-contaminated soil.

Compliance monitoring also includes confirming that no radiological contamination is present on the exterior of waste containers when they are released for off-site transport. The exterior surface of every outbound waste container will be surveyed prior to release, including the bottom of the container, just prior to loading onto a rail car or transport trailer.

Final procedures and methods for conducting compliance sampling will be developed as part of the RA preconstruction planning and procurement activities discussed in Section 5.1 of the Work Plan, and the FSP, QAPP, and WMP will be updated and submitted.

6.2.4 Contamination Control

For contamination control, the contractor will implement a monitoring program that includes surveying all inbound and outbound equipment or vehicles associated with this RA. Additionally, the contractor will implement a monitoring program of all personnel, equipment, and vehicles entering or leaving designated contaminated work areas to make sure that radioactive contamination is not transported around the project area. If survey results show that items are contaminated, then they will be decontaminated until survey results show that they meet release criteria.

The concentration of DU in airborne dust may be monitored to determine if dust control measures are needed to reduce dust emissions. Visible dust will be the trigger for implementing dust control measures. Dust control measures include wetting disturbed areas and soil stockpiles with water, covering stockpiles with plastic sheeting, and minimizing the speed of vehicles operating on disturbed areas.

Storm water and decontamination liquid will be evaluated, sampled, and managed in accordance with the WTS-SOP.

Consistent with the EPA Storm Water Pollution Prevention Plan guidance, a 2-year, 24-hour design storm will be used to calculate the required storage volumes. Adequate capacity to retain this volume of storm water will be available onsite.

6.3 Sampling Equipment and Procedures

The sampling equipment and procedures required to support the monitoring strategy are detailed in the project FSP and QAPP. Sampling procedures identify the equipment and techniques necessary to implement required sampling. These procedures address training, equipment, sampling, investigation derived waste management, equipment decontamination and cleaning, and record keeping.

6.4 Sample Management and Analysis

The project FSP and QAPP provides the framework and specific instructions for sample management and analysis requirements, processes, and procedures related to this RA.

6.5 Quality Assurance Program

The OU-8 RA will be performed in accordance with this Work Plan, supporting documents, associated procedures and guidance documents, and the project QAPP. This QAPP complies with key elements of the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006b).

This QAPP provides specific guidance and QA/QC requirements and evaluation criteria that result in generation of environmental data that have known quality and can be used to make site-specific decisions related to the OU-8 RA.

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7. WASTE MANAGEMENT

This section summarizes the approach for managing waste that will be generated during the OU-8 RA. The project WMP provides a management and planning tool for identifying and managing waste streams generated from the RA for contaminated soil and structures at OU-8. The WMP identifies the anticipated waste streams, describes methodologies for waste management and transportation, and identifies disposal pathways for each anticipated waste stream.

7.1 Waste Management Activities

Waste management activities address waste generated as a result of the IAAAP OU-8 RA. The contractor and its subcontractors will perform all activities described in this plan and the WMP, unless specifically stated otherwise. As part of the scope of this RA, the contractor will perform the following waste management activities:

- Waste planning (e.g., identify waste streams that will be generated, and shipping and disposal routes);
- Radiological and chemical characterization of wastes, including preparation of a sampling and analysis plan; researching and compiling process knowledge; review of data for regulatory classification (e.g., Resource Conservation and Recovery Act [RCRA], DOT, DOE, etc.) and treatment, storage, and/or disposal facility (TSDF) WAC compliance; and development of TSDF waste profiles;
- Defining packaging and storage requirements;
- Preparing shipping manifests and coordinating transportation of waste for disposal;
- Maintaining compliance with applicable regulations (e.g., RCRA, DOT, and *The Army Radiation Safety Program* [Department of the Army, 2011]); and
- Field implementation of the WMP.

The contractor will perform additional activities, including developing and reviewing supporting documentation (e.g., Work Plan, work packages, procedures, plans, training documents, and QA), conducting assessments, evaluating non-conformances, and developing corrective action plans that support waste management. All documentation created in support of waste management, shipping, and disposition will be maintained by the contractor and copies will be provided to USACE upon request and at the completion of the project.

7.2 Waste Management Overview

The WMP provides information concerning the type of waste anticipated because of this RA (including low level, hazardous, mixed, and industrial), and identifies and discusses disposal options.

7.3 Waste Characterization

Waste will be characterized, and waste profiles prepared, based on a combination of process knowledge, historical data, and chemical and radiological analysis of samples. Using this characterization information, a waste profile will be developed for each waste stream. It is anticipated that additional information, as determined by the WAC of the chosen receiving facility, will be needed to properly profile some waste streams, and waste characterization will be ongoing through this remedial/clean-up effort, potentially modifying waste type quantities and their anticipated packaging and disposition pathways. The WMP identifies the requirements and process for waste characterization.

7.4 On-Site Waste Management, Transportation, and Disposal

The overall process for managing waste, waste containers, characterization information, and documentation is presented in the WMP. The primary elements and areas of control during waste management are identified as follows:

- Remediation Areas – Remedial activities in remediation areas generate various waste materials that will be managed.
- On-Site Processing Area – Waste will be transported to an on-site processing area at FS-12 where soil and debris will be segregated and processed in preparation of DU contaminated soil disposal. Other processing activities that may be performed in this area include decontamination of debris and equipment, and treatment of storm water and decontamination liquids.
- Soil Storage and Staging Area – Soil identified as having DU levels below the RG will be stored in an area where it cannot become contaminated by being mixed with contaminated soil. If there is a potential for this soil to be a hazardous waste, then it will be stored until analytical results are available to support release as below the RG, non-hazardous material, or alternatively indicate that it must be managed as hazardous waste (although this is not likely).
- Contaminated Soil Storage and Staging Area – Soil identified as having radiation levels above the RG, and any debris that has radiation levels above structural RG limits or surface activity-based free release criteria, will be stored and placed into transportation containers. Each container will be surveyed to confirm that the exterior is not contaminated, decontaminated if necessary, and then moved to a separate storage area pending off-site transportation. This approach is based on the assumption that intermodal shipping containers or super sacks will be used for transporting waste. However, if soil is transported in bulk in rail cars, then an additional rail car loading area would be established at a rail yard.
- Inbound Container Staging Area – Waste containers that have been previously used (i.e., intermodal containers or rail cars) will be surveyed upon arrival at the inbound container storage area to be located at the FS-12 site to identify any contamination. Only containers that have insignificant levels of contamination will be accepted for use on this project. Containers that are determined to be clean will be stored in a segregated area until needed, and then will be transferred to the contaminated soil and debris storage area where they will be filled with waste.
- Outbound Container Staging Area – After a container has been filled with waste, it will be moved to a storage area. Any analytical work needed to confirm that the waste complies with the disposal facility's WAC will be completed, shipping documents and placarding will be completed, and compliance with facility and DOT requirements for packaging and transportation will be verified.
- Offsite Railroads and Highways – After compliance with facility and DOT requirements has been confirmed, waste containers will be transported by rail or highway to off-site facilities for disposal.
- Off-Site TSDFs – Waste will be disposed at off-site facilities permitted for low-level waste or mixed waste. Metallic DU may require treatment to reduce the DU concentration to less than 5% by weight, followed by disposal. After waste has been treated and/or disposed, the facility will issue a certificate of disposal to document the final disposition of the waste. The TSDF(s) used for project waste disposal will be identified during the field planning and procurement phase of the project, as described in Section 5.1 of this Work Plan.

8. ACCIDENT PREVENTION

For the OU-08 RA for firing sites soils, the major hazards are associated with construction activities (e.g., heavy equipment operation, clearing underbrush, or noise) and exposure to low levels of radioactive materials, particularly dust that contains uranium. Environmental hazards (e.g., heat, cold, sunburn, poisonous plants and animals, or rough terrain) that are typical of outdoor work are also applicable to this project. For structures remediation, especially the air filter in Building 1-63-6, the potential to suspend DU-contaminated dust is a particular concern. For remediation of the floor grate in Building 1-11, an additional hazard is working around the open production pit.

Field activities for the OU-08 RA will be conducted in accordance with a project-specific APP/SSHP. The purpose of the APP is to ensure that health and safety issues anticipated during the selected removal action are considered and addressed prior to starting work. The APP identifies applicable site-specific hazards and site-specific safety and health considerations encountered during the removal action activities at IAAAP.

This SSHP establishes the safety and health procedures, guidelines, and requirements that will be used to safely perform the activities necessary for site cleanup operations. The SSHP, along with the project APP, have been prepared in accordance with all local, state, and in accordance with EPA requirements, Occupational Safety and Health Act (OSHA) standards (29 CFR Parts 1910 and 1926), and the USACE Safety and Health Requirements Manual (EM 385-1-1).

The contents of the APP/SSHP may be revised and/or amended if additional information becomes available regarding hazards present at the site and/or if significant changes occur in the scope of work, operational procedures, site hazards, and/or hazard control measures.

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9. REMEDIAL ACTION COST AND SCHEDULE

This section addresses the cost and schedule for OU-8 remedial activities.

9.1 Cost

The total cost used for this Work Plan was taken from the ROD (USACE, 2011a). These costs will be re-evaluated and refined during the preconstruction planning and procurement phase of the RA. At that time, a more accurate cost estimate can be developed as actual details related to transportation and disposal methods and vendors become available. The final cost for this action will depend upon FUSRAP funding levels during the RA period of performance.

Based on the ROD, the total cost for the selected remedy was evaluated based on the best available information and over a 30-year costing period. The total cost of the selected remedy is $45,275,000. These costs assume that all DU-contaminated soil must be shipped offsite for disposal. The capital, annual O&M, and total present worth costs for the duration of the evaluation period (30 years) and the discount rate (7%) are presented in Tables 2-10 and 2-11 of the ROD.

9.2 Schedule

A schedule for the performance of this RA is presented in Appendix C. During the RA preconstruction planning and procurement activities, a schedule will be prepared and will contain activities and interfaces necessary to accomplish the tasks detailed in this Work Plan. As with the cost estimate, the final schedule for performing this action will be dictated by FUSRAP funding levels during the RA period of performance. If the project can be fully funded, an estimate of duration would be approximately 3 years. Updated information regarding the schedule will be discussed at the periodic Project Manager conference calls.

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10. REFERENCES

10 CFR 20, *Code of Federal Regulations*, Title 10, “Energy,” Part 20, “Standards for Protection against Radiation,” Office of the Federal Register.

16 USC § 1538 et seq., 2006, *United States Code,* “Prohibited Acts.”

29 CFR 1910, 2000, *Code of Federal Regulations*, Title 29, “Labor,” Part 1910, “Occupational Safety and Health Standards,” Office of the Federal Register.

29 CFR 1926, *Code of Federal Regulations*, Title 29, Part 1926, “Occupational Safety and Health Standards for the Construction Industry,” Office of the Federal Register.

40 CFR 300, 2000, *Code of Federal Regulations*, Title 40, “Protection of Environment,” Part 300, “National Oil and Hazardous Substances Pollution Contingency Plan,” Office of the Federal Register.

42 USC § 9601 et seq., 1980, “Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund),” *United States Code*, December 11, 1980.

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USACE, 2011b. *FUSRAP Feasibility Study Report for the Iowa Army Ammunition Plant Middletown, Iowa.* U.S. Army Corps of Engineers St. Louis District Office Formerly Utilized Sites Remedial Action Program. April 2011.

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USACE, 2013b. "Remedial Design/Remedial Action Quality Assurance Project Plan, Iowa Army Ammunition Plant, Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation, Middletown, Iowa (FINAL)," Revision 0, U.S. Army Corps of Engineers, February 2013.

USACE, 2013c. "Remedial Design/Remedial Action Waste Management Plan, Iowa Army Ammunition Plant, Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation, Middletown, Iowa (FINAL)," Revision 0, U.S. Army Corps of Engineers, February 2013.

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11. FIGURES

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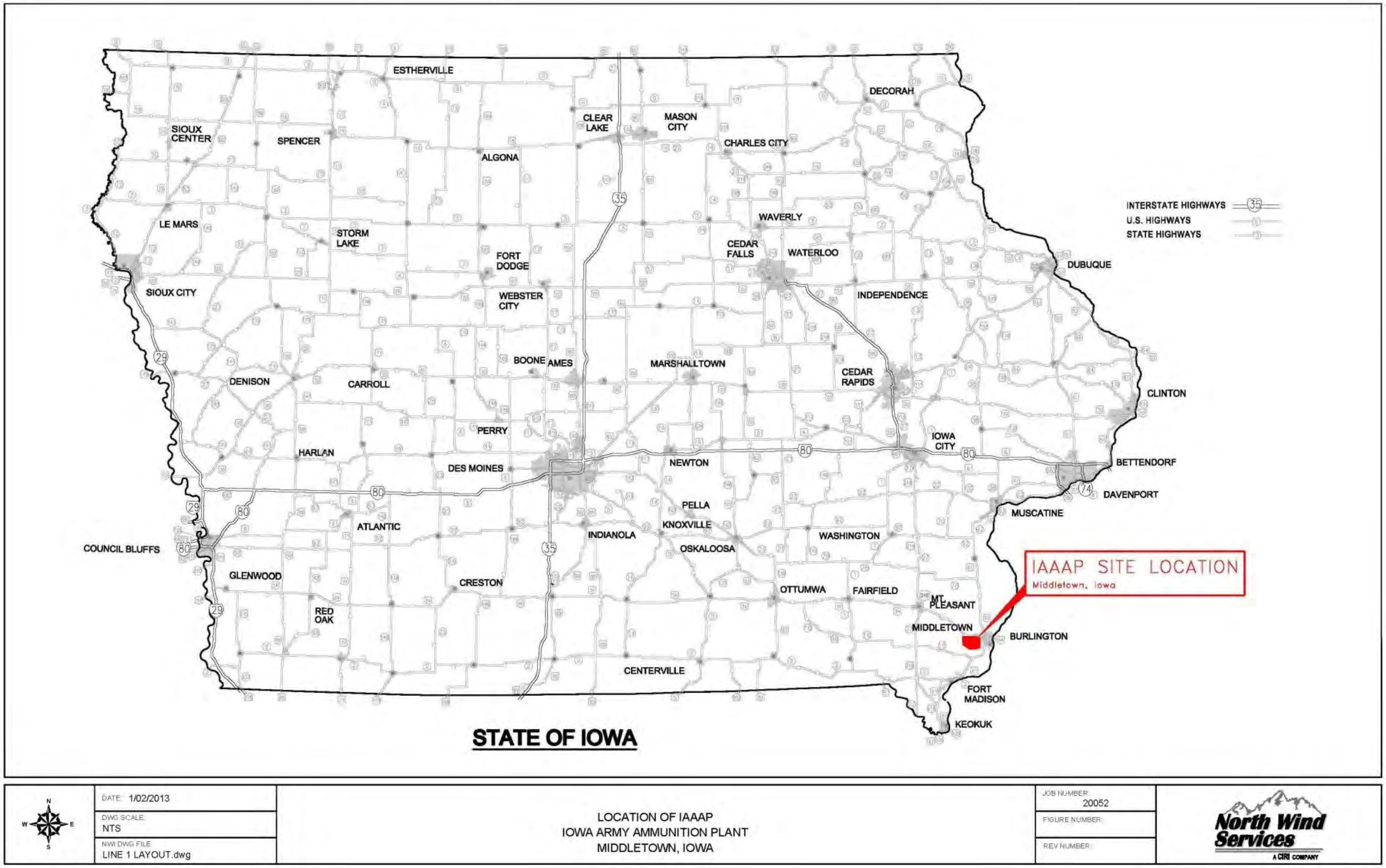

Figure 1-1. Location map for IAAAP.

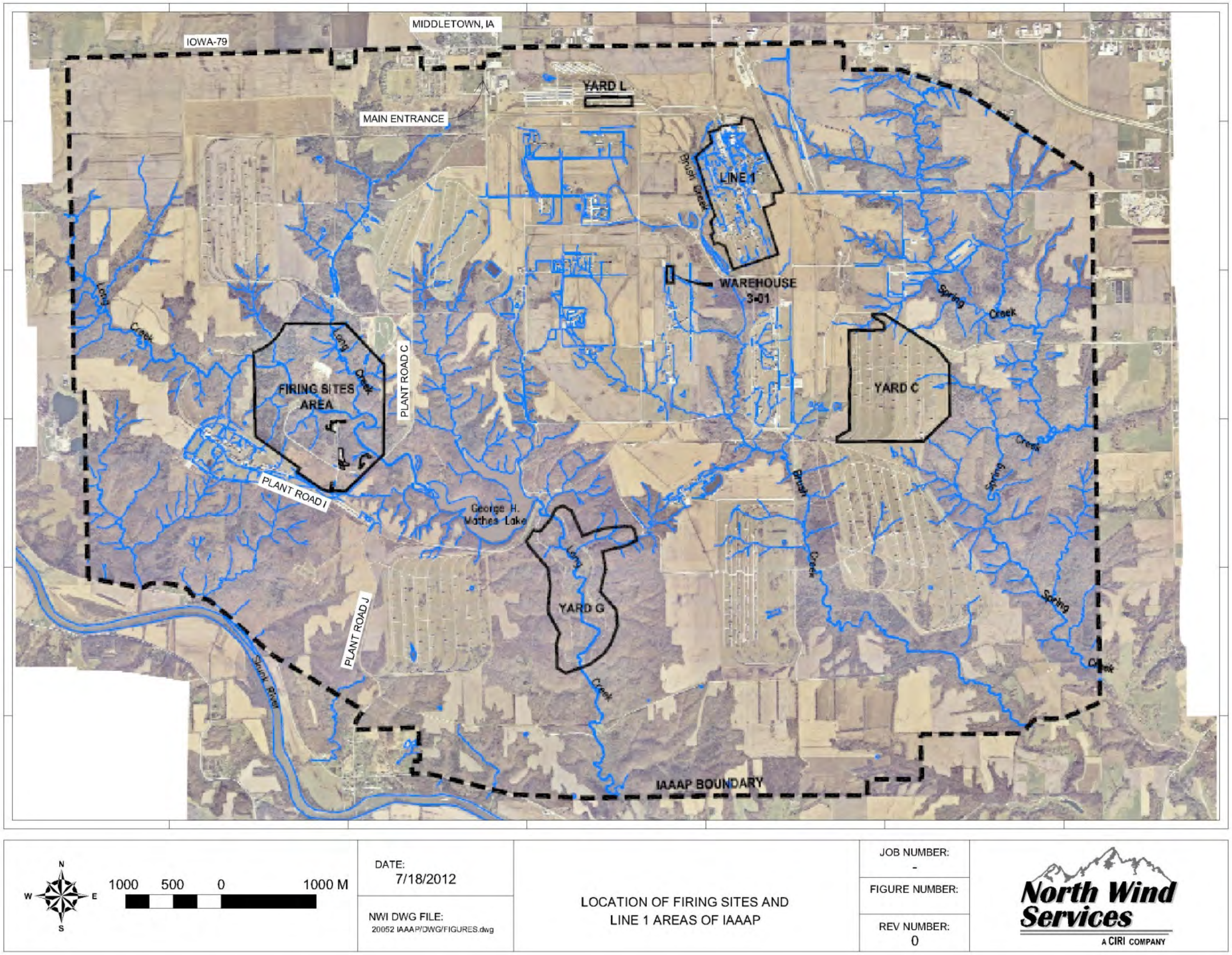

Figure 1-2. IAAAP Operable Unit 8.

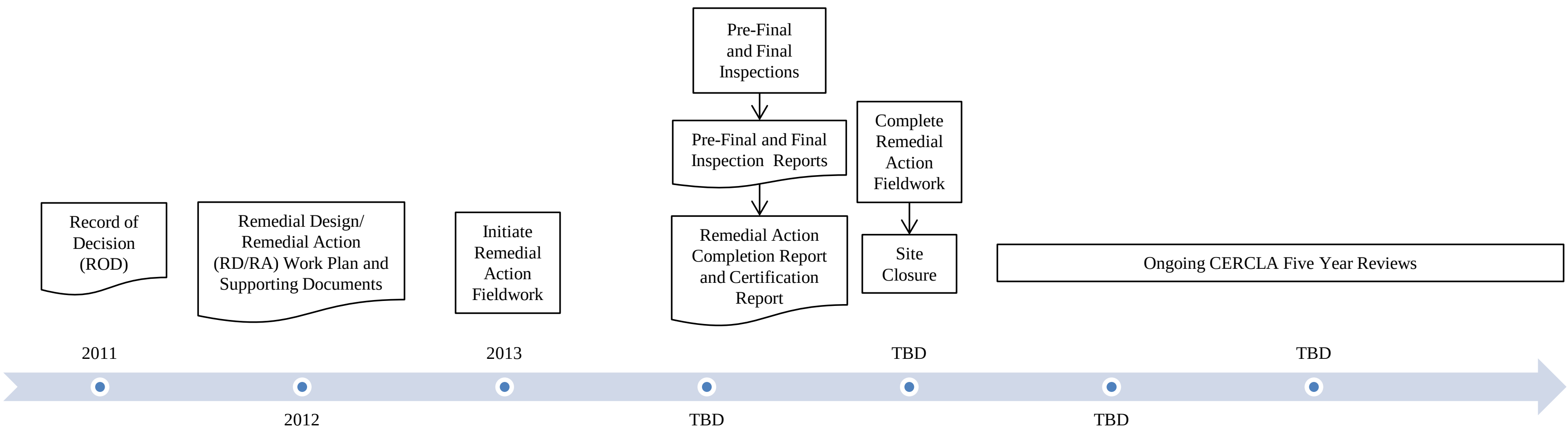

Figure 1-3. OU-8 CERCLA RA process.

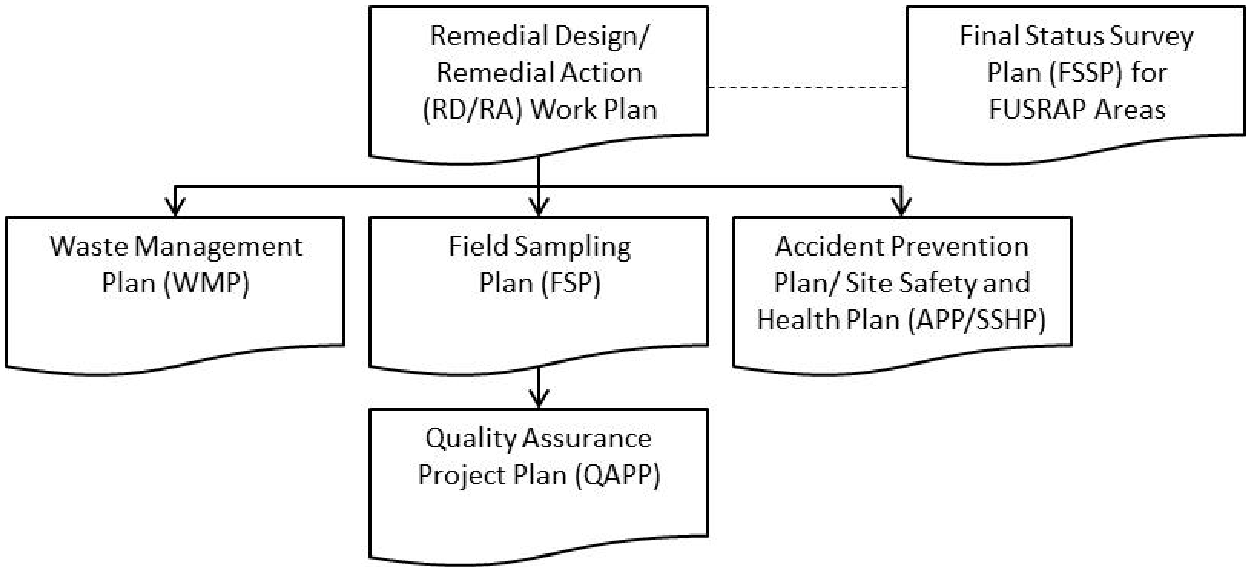

Figure 1-4. Relationship of RD/RA Work Plan and supporting documents for OU-8 RA.

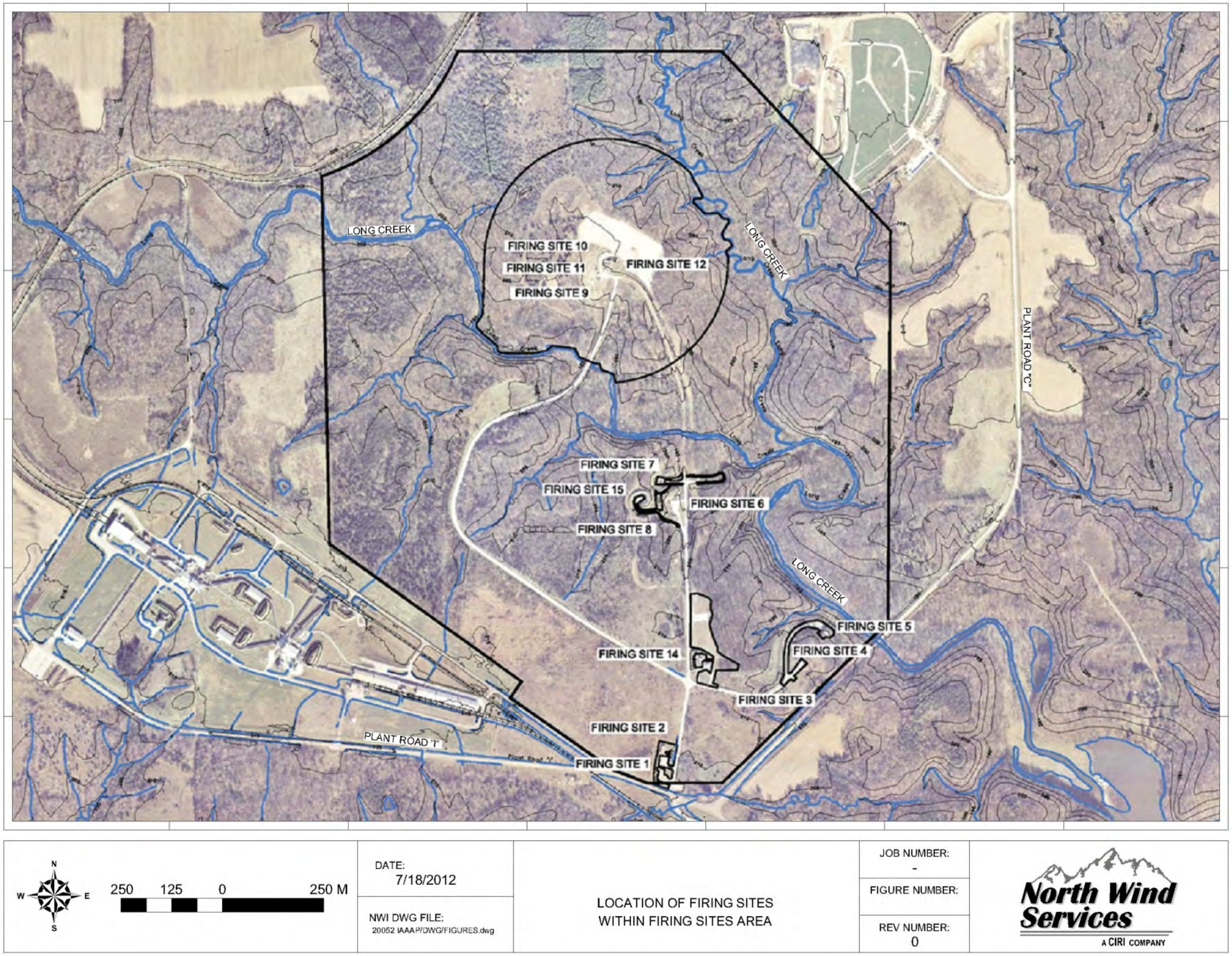

Figure 4-1. Location of firing sites within the Firing Sites Area.

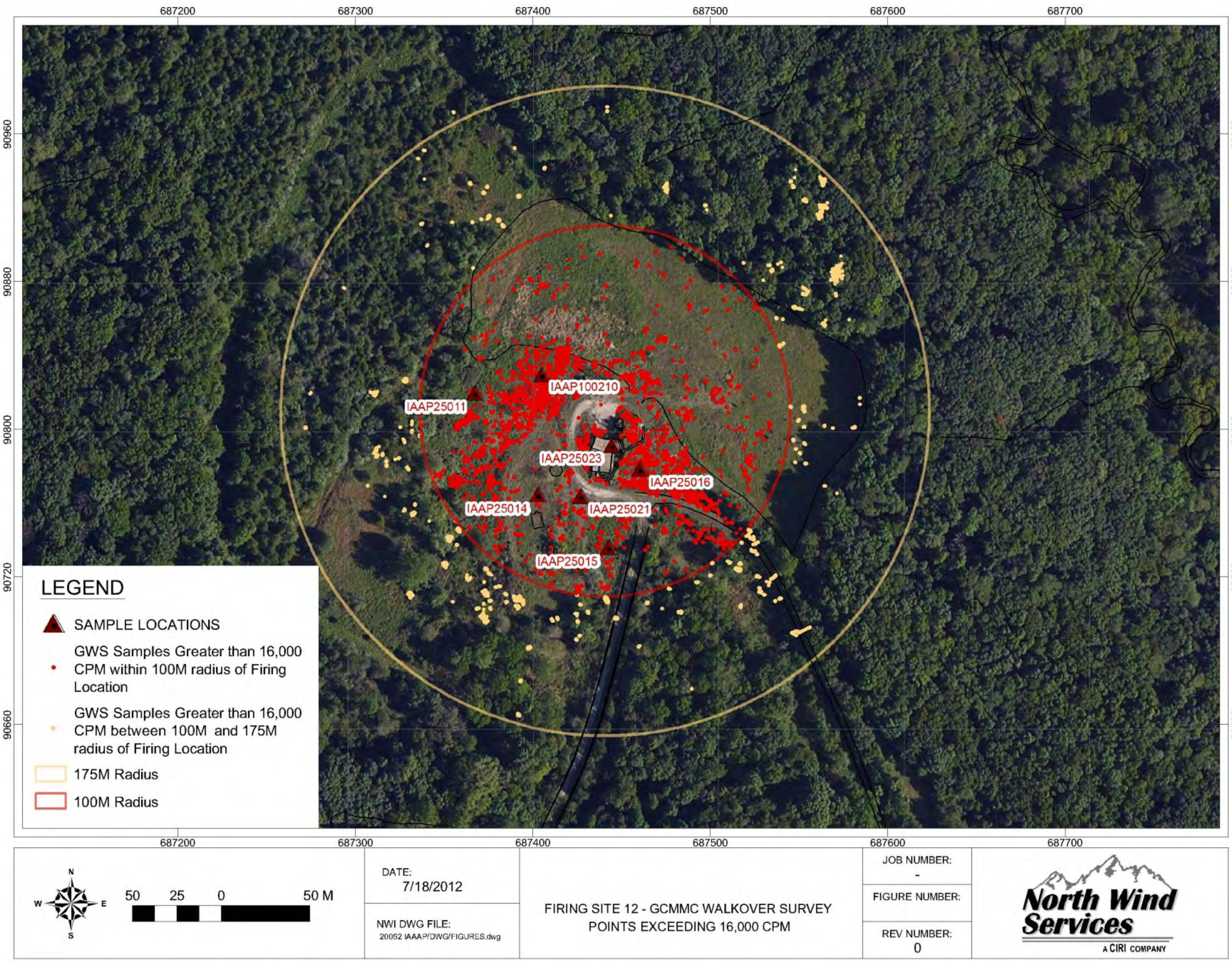

Figure 4-2. FS-12 gamma walkover survey points exceeding 16,000 cpm.

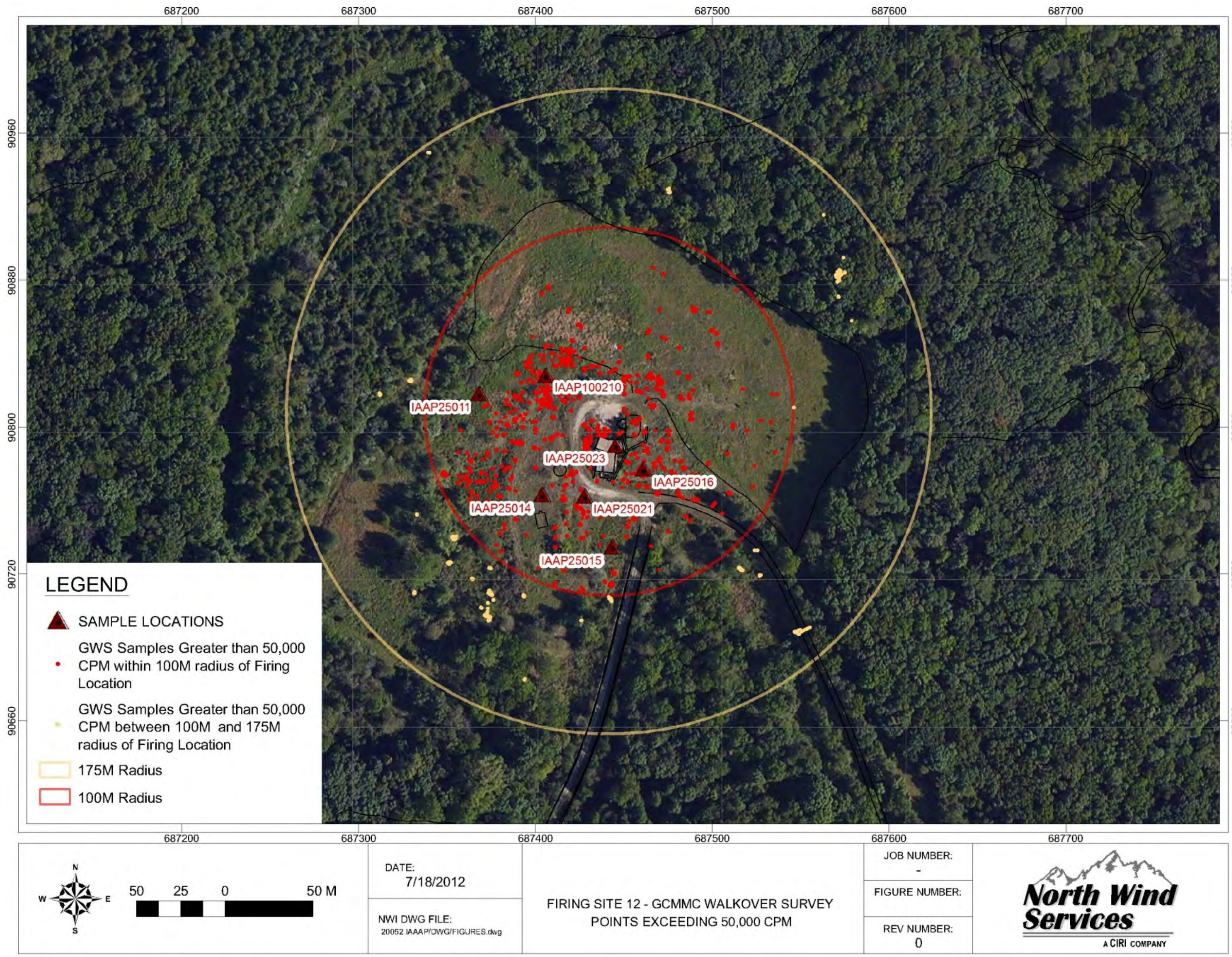

Figure 4-3. FS-12 gamma walkover survey points exceeding 50,000 cpm.

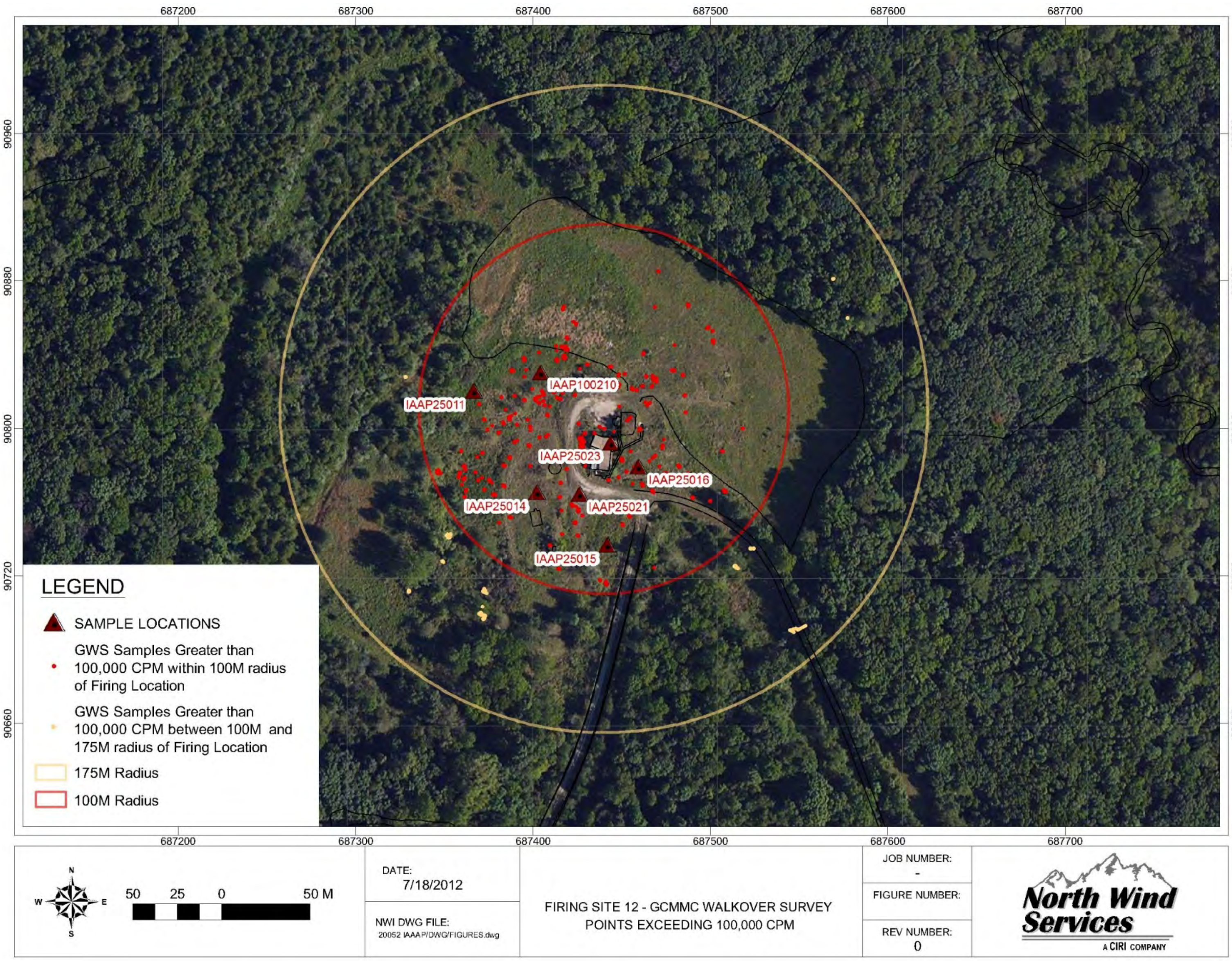

Figure 4-4. FS-12 gamma walkover survey points exceeding 100,000 cpm.

Figure 4-5. DU-contaminated area at FS-1 and FS-2.

Figure 4-6. DU-contaminated area at FS-3, FS-4, and FS-5.

Figure 4-7. DU-contaminated soil at FS-6.

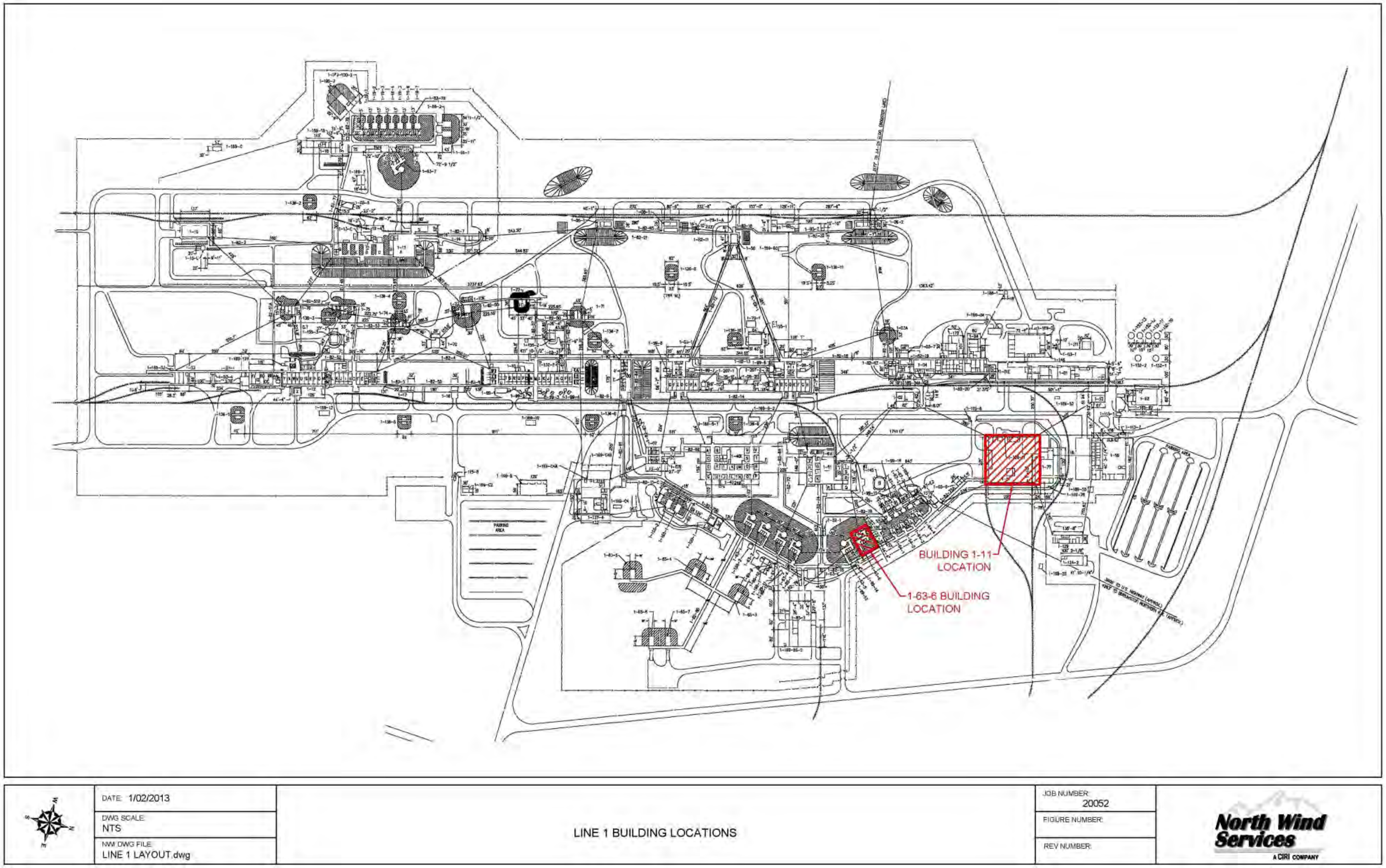

Figure 4-8. Line 1 building locations.

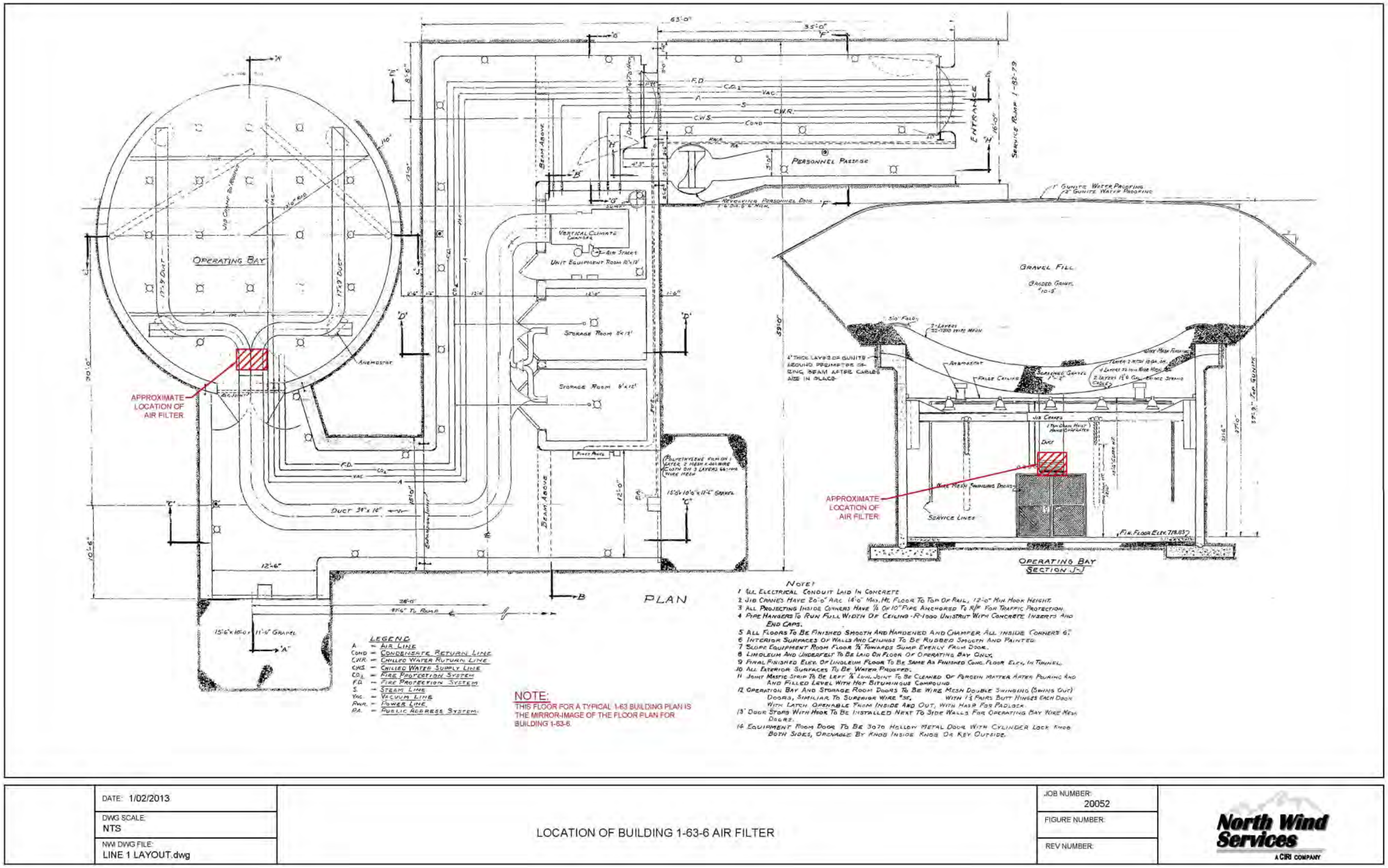

Figure 4-9. As-built floor plan for a generic 1-63 type building. The floor plan of Building 1-63-6 is the mirror image of the generic floor plan.

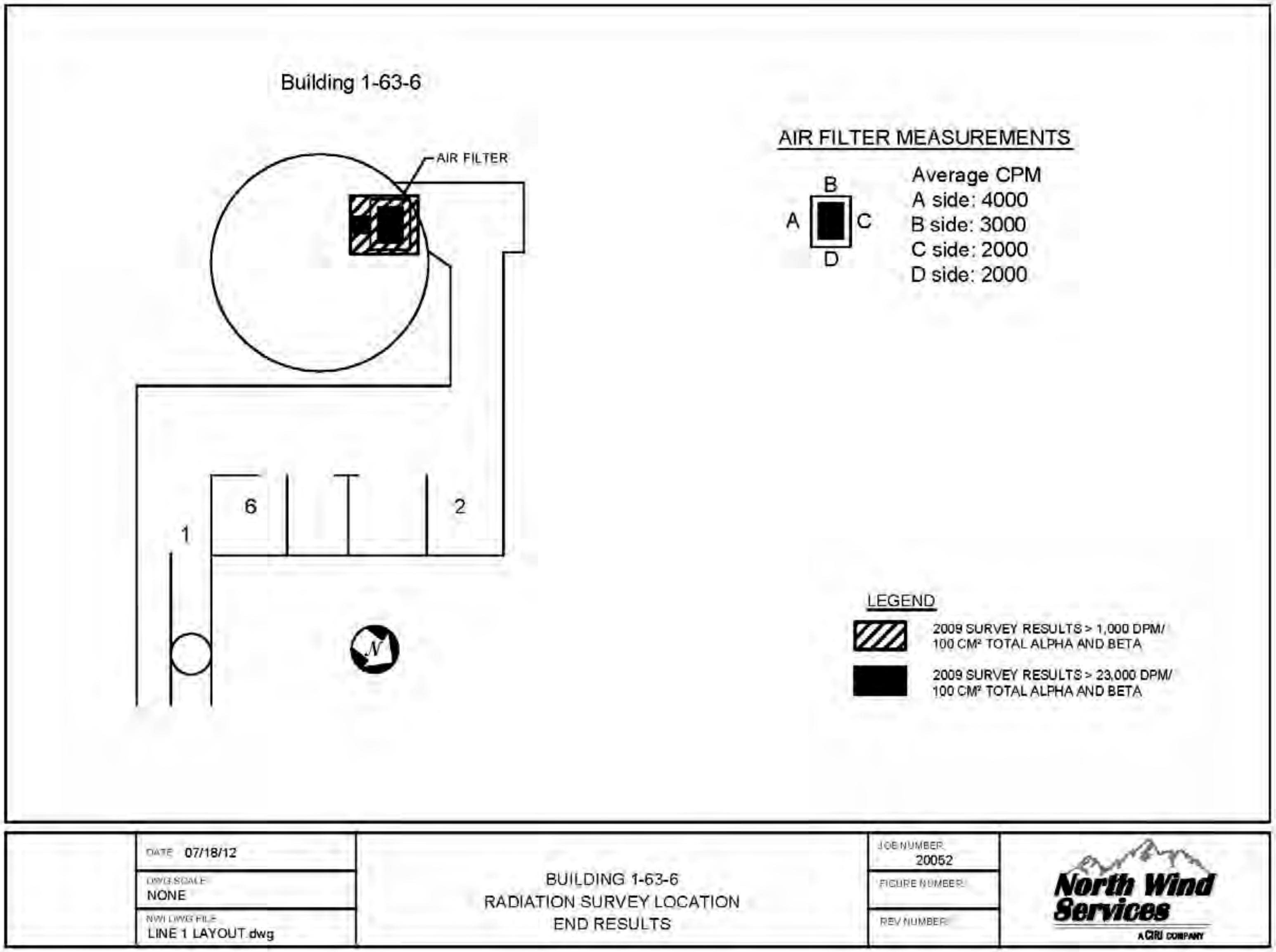

Figure 4-10. Radiological survey results for Building 1-63-6.

Figure 4-11. Photograph of the HVAC air filter in Building 1-63-6.

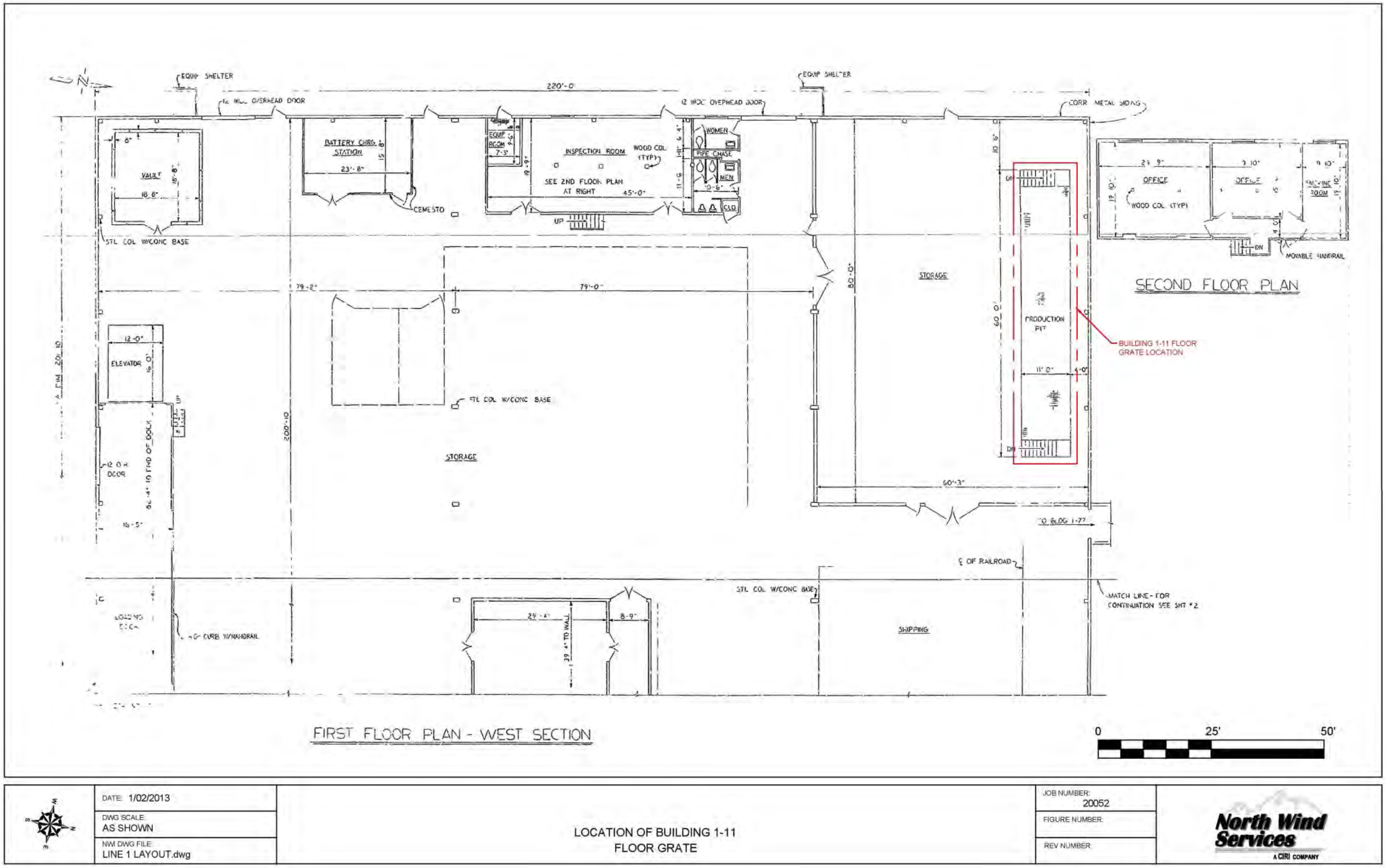

Figure 4-12. As-built floor plan for western portion of Building 1-11.

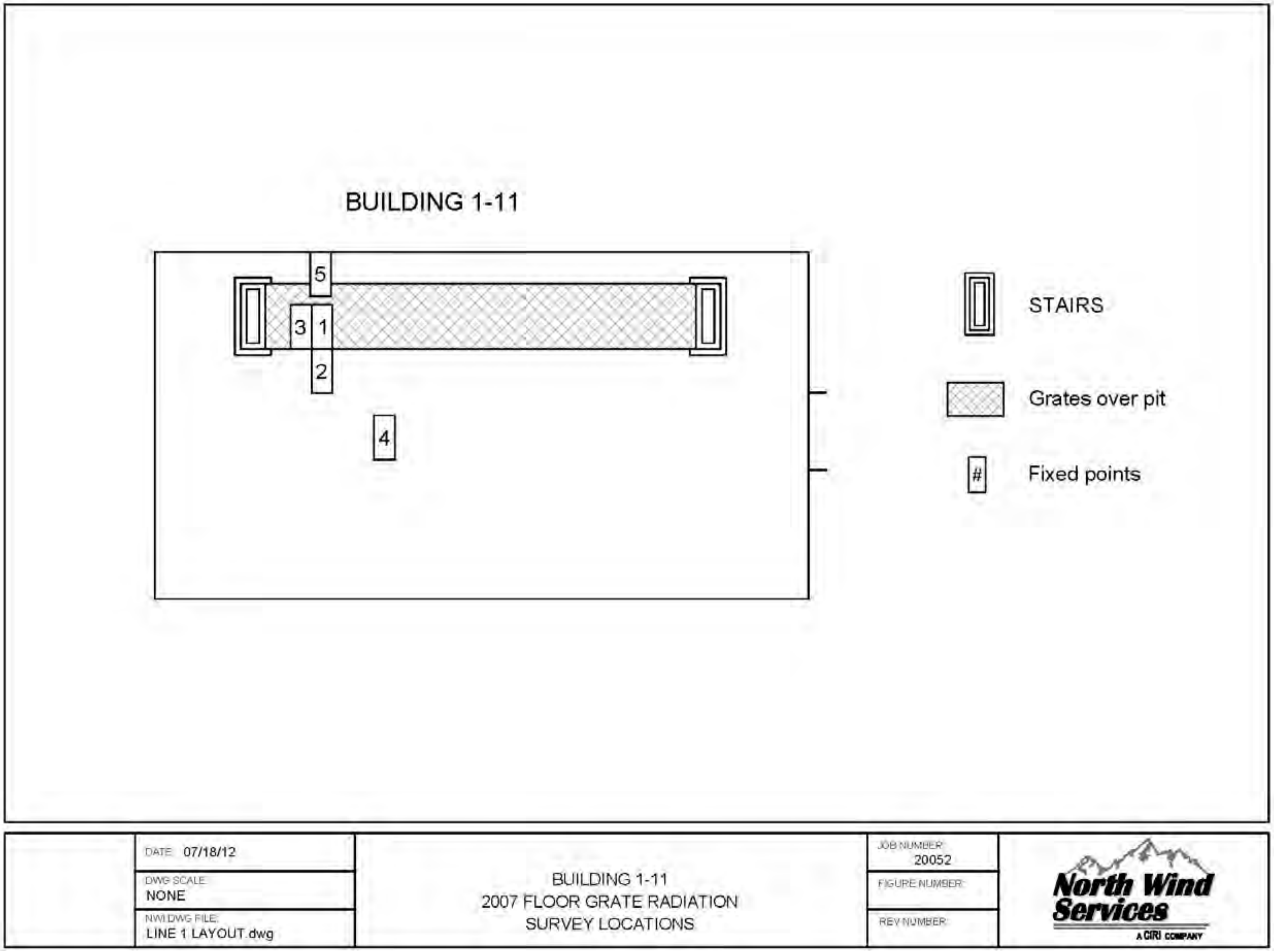

Figure 4-13. 2007 rad survey location for Building 1-11 production pit grate vicinity.

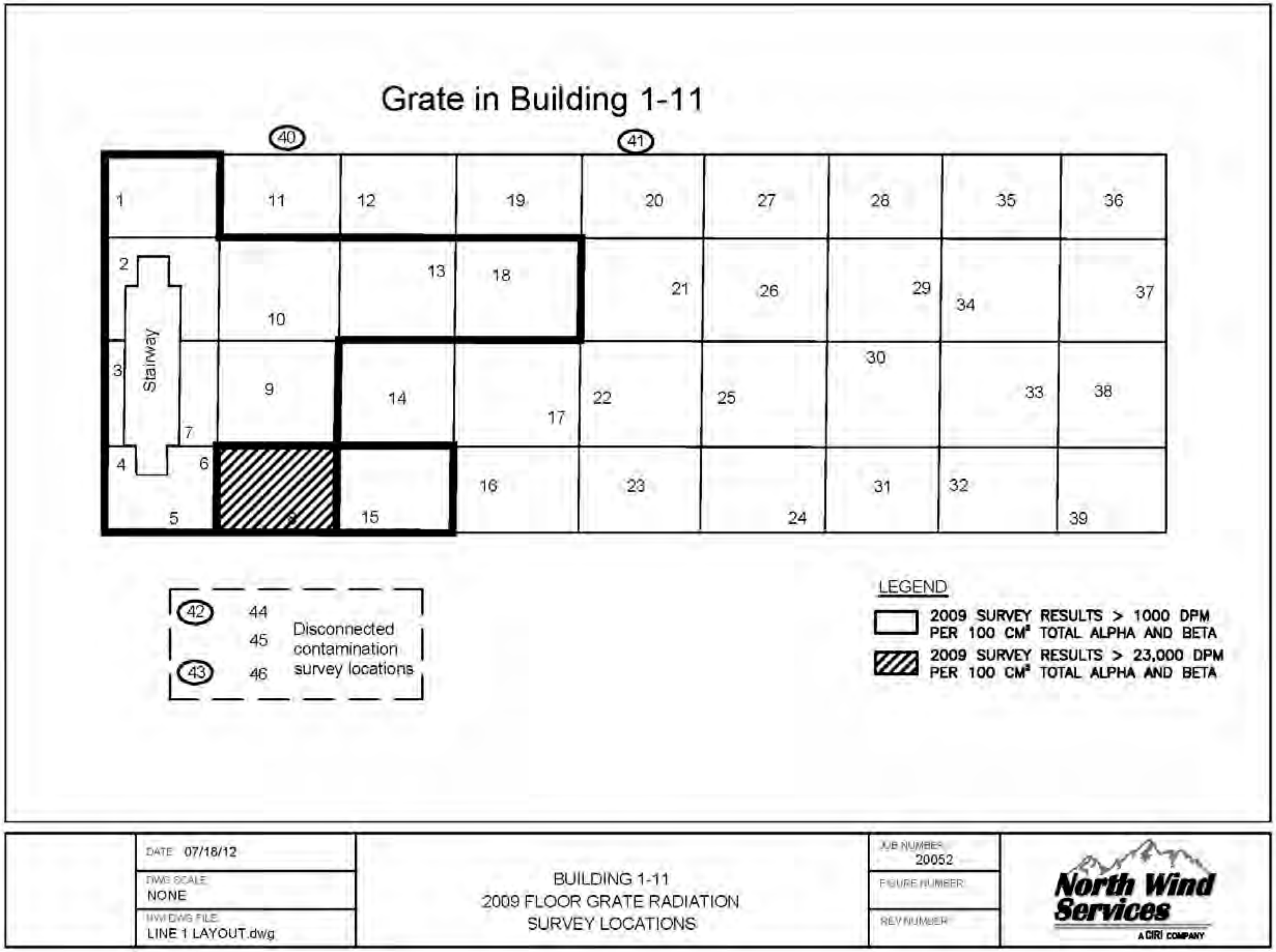

Figure 4-14. 2009 radiological survey results for Building 1-11 production pit grate vicinity.

Figure 4-15. Photograph of Building 1-11 production pit grate and vicinity looking northwest.

12. TABLES

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Table 3-1. Project applicable or relevant and appropriate requirements.

Requirement	Citation	Description	ARAR Determination
10 CFR 20, Subpart E NRC Radiological Criteria for License Termination	10 *CFR* 20.1403 (b) and (e)	These provisions identify the criteria under which a site is acceptable for license termination under restricted conditions. 10 *CFR* 20.1403(b) requires that there be provisions for legally enforceable institutional controls that provide reasonable assurance that the total effective dose equivalent from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem/yr. 10 *CFR* 20.1403(e) requires that the annual dose to an average member of the critical group is as low as reasonably achievable and would not exceed 100 m (328 ft) rem/yr if land use controls are no longer present.	<u>Chemical-Specific ARAR.</u> These criteria are relevant and appropriate to the cleanup of DU-contaminated soil and structures at FUSRAP areas. They were used to develop the industrial RGs for soil and structures. The selected remedy complies with these criteria through the excavation and off-site disposal of soil and structural material that exceed the industrial RGs.
Endangered Species Act	16 U.S.C §1538(a)(1)	These provisions prohibit the illegal taking of a federally listed endangered species. Federal agencies are required to ensure that their actions do not jeopardize the continued existence of a listed species or result in destruction of or adverse modification of its critical habitat.	<u>Location-Specific ARAR.</u> A federally listed endangered species, the Indiana bat, may be found as a transient species within the FUSRAP areas of IAAAP. Therefore, these requirements are relevant and appropriate for RAs conducted within the FUSRAP areas. The selected remedy complies with these provisions.
10 CFR 20, Subpart B, Radiation Protection Programs	10 *CFR* 20.1101(d)	These provisions impose a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, such that the highest individual dose to the public will not exceed 10 mrem/yr.	<u>Action-Specific ARAR.</u> The provisions of Section 20.1101(d) are relevant and appropriate to actions involving releases of airborne radioactive materials during remediation. The selected remedy complies with these provisions.

Table 4-1. Operable Unit-8 RA areas.

Media	Subarea Name	Site/Structure Names
Soil	FS-1 and FS-2 Soil[a]	FS-1 and FS-2
	FS-3, FS-4, and FS-5 Soil	FS-3, FS-4, and FS-5
	FS-6 Soil	FS-6
	FS-12 Soil	FS-9, FS-10, FS-11, and FS-12
	FS-12 Structures	Bunker and Firing Site Control Facility
Structures	Line 1 Buildings	Building 1-63-6 and Building 1-11

a. DU-contaminated soil from FS-1 and FS-2 has already been removed.

Table 4-2. Estimated in-situ volume of soil exceeding the RG (150 pCi/g) for DU.

Location	Surface Soil Volumes 0-30 cm (0-1 ft) depth		Subsurface Soil Volumes 30 to 60 cm (1-2 ft) depth		Total Soil Volumes	
	(m^3)	**(yd^3)**	**(m^3)**	**(yd^3)**	**(m^3)**	**(yd^3)**
Firing Sites 1[a] and 2[a]	0.8	1	0	0	0.8	1
Firing Sites 3, 4, and 5[b]	0.8	1	0	0	0.8	1
Firing Site 6 Area[b]	0.8	1	0	0	0.8	1
Firing Site 12 Area	10,558	13,809	2,392	3,129	12,950	16,938
Total Volume	**10,560.4**	**13,812**	**2392**	**3,129**	**12,952.4**	**16,941**

a. DU-contaminated soil from FS-1 and FS-2 has already been removed.
b. Only has isolated DU fragments.

Table 4-3. Summary of process alternatives.

					Disposal Facilities						
	Alternative	Description	Pros	Cons	Clive, UT	Perma-Fix	NNSS	Effectiveness	Implementability	Cost	Recommendation
1	Excavation Only	Excavate, package, and dispose all DU-contaminated soil materials in one waste stream	• Only one activity • Only one waste stream • May provide cost effective means to dispose of DU materials	No reduction in volume	Must meet the <5% by weight DU requirement			High Removes all contaminants	Easy Applicable to all alternatives	High Excavation costs (needed for all alternatives) Medium Soil disposal cost	• Recommended if disposal option for DU fragments is not available or DU disposal is cost prohibitive • Also recommended if sorting is not able to achieve a significant soil volume reduction
2	Physical DU/ Fragment Separation	Density classification using air fluidization	• Will effectively separate the DU from the soils materials • More efficient separation than screening	Not based on rad measurements so both waste streams could be high in radioactive contamination	Remaining Soil	DU Fragments	DU Fragments	Medium Dependent on ability to separate DU particles from soil particles in the fine textured, cohesive site soils	Medium Additional air supply and utilities are required and additional waste stream and disposal are required	Medium Separation cost High DU disposal cost	• High cost of equipment and production of an additional waste stream (filters) • Will not likely separate DU sufficiently to achieve the cleanup criteria for the soils • Not recommended
		Vibrating screen	Very effective in separating fragments from soils	• Not based on rad measurements so both waste streams could be high in radioactive contamination • Small DU particles could have high radioactivity levels	Remaining Soil	DU Fragments	DU Fragments	Medium Effective down to specific particle sizes	Easy Has been used many times in the past	Low Separation cost High DU disposal cost	• Will not separate all DU fragments from soil media • Not recommended unless needed to support processing of materials through the radiological monitoring and segregation system
3	Soil Survey and Segregation	Walk-over survey and manual removal	• DU can be detected with portable equipment in a walkover survey	• Labor intensive • Numerous DU fragments	Remaining Soil	DU Fragments	DU Fragments	High Dependent on manual observations	Medium Labor intensive for identification and material handling	Medium Separation cost may be offset by reduced system segregation cost Medium DU disposal cost	Potential for use on this project • High probability of cost reduction • Use to compare cost and approach from implementing contractors • Proven system • Very labor intensive
		ISO-PACIFIC S3 Separations Systems	• Updated separation efficiency and speed • Currently available for use	• Has not been used to date for full-scale operations • Needs to be tested with site-specific materials	Reduced Volume	DU fragments	DU fragments	High All indications are that high volumes reduction can be achieved	Medium Additional equipment and utilities will be needed to support operations	Low High equipment costs should be offset by reduced soil disposal cost	Potential for use on this project • Use to compare cost and approach from implementing contractors • Only issue is that it is not yet proven, although it is an upgrade to a proven system
		AMEC - Orion ScanSort	• Efficient separation with high throughput • Proven process - 3 projects • Has been utilized in “wet” environments • Currently available	Need to test with site specific materials	Reduced Volume	DU Fragments	DU Fragments	High All indications are that high volumes reduction can be achieved	Medium Additional equipment and utilities will be needed to support operations	Low High equipment costs should be offset by reduced soil disposal cost	Potential for use on this project • Highest probability of cost reduction • Proven system
		Eberline SGS Sort and Segregation System	System has been used at multiple sites in the past	• Has not been used for a long period of time • Requires refurbishment and testing	Reduced Volume	DU Fragments	DU Fragments	High All indications are that high volumes reduction can be achieved	High Equipment not readily available, and refurbishment would have to be included in schedule	Medium Additional cost to support refurbishment	Not recommended Similar systems are readily available from other vendors without the time or cost for refurbishing an inactive system

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Appendix A

Remedial Design Drawings
Operable Unit-08 Depleted Uranium Contaminated Soil and Structures Remedial Design

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OPERABLE UNIT-08
DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURES REMEDIAL DESIGN

INDEX OF DRAWINGS		
	SHEET	DRAWING TITLE
GENERAL DRAWINGS		
1	G-1	TITLE SHEET
2	G-2	SITE LAYOUT AND UTILITIES
CIVIL DRAWINGS		
3	C-1	EXISTING CONDITIONS PLAN
4	C-2	ADDITIONAL WALKOVER SURVEY PLAN
5	C-3	SITE EXCAVATION AND PHASING PLAN
6	C-4	UNDERGROWTH CLEARING PLAN
7	C-5	FINAL CONTOURS GRADING PLAN
8	C-6	HAUL ROUTE PLAN
9	C-7	STORM WATER AND REVEGETATION PLAN
10	C-8	STORM WATER DETAILS
PROCESS DRAWINGS		
11	P-1	PROCESS FLOW DIAGRAM
12	P-2	STAGING AND SYSTEM LAYOUT
13	P-3	PROCESS EQUIPMENT LAYOUT
ELECTRICAL DRAWINGS		
14	E1	ELECTRICAL ONE-LINE DIAGRAM
15	E2	POWER DISTRIBUTION SKID

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SUBMITTED BY: G. MECHAM | CONTRACT NO.:
PLOT SCALE: NTS | PLOT DATE: 7/9/12 | FILE NUMBER: NW12-271
SIZE: ANSI B | FILE NAME: 20052G-001.DWG

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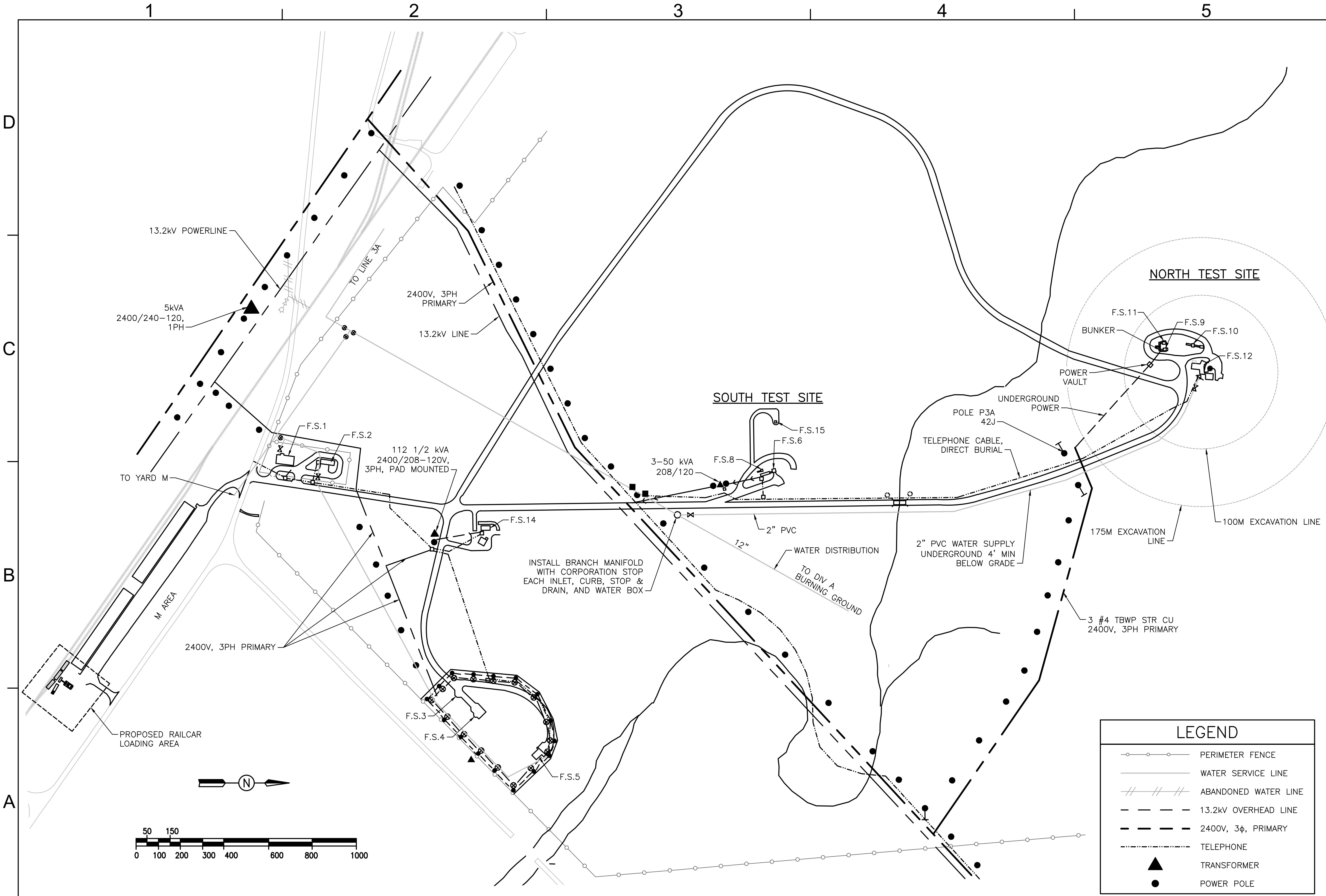
OPERABLE UNIT (OU) - 8
IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

TITLE SHEET

Sheet ID
G-1



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SIZE: ANSI B	FILE NAME: G-2 SITE LAYOUT.DWG	

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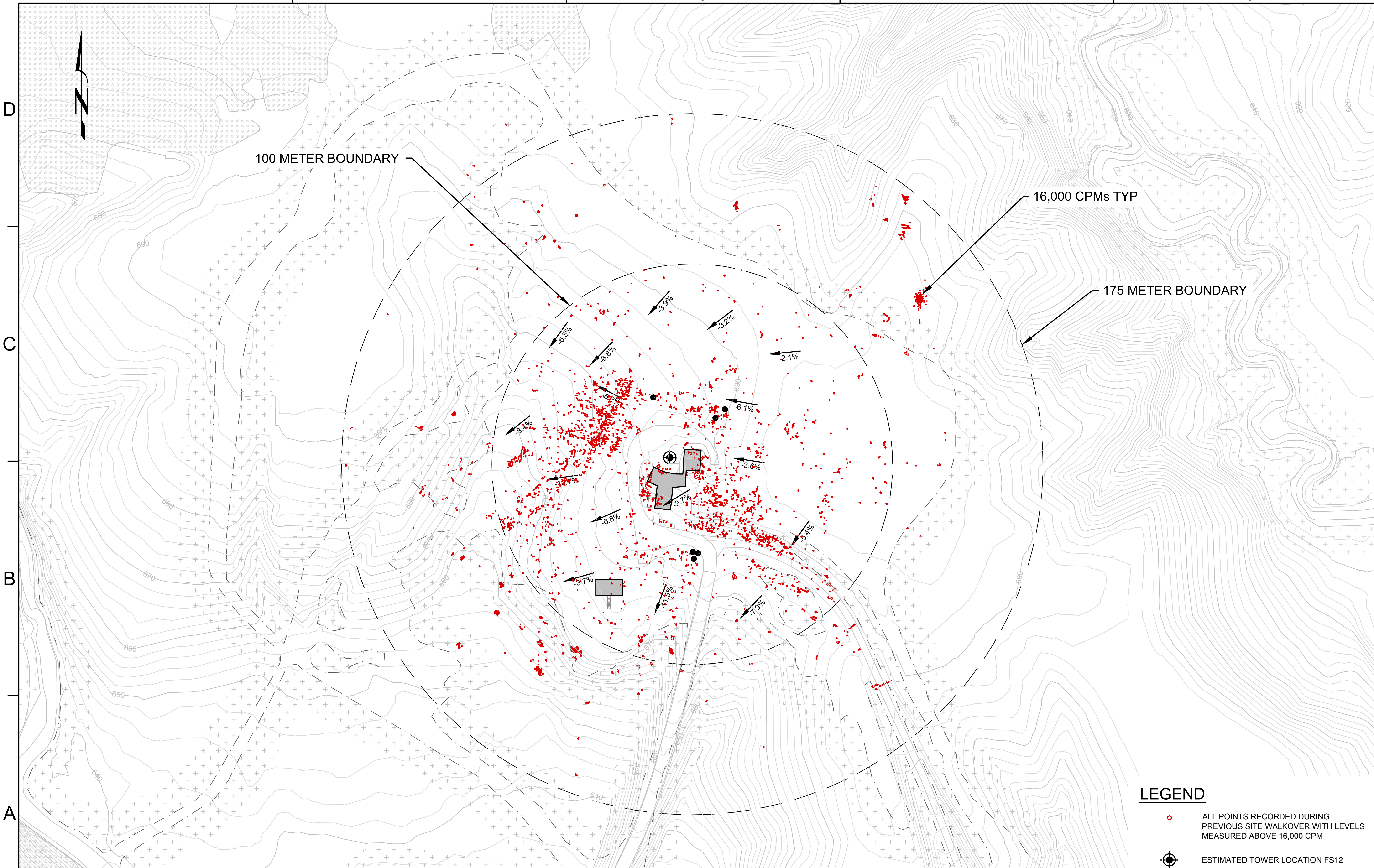
SITE LAYOUT
AND UTILITES

Sheet
ID
G-2



EXISTING CONDITIONS PLAN

SCALE: 1" = 150'

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SIZE: ANSI B	FILE NAME: 20052C-101.DWG	

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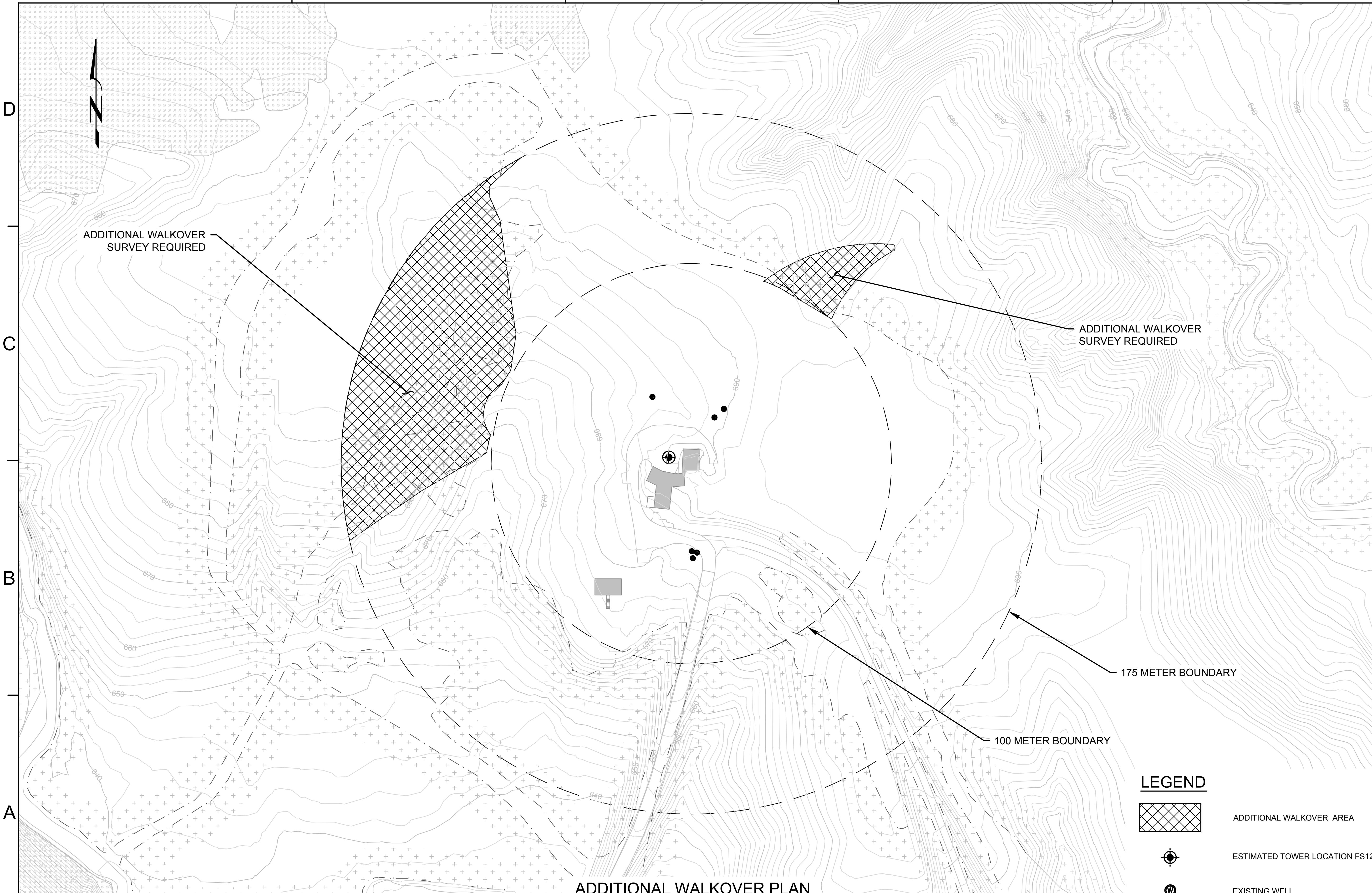
EXISTING CONDITIONS PLAN

Sheet ID
C-1



ADDITIONAL WALKOVER PLAN

SCALE: 1" = 150'

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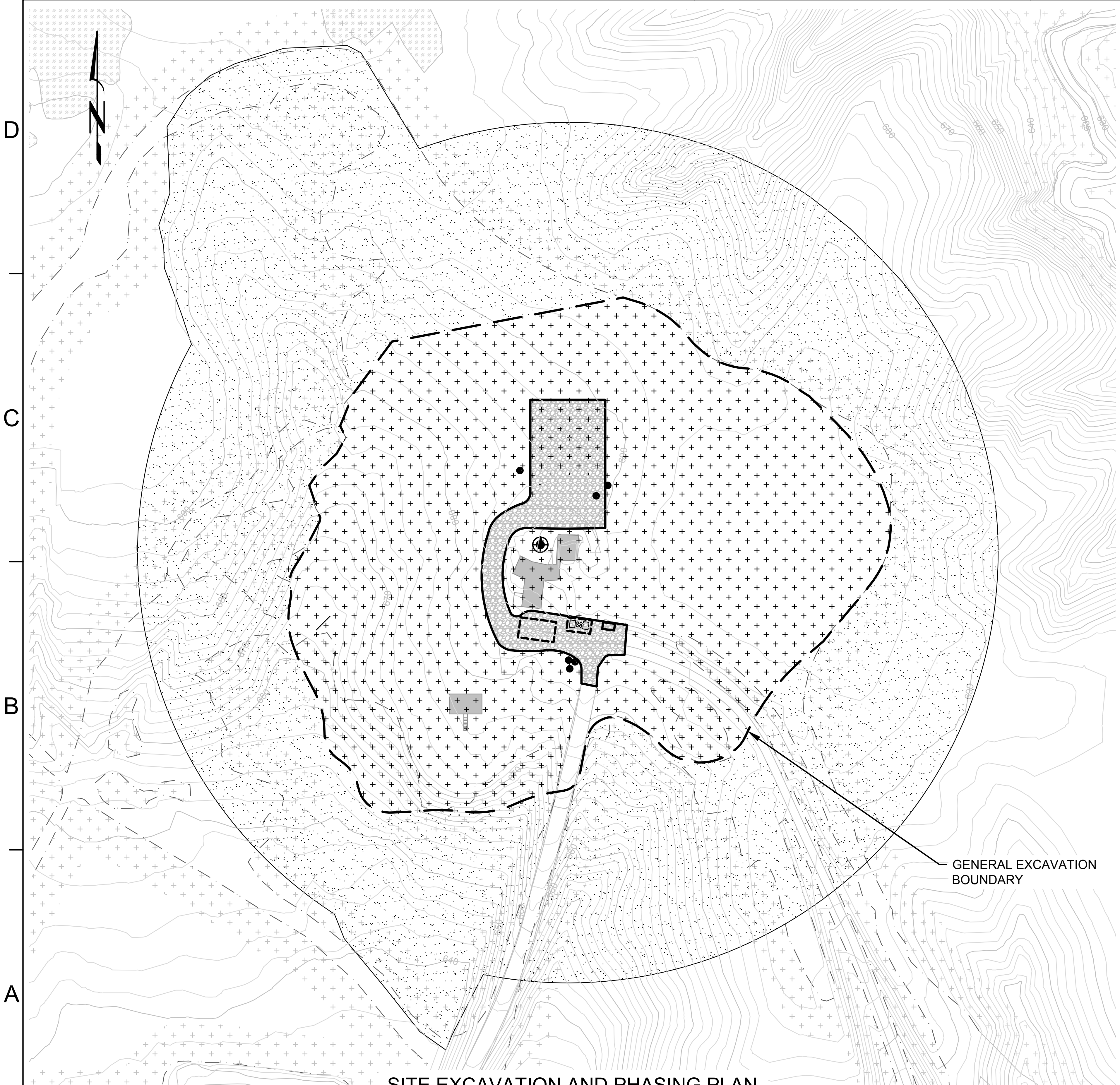
ADDITIONAL WALKOVER SURVEY PLAN

Sheet ID
C-2



SITE EXCAVATION AND PHASING PLAN

SCALE: 1" = 150'

LEGEND:

- GENERAL EXCAVATION AREA
- LOCALIZED EXCAVATION AREA
- PROCESS AND STAGING AREAS
- TREE LINE
- CENTER OF FIRING SITE
- EXISTING MONITORING WELLS

NOTES:

1. FOR THE GENERAL EXCAVATION AREAS THE SOIL WILL BE REMOVED IN PIE SLICE SEGMENTS. WITH THE SOIL REMOVED FROM A SEGMENT IT WILL BE SURVEYED AND LOCAL HIGH COUNT AREAS REMOVED UNTIL THE SEGMENT PASSES THE CRITERIA SET FOR THE FINAL SITE SURVEY.
2. THE SOIL WILL BE PROCESSED WITH A RADIOLOGICAL SORTER AND THE CLEAN SOIL RETURNED AS BACKFILL WITHIN THE EXCAVATED AREA.
3. EACH LOCAL SOURCE AREA WILL BE LOCATED AND THE SOIL LOCALLY REMOVED USING HAND SHOVELS, A VACUUM EXCAVATOR OR SMALL MECHANICAL EQUIPMENT, UNTIL THE SURROUNDING SOIL IS BELOW THE RG.
4. PROCESS AND STAGING AREAS AND ROAD WILL ALSO BE EXCAVATED WITHIN THEIR RESPECTIVE AREAS.
5. AVOID AND PROTECT EXISTING MONITORING WELLS.
6. REMOVE AND DISPOSE OF METAL STRUCTURES AND CONCRETE BLOCKS.

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SIZE: ANSI B	FILE NAME: 20052C-101.DWG	

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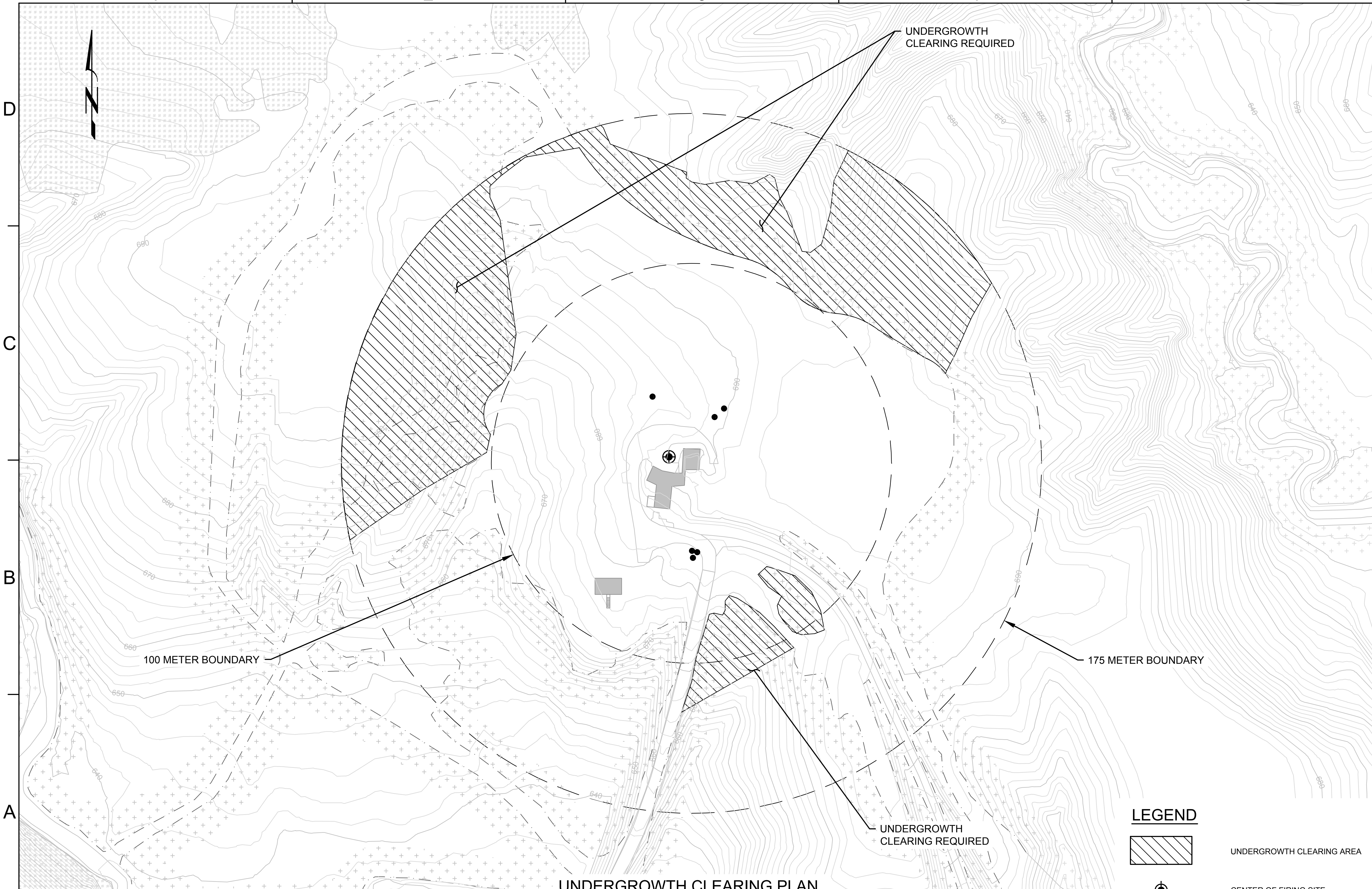
MIDDLETOWN, IOWA

SITE EXCAVATION AND PHASING PLAN

Sheet ID
C-3



UNDERGROWTH CLEARING PLAN

SCALE: 1" = 150'

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SIZE: ANSI B	FILE NAME: 20052C-101.DWG	

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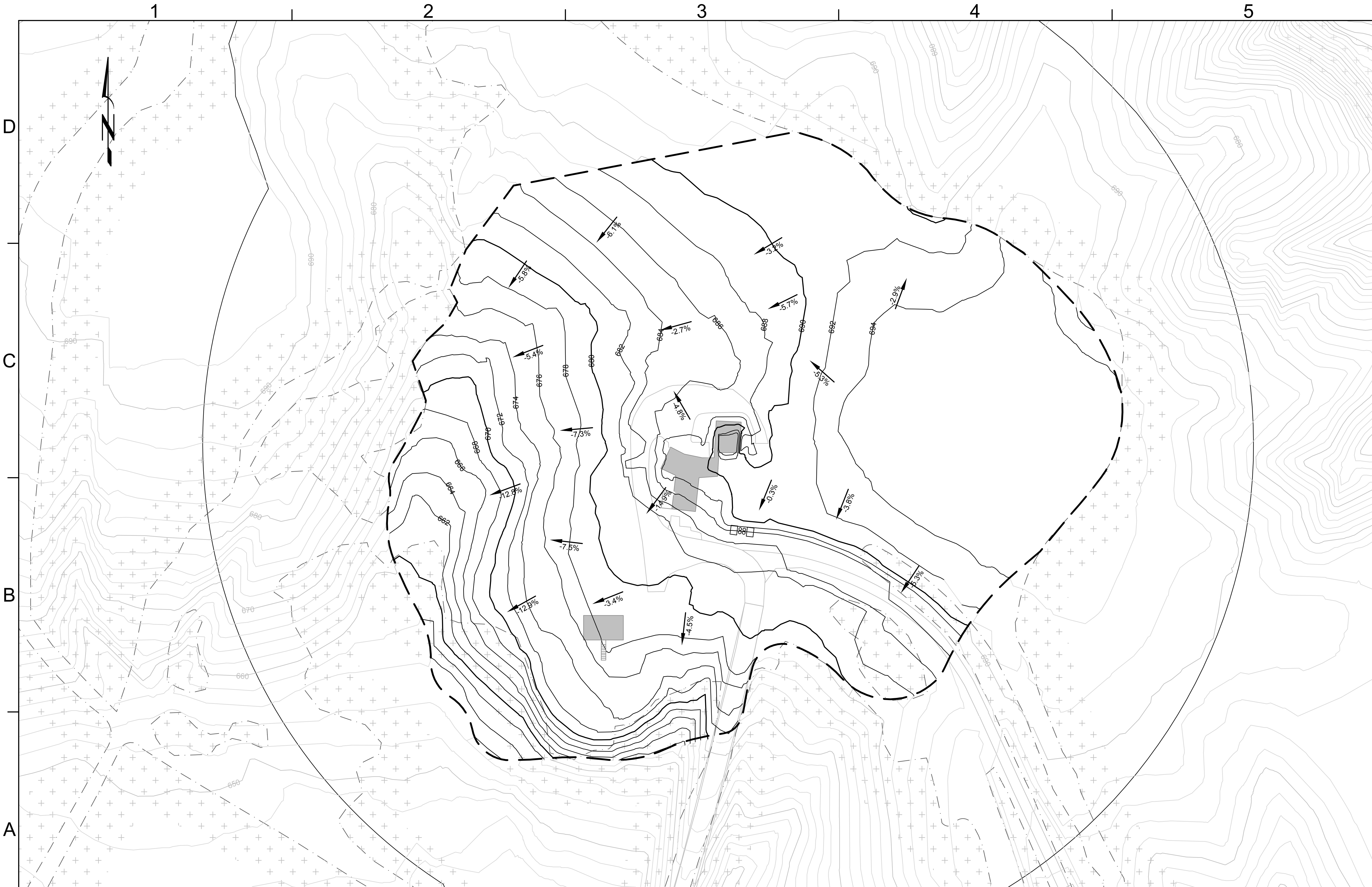
MIDDLETOWN, IOWA

UNDERGROWTH CLEARING PLAN

Sheet
ID
C-4



FINAL GRADING PLAN
SCALE: 1" = 100'

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SIZE: ANSI B	FILE NAME: 20052C-101.DWG		

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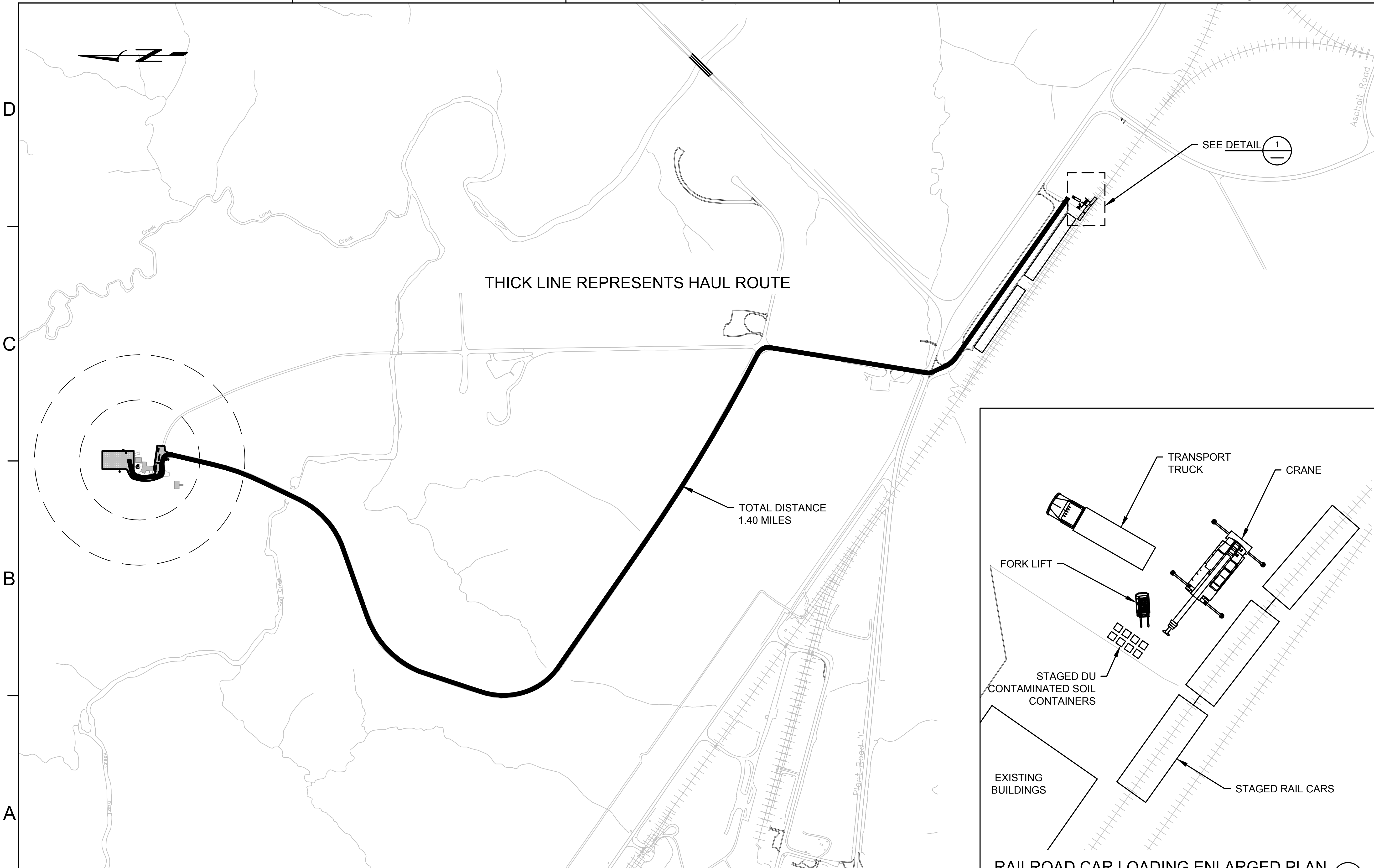
MIDDLETOWN, IOWA

FINAL GRADING PLAN

Sheet
ID
C-5



HAUL ROUTE PLAN

SCALE: 1" = 500'

RAILROAD CAR LOADING ENLARGED PLAN 1

SCALE: 1" =40'

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SIZE: ANSI B	FILE NAME: 20052C-101.DWG		

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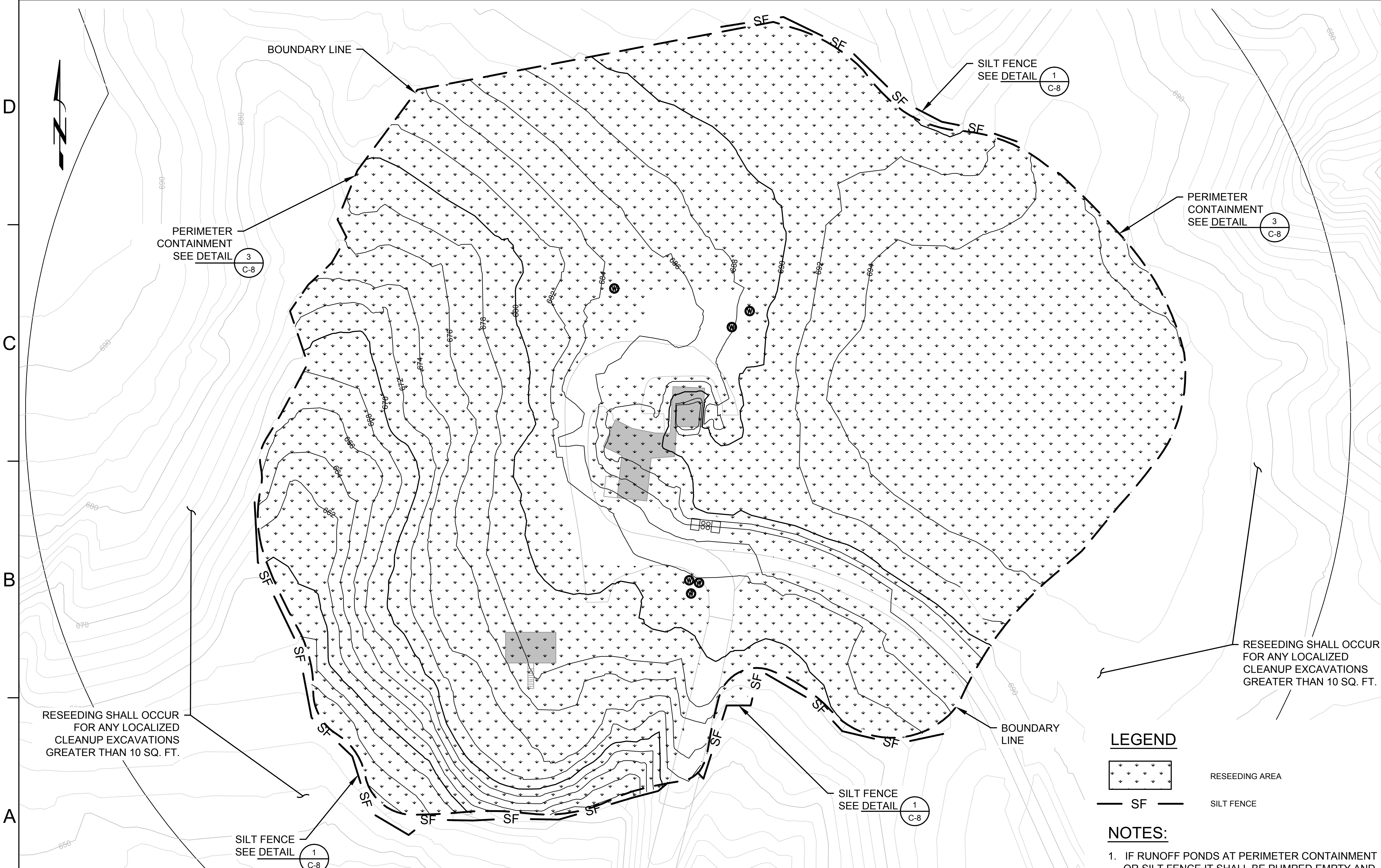
IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

HAUL ROUTE PLAN

Sheet ID
C-6



LEGEND

(reseeding symbol)	RESEEDING AREA
— SF —	SILT FENCE

NOTES:

1. IF RUNOFF PONDS AT PERIMETER CONTAINMENT OR SILT FENCE IT SHALL BE PUMPED EMPTY AND TREATED.

STORM WATER AND REVEGETATION PLAN

SCALE: 1" = 80'

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FILE NAME: 20052C-101.DWG
DATE: 7/13/12
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CONTRACT NO.:
FILE NUMBER: NW12-280

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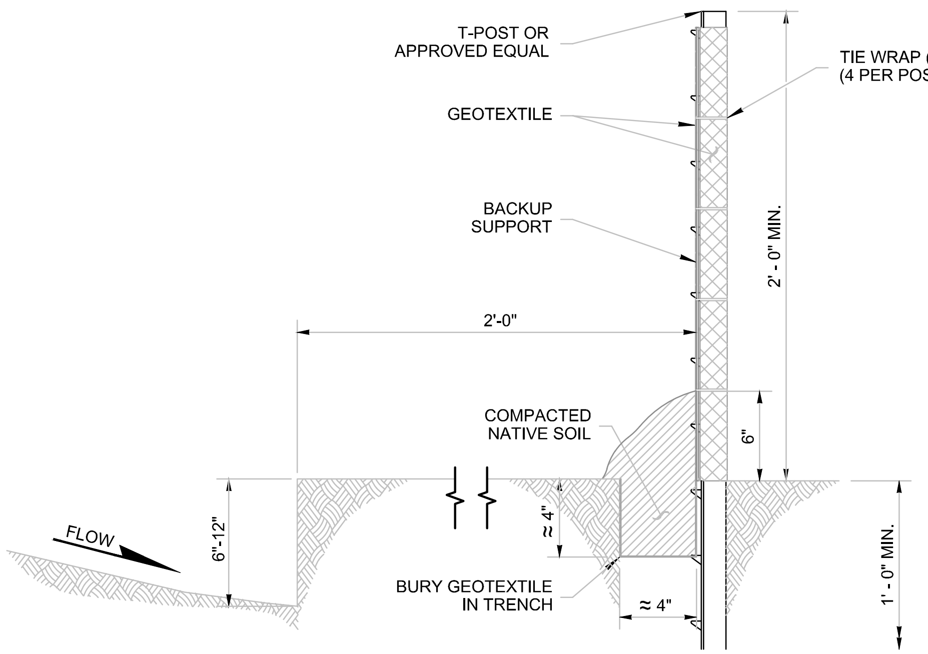
MIDDLETOWN, IOWA

STORMWATER AND REVEGETATION PLAN

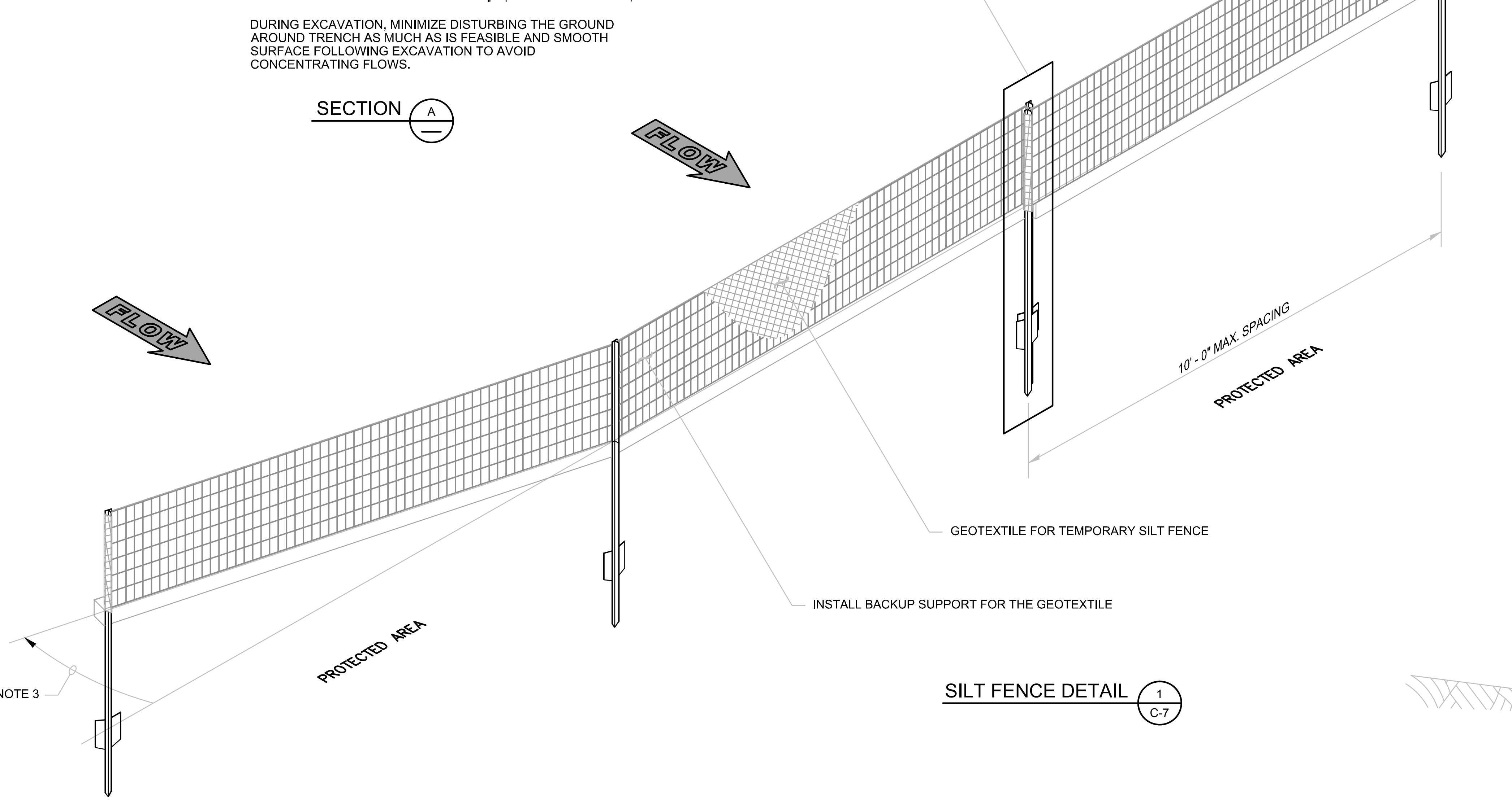
Sheet ID
C-7

1. MAXIMIZE DETENTION OF STORMWATER BY PLACING FENCE AS FAR AWAY FROM TOE OF SLOPE AS POSSIBLE WITHOUT ENCROACHING ON SENSITIVE AREAS OR OUTSIDE OF THE CLEARING BOUNDARIES.
2. INSTALL SILT FENCING ALONG CONTOURS.
3. INSTALL THE ENDS OF THE SILT FENCE TO POINT SLIGHTLY UP-SLOPE TO PREVENT SEDIMENT FROM FLOWING AROUND THE ENDS OF THE FENCE.

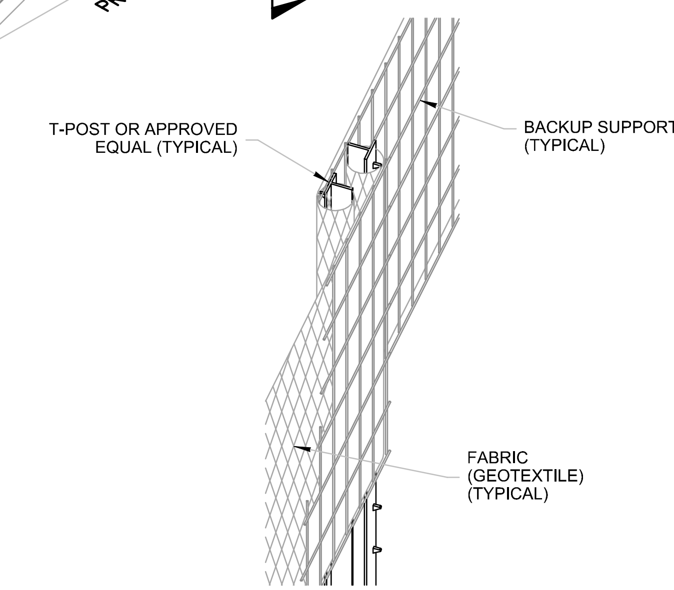


DURING EXCAVATION, MINIMIZE DISTURBING THE GROUND AROUND TRENCH AS MUCH AS IS FEASIBLE AND SMOOTH SURFACE FOLLOWING EXCAVATION TO AVOID CONCENTRATING FLOWS.

SECTION A

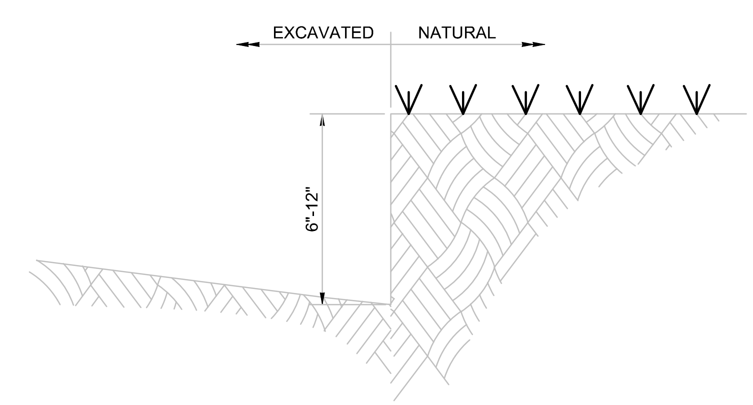


SILT FENCE DETAIL 1 C-7



SPLICED FENCE SECTIONS SHALL BE CLOSE ENOUGH TOGETHER TO PREVENT SILT LADEN WATER FROM ESCAPING THROUGH THE FENCE AT THE OVERLAP. JOINING SECTIONS SHALL NOT BE PLACED IN LOW SPOTS OR IN SUMP LOCATIONS.

TYPICAL SPLICE DETAIL 2



PERIMETER CONTAINMENT DETAIL 3 C-7

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SIZE: ANSI B	FILE NAME: 20052C-501.DWG	

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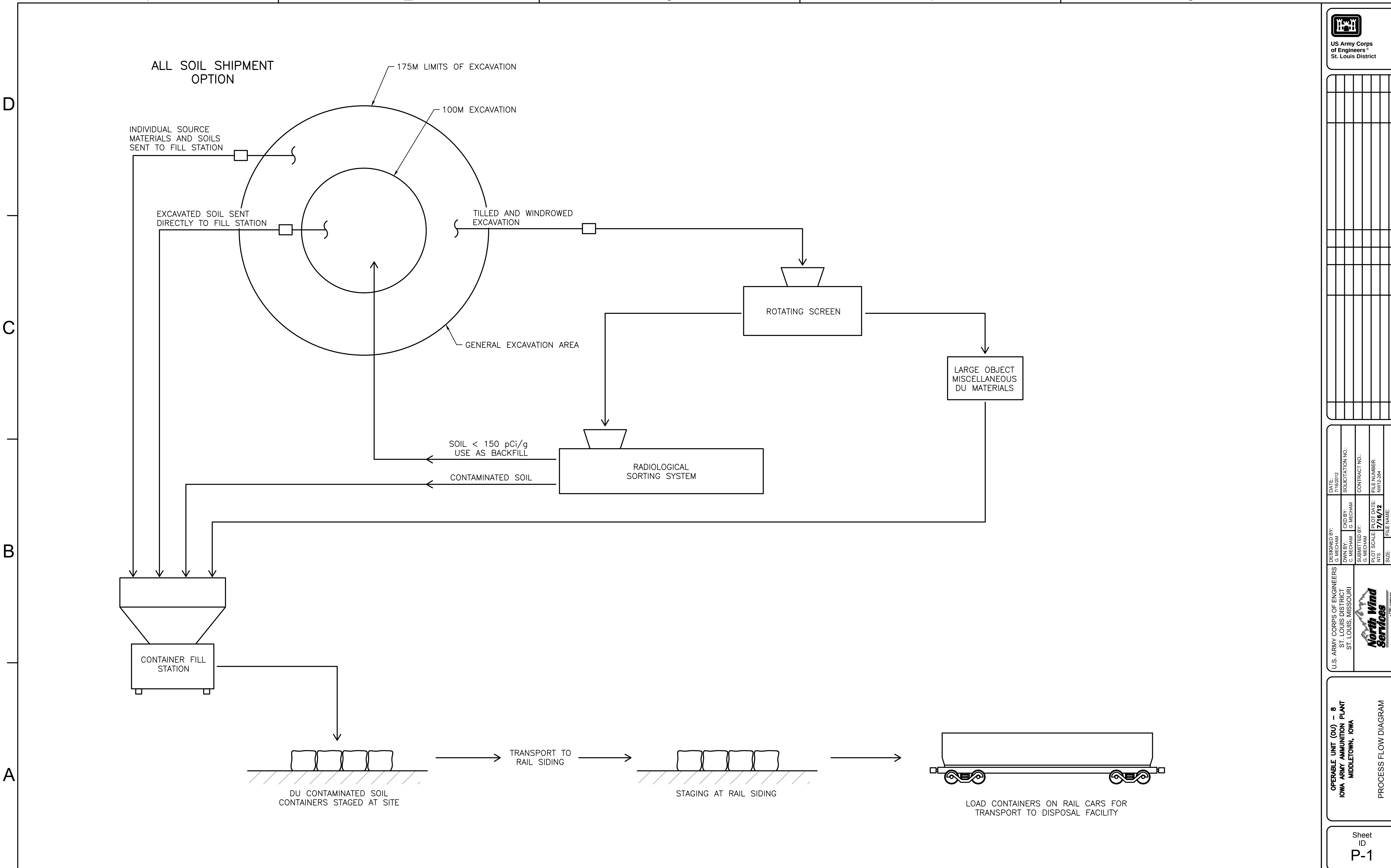
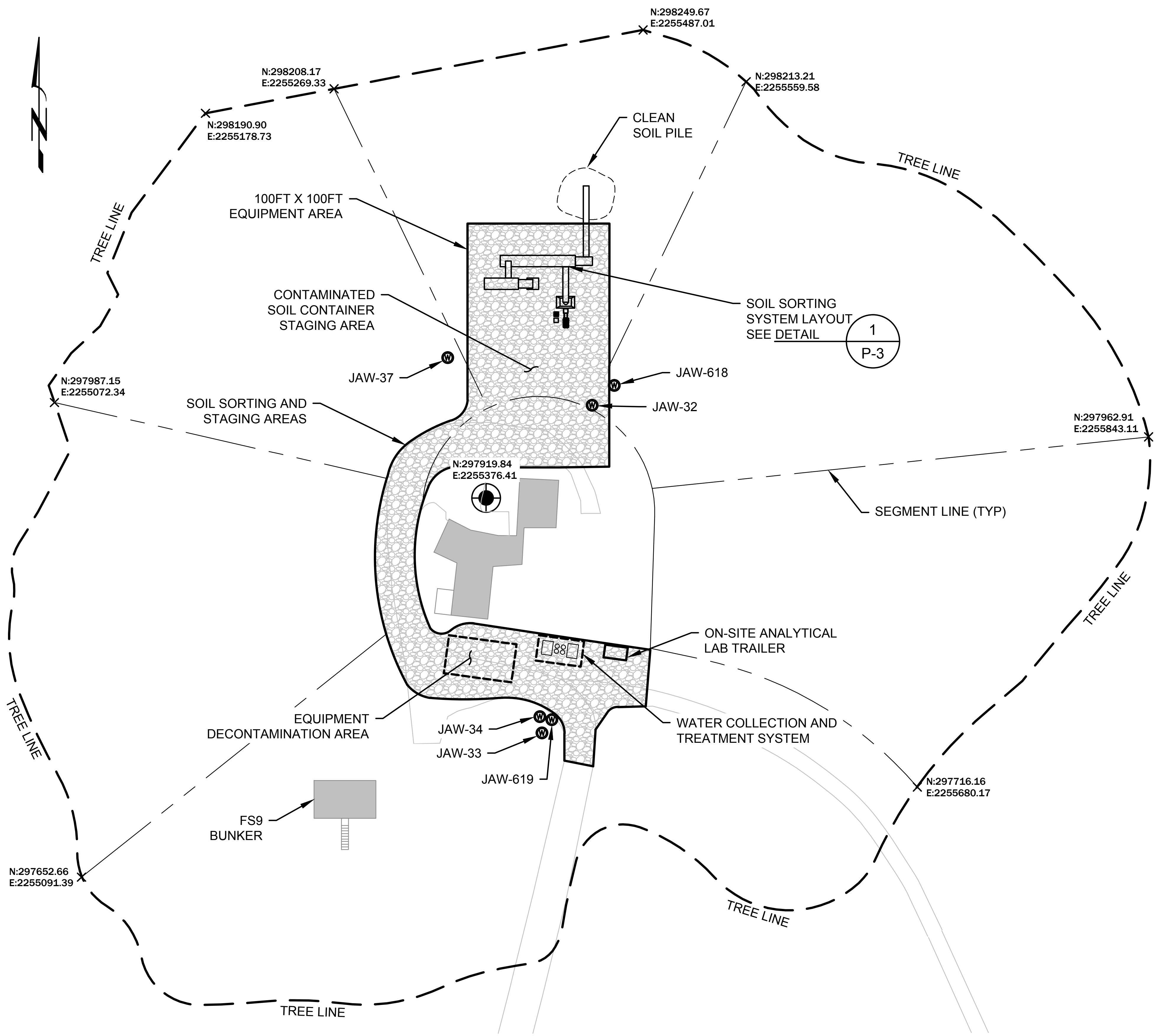
MIDDLETOWN, IOWA

STORMWATER DETAILS

Sheet ID
C-8


ALL SOIL SHIPMENT OPTION
175M LIMITS OF EXCAVATION
100M EXCAVATION
INDIVIDUAL SOURCE MATERIALS AND SOILS SENT TO FILL STATION
EXCAVATED SOIL SENT DIRECTLY TO FILL STATION
TILLED AND WINDROWED EXCAVATION
GENERAL EXCAVATION AREA
ROTATING SCREEN
LARGE OBJECT MISCELLANEOUS DU MATERIALS
SOIL < 150 pCi/g USE AS BACKFILL
CONTAMINATED SOIL
RADIOLOGICAL SORTING SYSTEM
CONTAINER FILL STATION
DU CONTAMINATED SOIL CONTAINERS STAGED AT SITE
TRANSPORT TO RAIL SIDING
STAGING AT RAIL SIDING
LOAD CONTAINERS ON RAIL CARS FOR TRANSPORT TO DISPOSAL FACILITY
US Army Corps of Engineers St. Louis District
U.S. ARMY CORPS OF ENGINEERS ST. LOUIS DISTRICT ST. LOUIS, MISSOURI
DESIGNED BY: G. MECHAM
DWN BY: C. MECHAM
CKD BY: G. MECHAM
SUBMITTED BY: G. MECHAM
DATE: 7/16/2012
PLOT SCALE: NTS
PLOT DATE: 7/16/12
SIZE: ANSI B
FILE NAME: P-1 PROCESS FLOW AND P&ID.DWG
FILE NUMBER: NW12-284
OPERABLE UNIT (OU) – 8 IOWA ARMY AMMUNITION PLANT MIDDLETOWN, IOWA
PROCESS FLOW DIAGRAM
Sheet ID P-1



STAGING AND SYSTEM LAYOUT

SCALE: 1" = 80'

INSTRUCTIONS

(SEQUENCE MAY BE VARIED AS NEEDED AS THE WORK PROGRESSES)

1. DETERMINE AND MARK EXCAVATION BOUNDARIES.
2. SHRED GRASS, BRUSH AND SMALL TREES WITHIN THE SELECTED EXCAVATION AREA.
3. GRADE, LEVEL AND GRAVEL THE PROCESS AND STAGING AREAS.
4. ROTO-TILL THE EXCAVATION AREAS AND GRADE AND WINDROW SOIL TO SPECIFIED DEPTHS.
5. SETUP SCREENING, SORTING, PILING AND LOADING EQUIPMENT. SETUP ON-SITE ANALYTICAL LAB.
6. PERFORM PILOT STUDY BY FEEDING WINDROWED SOIL THROUGH THE SOIL SORTING EQUIPMENT.
7. DIVIDE PROPOSED EXCAVATION AREA INTO SUBSECTIONS TO BE USED FOR EXCAVATION SEQUENCING.
8. PERFORM AREA RADIOLOGICAL SURVEYS WITHIN SUBSECTION BEING EXCAVATED UNTIL IT IS DETERMINED THAT ALL DU CONTAMINATED SOILS ABOVE THE RG HAVE BEEN REMOVED. STAGE THE SOIL FROM THE EXCAVATED SECTION ONTO AN ADJACENT SECTION.
9. PROGRESS THROUGH THE INDIVIDUAL SUBSECTIONS STARTING AT THE HIGHEST ELEVATION SUBSECTION.
10. AS EACH SECTION IS PROCESSED RETURN THE CLEAN SOIL TO A PREVIOUSLY REMEDIATED SECTION.

LEGEND

- PROPOSED GENERAL EXCAVATION AREA
- POSSIBLE EXCAVATION SEGMENT LINES
- SOIL SORTING AND STAGING AREAS
- MONITORING WELL

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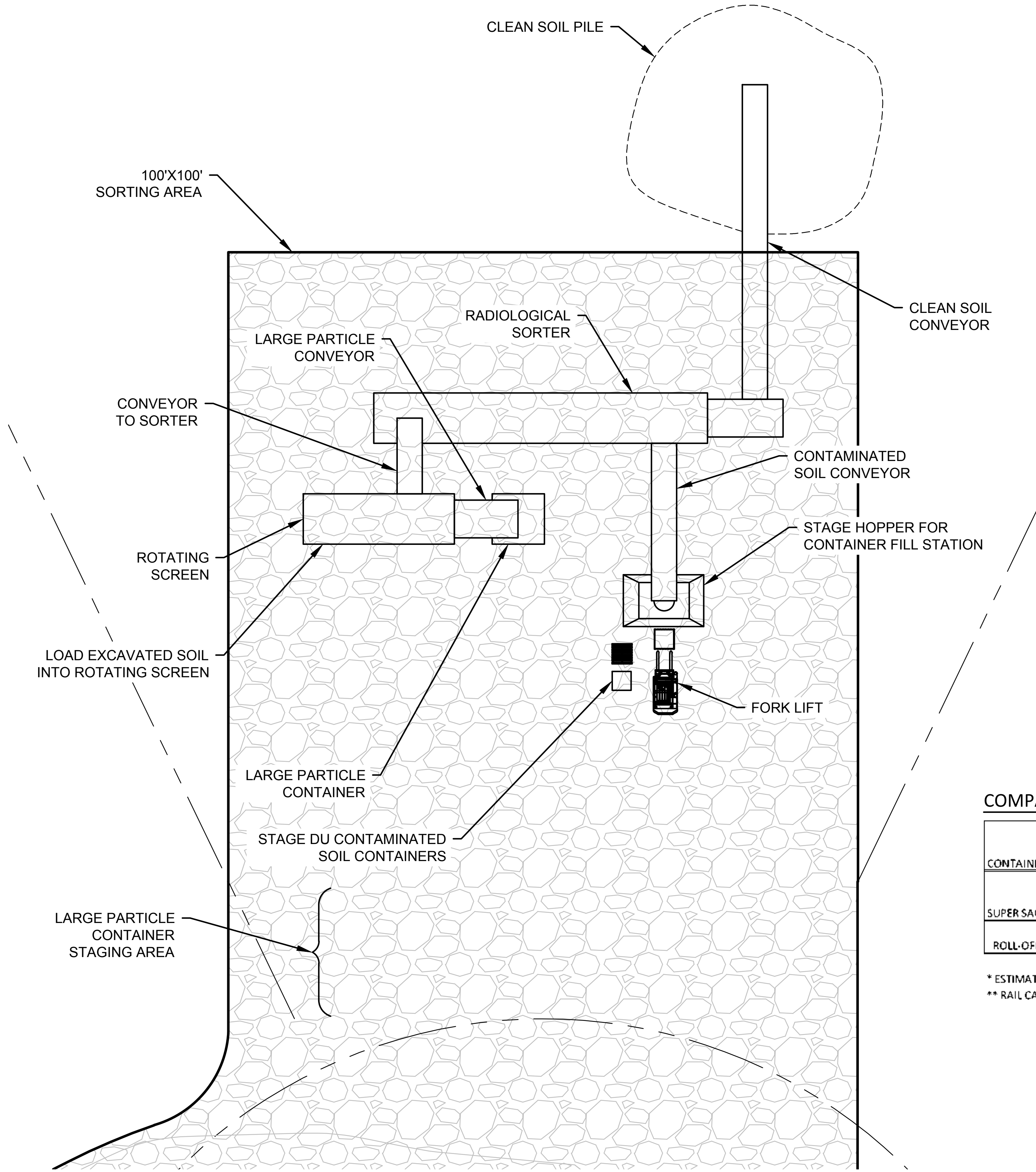
MIDDLETOWN, IOWA

STAGING AND SYSTEM LAYOUT

Sheet ID
P-2



MACHINERY LAYOUT DETAIL 1 / P-2
SCALE: 1" = 40'

EQUIPMENT LIST

IT IS NOT INTENDED THAT EQUIPMENT WILL BE PURCHASED FOR THE PROJECT. IT IS ANTICIPATED THAT EQUIPMENT WILL BE SUPPLIED BY CONTRACTORS, SUCH AS THE RADIOLOGICAL SORTER CONTRACTOR, OR WILL BE RENTED.

MANUFACTURES AND MODEL NUMBERS SHOWN FOR EQUIPMENT ARE EXAMPLES DEMONSTRATING THAT EQUIPMENT IS AVAILABLE TO ACCOMPLISH THE TASKS PLANNED FOR THE PROJECT. HOWEVER, DIFFERENT MODELS FROM THE MANUFACTURER LISTED OR EQUIPMENT FROM OTHER MANUFACTURES MAY WELL BE SELECTED FOR THE PERFORMANCE OF THE PROJECT.

1.0 REQUIREMENTS FOR RADIOLOGICAL SORTER
- ABILITY TO SORT AND DIVERT SOIL WITH DEPLETED URANIUM CONTAMINATION GREATER THAN 150 PCI/G.
- VARIABLE FEED RATE WITH A CAPACITY OF 100 TONS PER HOUR OR MORE.
- EXAMPLES:
  - AMEC ORION SCAN SORT
  - ISO PACIFIC NUCLEAR ASSAY SYSTEMS S3
  - ANTECH MODEL 3107 SOIL MEASURING AND SEGREGATION SYSTEM
  - EBERLINE SEGMENTED GATE SYSTEM

2.0 REQUIREMENTS FOR ROTATING SCREEN
- ROTATING SCREEN WITH CAPACITY OF 100 TONS PER HOUR OR MORE
- EXAMPLE:
  - 612W TROMMEL SCREEN MANUFACTURED BY SCREEN MACHINE INDUSTRY (SMI)

3.0 REQUIREMENTS FOR ROLL-OFF BOXES
- 20 CU YD CAPACITY
- TIE DOWN CAPABILITY TO SECURE TO RAILCAR
- CAPABILITY TO BE LIFTED AND LOADED ON A RAILCAR
- EXAMPLE:
  - BAKER INTERMODAL ROLL-OFF BOX WITH 20 YD3 CAPACITY

4.0 REQUIREMENTS FORCRANES FOR LOADING ROLL-OFF BOXES
- MOBILE CRANE WITH 35 TON RATED CAPACITY
- EXAMPLE:
  - GROVE CRANE RT540E-2 40 TON ROUGH TERRAIN CRANE

5.0 REQUIREMENTS FOR WHEEL LOADER
- BUCKET CAPACITY OF APPROXIMATELY 2 CU YD
- EXAMPLE:
  - CATERPILLAR 924H WHEEL LOADER WITH CAPACITY 2.2 - 3.6 YD3

6.0 REQUIREMENTS FOR CLEAN SOIL CONVEYOR
- CAPACITY OF 100 TONS PER HR
- STACK HEIGHT OF 20 FT
- LENGTH 40 TO 60 FT
- EXAMPLE:
  - SCREEN MACHINE INDUSTRIES (SMI) 40 FT RADIAL STACKING CONVEYOR. MODEL CE40-36

COMPARISON OF POSSIBLE DU CONTAMINATED SOIL CONTAINERS

CONTAINER	SIZE	ESTIMATED NO. REQUIRED	TIME SEQUENCE @ 100 TON/HR @ 80% REDUCTION	HANDLING: ON-SITE	RAIL YARD	TRANSPORT	DISPOSAL FACILITY	NOTES
SUPER SACK	~2 YD (4,400 LB)	2000	10/HR	FORKLIFT, SMALL CRANE	FORKLIFT, SMALL CRANE	GONDOLA RAIL CAR**	CUSTOM RAIL CAR UNLOADING	SUPER SACKS DISPOSED WITH WASTE
ROLL-OFF	20 YD	200*	1/HR	ROLL-OFF TRUCK	LARGE CRANE	FLAT RAIL CAR	LARGE CRANE	

* ESTIMATED NUMBER DOES NOT INCLUDE POSSIBLE RE-USE
** RAIL CARS WILL BE PROVIDED BY DISPOSAL FACILITY

US Army Corps of Engineers® St. Louis District

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: G. THORSON
DWN BY: J CROFT
CKD BY: G. THORSON
SUBMITTED BY: G. MECHAM
DATE: 7/13/12
SOLICITATION NO.:
CONTRACT NO.:
PLOT SCALE: NOTED
PLOT DATE: 7/9/12
FILE NUMBER: NW12-286
SIZE: ANSI B
FILE NAME: 20052C-101.DWG

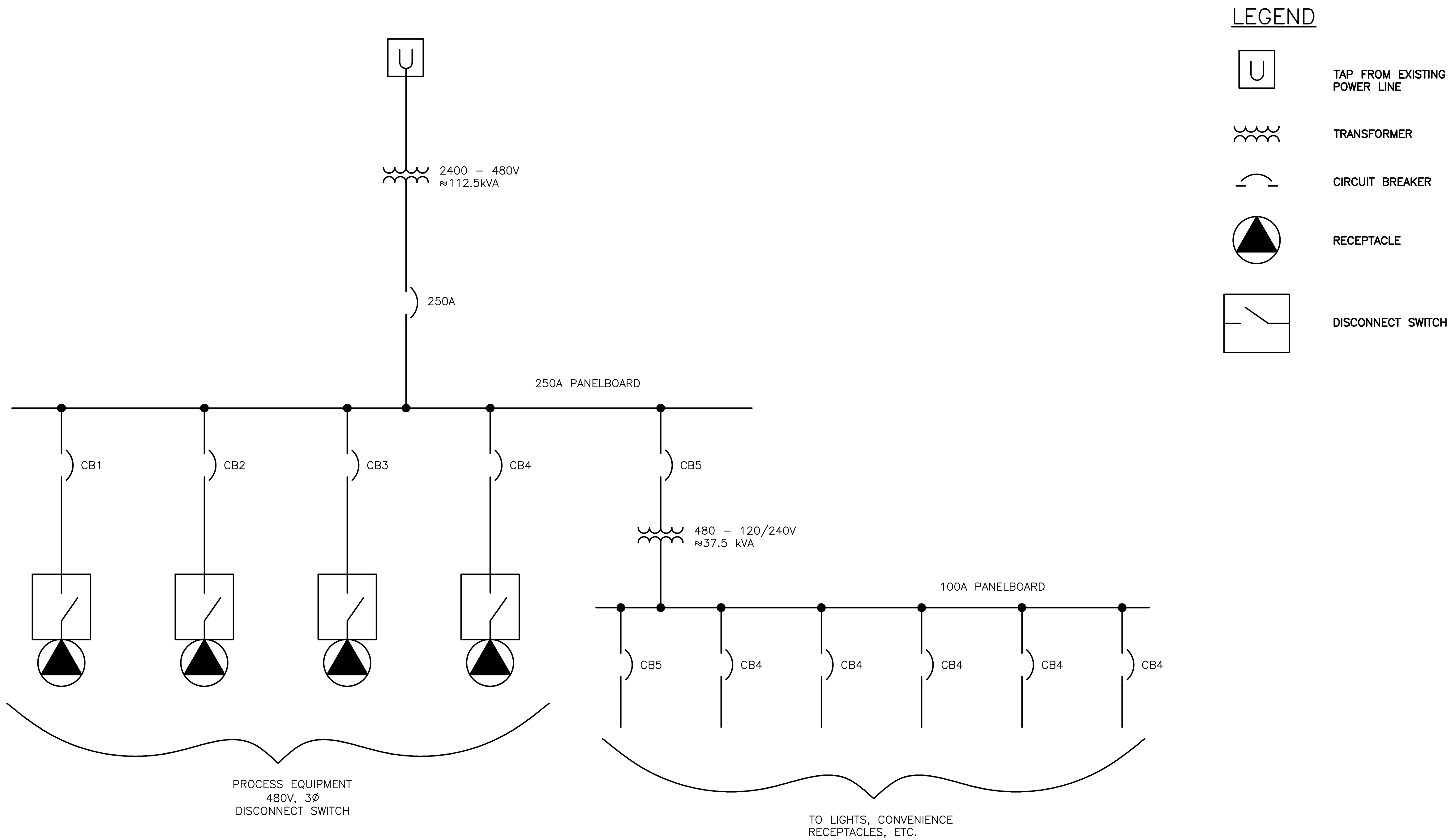
U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI

North Wind Services

OPERABLE UNIT (OU) - 8
IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

PROCESS EQUIPMENT LAYOUT

Sheet ID
P-3



US Army Corps of Engineers®
St. Louis District

MARK	DESCRIPTION	DATE	APPR

MARK	DESCRIPTION	DATE	APPR

DESIGNED BY: J. BRUNSON		DATE: 7/16/2012
DWN BY: C. MECHAM	CKD BY: G. MECHAM	SOLICITATION NO.:
SUBMITTED BY: G. MECHAM		CONTRACT NO.:
PLOT SCALE: NTS	PLOT DATE: 7/16/12	FILE NUMBER: NW12-288
SIZE: ANSI B	FILE NAME: E-1 ONE LINE DIAGRAM.DWG	

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI

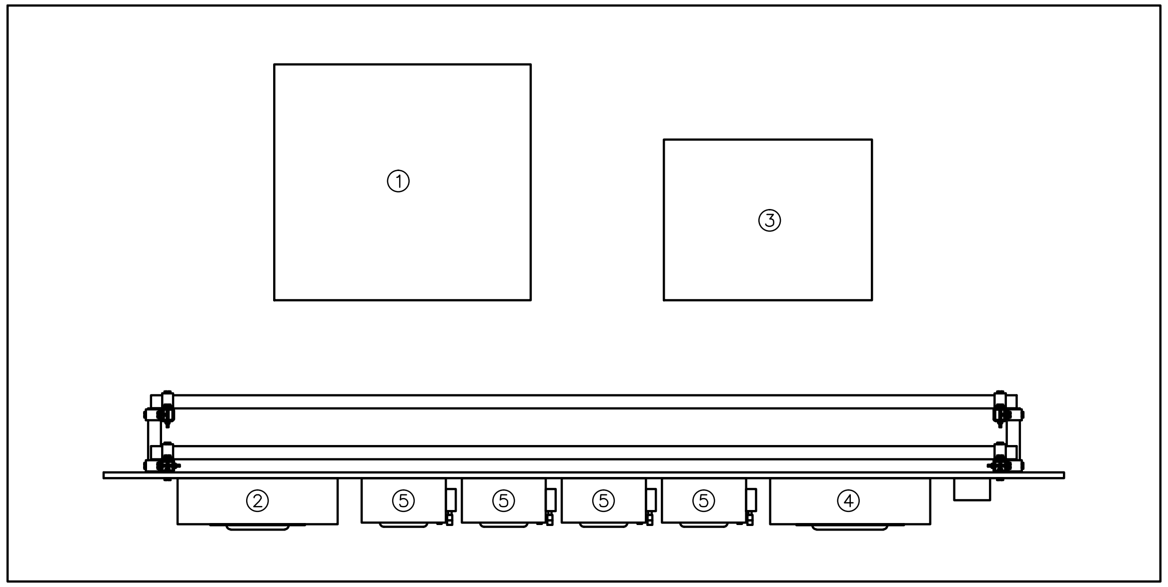
North Wind Services
A CIRI COMPANY

OPERABLE UNIT (OU) – 8
IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

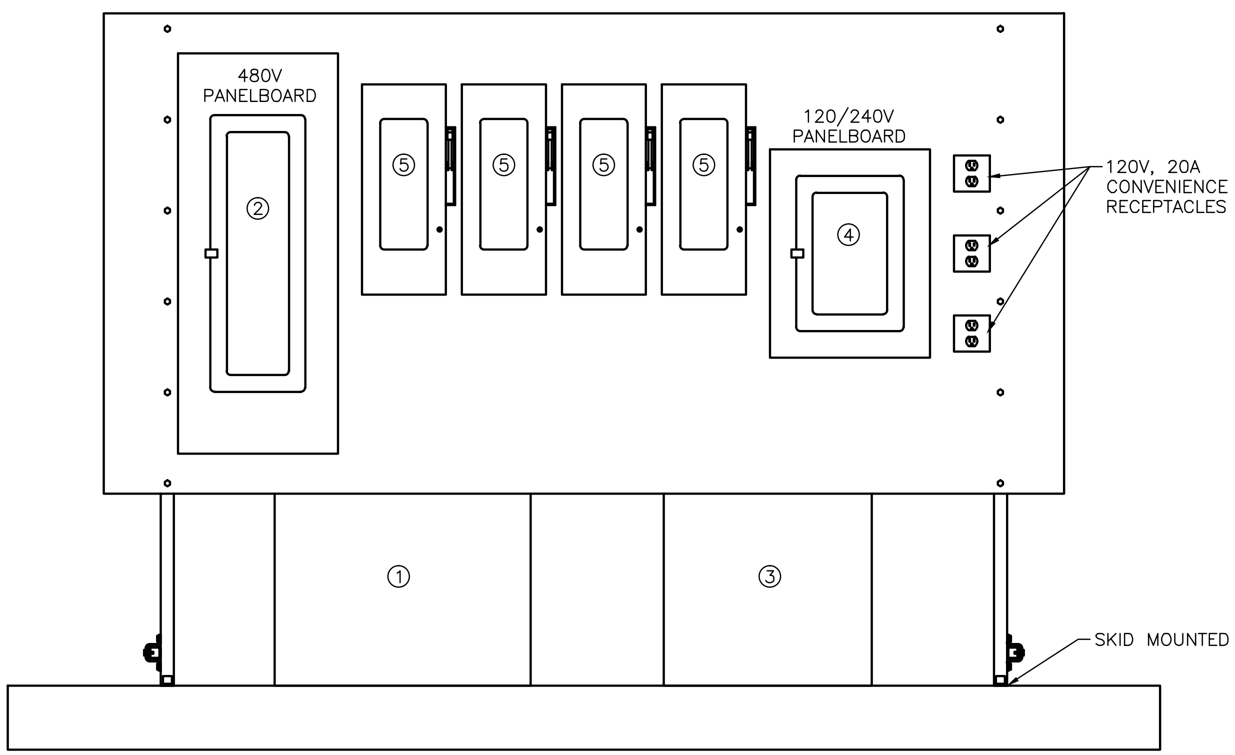
ELECTRICAL ONE-LINE DIAGRAM

Sheet
ID
E-1

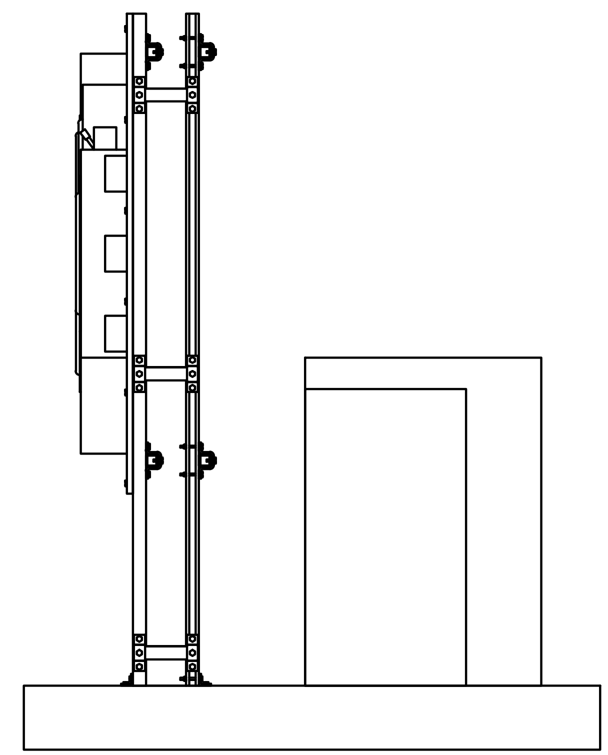
	Qty	Item	Description	Mounting	Length	Width	Height
1	1	Transformer	2,400V - 480/277V, 3-phase approx 112,5KVA, NEMA 3R	Floor mount	29.5"	32"	41"
2	1	Panelboard	250A, 480V, 3-phase, 4-wire Panelboard, NEMA 3R	Wall Mount	20"	5.75"	50"
3	1	Transformer	480V - 120/240, 1-phse approx 37.5KVA, NEMA 3R	Floor mount	20.1"	26"	37.1"
4	1	Panelboard	100A, 120/240V, 1-phase, 3-wire Panelboard, NEMA 3R	Wall Mount	20"	5.75"	26"
5	4	Dsw/Rcpt	100A, 480V Interlocked Disconnect and Receptacle, NEMA 3R	Wall mount	10.5"	5.53"	26.25"
	as req'd	Rcpt	20A, 120V, GFCI Receptacles				



PLAN VIEW



PANELBOARD ELEVATION



END ELEVATION

US Army Corps of Engineers St. Louis District

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
ST. LOUIS, MISSOURI

North Wind Services

DESIGNED BY: G. MECHAM
DWN BY: C. MECHAM
CKD BY: G. MECHAM
SUBMITTED BY: G. MECHAM
PLOT SCALE: 1" = 200'-0"
PLOT DATE: 7/16/12
SIZE: ANSI B
FILE NAME: E-1 ONE LINE DIAGRAM.DWG
DATE: 7/16/2012
SOLICITATION NO.:
CONTRACT NO.:
FILE NUMBER: NW12-289

OPERABLE UNIT (OU) – 8
IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

POWER DISTRIBUTION SKID

Sheet ID
E-2

Appendix B

Technical and Functional Requirements

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FINAL

TECHNICAL AND FUNCTIONAL REQUIREMENTS IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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FINAL

TECHNICAL AND FUNCTIONAL REQUIREMENTS IOWA ARMY AMMUNITIONS PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

Prepared by:
U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:
North Wind Services, LLC
Under Contract No. W912P9-12-D-0510

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ACRONYMS

AEC	Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
CFR	Code of Federal Regulations
CR	carcinogenic risk
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DU	depleted uranium
EPA	United States Environmental Protection Agency
FSA	Firing Sites Area
FUSRAP	Formerly Utilized Sites Remedial Action Program
IAAAP	Iowa Army Ammunition Plant
IBC	International Building Code
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
OU	operable unit
pCi/g	pico curies per gram
RAO	remedial action objective
RG	remediation goal
RI	Remedial Investigation
ROD	Record of Decision
SF	slope factor
TEDE	total effective dose equivalent
UUUE	unlimited use and unrestricted exposure
WAC	Waste Acceptance Criteria
yd^3	cubic yards

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Technical and Functional Requirements Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation Middletown, Iowa

1. INTRODUCTION

This document identifies the design basis and project information needed to define the design requirements applicable to the Iowa Army Ammunition Plant (IAAAP) Operable Unit (OU)-8 remediation activities.

The IAAAP is located in Des Moines County near Middletown, Iowa. It consists of approximately 19,000 acres and has security fencing around the entire facility. Approximately 7,800 acres consist of forested land, approximately 7,100 acres are leased for agricultural use, and the remaining acres are occupied by active and formerly active munitions production or storage facilities.

Past activities at the site have resulted in depleted uranium (DU) contamination present in some of the firing site areas and within some of the process buildings. Environmental remediation of these areas have been designated to be performed under the Formerly Utilized Sites Remedial Action Program (FUSRAP).

The known and suspected sources of the DU contamination at the FUSRAP areas are associated with historic Atomic Energy Commission (AEC) weapon-assembly operations conducted at portions of the IAAAP from 1947 to 1975. Line 1 is an area constructed during World War II to manufacture munitions. The AEC conducted operations at Line 1 after World War II, which included fabricating explosive components of nuclear weapons and fabricating DU test objects used for testing the performance of weapons components. AEC operations conducted prior to 1975 at Line 1 are the likely source of the DU contamination present as particles embedded in and/or adhered to Line 1 structural surfaces.

DU objects were used in explosive tests conducted at firing sites, primarily Firing Site 12. DU was found as fragments and particles in soil at the Firing Site 6 Area and the Firing Site 12 Area. The DU that is present at the Firing Site 6 Area is a product of the testing of munitions containing DU during past AEC operations at the site. The DU contamination at the Firing Site 12 Area appears to be the result of specialized tests (called hydro-shots) that the AEC conducted between 1965 and 1973. Hydro-shots used DU as a surrogate for weapons-grade material.

1.1 Scope

The scope of this remediation project will include removal and/or decontamination of all DU contaminated soil and components that have been identified in the IAAAP OU-8 Record of Decision (ROD) (USACE 2011a). Alternative 4 was identified in the ROD as the Selected Remedy, and this remedy includes excavation of contaminated soils; sorting and separating soil below the remediation goal (RG) from contaminated soil; decontaminating or removing specific contaminated surfaces; and packaging, transporting, and disposing of the remaining contaminated materials.

1.2 Objectives

The main components and objectives of the Selected Remedy for soil include:

- Excavation of DU-contaminated soil to meet the industrial RG at Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area.

- Physical treatment of DU-contaminated soil excavated from Firing Sites 1 and 2; Firing Sites 3, 4, and 5; the Firing Site 6 Area; and the Firing Site 12 Area via soil sorting.

- Materials exceeding the DU RG will be disposed at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill.

- Site restoration of excavated areas at firing sites, including backfilling, grading, and re-vegetation.

- Continued industrial land use supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

- Five-year reviews for FUSRAP areas where contaminants are left above levels acceptable for unlimited use and unrestricted exposure (UUUE) to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use would be verified during each 5-year review.

The main components and objectives for the Selected Remedy for structures (Alternative S3 in the ROD) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures.

- Disposal of DU-contaminated materials at a properly permitted off-site facility.

- Continued industrial land use supported by use restrictions and outgrants administered by the U.S. Army as part of its land management responsibilities.

- Include structures in 5-year reviews if they exceed levels appropriate for UUUE to ensure continued protectiveness of human health under industrial land use. Industrial land use would be verified during each 5-year review.

1.3 Project Description

Figure 1-1 shows the locations of the contaminated firing sites. The majority of the remediation actives are associated with the contaminated soils located at Firing Site 12.

DU contamination was observed in soil samples collected at the firing sites area (FSA). FUSRAP Remedial Investigation (RI) results showed that the extent of soil contamination of DU was generally limited to soil directly beneath DU fragments that were observed in the field to be oxidizing and typically extended into the soils to a depth of 2 feet (ft) (USACE 2008).

DU fragments were found in small localized areas at the Firing Sites 1 and 2 Areas, the Firing Sites 3, 4, and 5 Areas, and at the Firing Site 6 Area, with contamination being limited to approximately 1 square meter (m^2) surrounding the fragments. At Firing Site 12, DU fragments were found across an extensive area extending in all directions from ground zero (i.e., the location where explosions were detonated to test DU components).

Investigations indicate that the DU fragments are primarily concentrated within a 100-meter (m) radius of ground zero. However, a significant number of DU fragments were found beyond the 100-m radius, but the quantity and density of identified fragments decreased with distance from ground zero. The investigations extended to a distance of approximately 175 m from ground zero. The DU-contaminated area probably extends farther from ground zero. Previous investigations were limited in these areas because heavy vegetative ground cover and underbrush limited access for investigation.
In addition to the firing sites, surveys of the Line 1 buildings indicated that small interior surfaces of some structural components at two buildings (Buildings 1-11 and 1-63-6) exhibited discrete areas of radiation that exceeded the structural DU RG.

The following bullets describe the remedy components as described in the approved ROD (USACE 2011a):

> <u>*Remedy Components (soils):*</u>
>
> ***Excavation:*** *Surface and subsurface soil will be excavated to an estimated depth of 2 feet at areas where soil concentrations exceed the industrial RG for DU. These areas include: Firing Sites 1 and 2; Firing Sites 3, 4, and 5; Firing Site 6 Area; and Firing Site 12 Area. No excavation activities will be required at Yards C, G, and L and Firing Site 14. The estimated total volume of soil that will need to be excavated is 16,941 in-situ cy^3. The excavated materials will be staged at a soil staging area prior to treatment and/or loading onto long-haul trucks or similar for off-site disposal. Below-grade structural surfaces that become exposed during soil excavation at the Firing Site will be surveyed for the presence of DU-contaminated soil. If DU-contaminated soil is found adhered to these surfaces, the structural surface will be decontaminated. If the structural surface cannot be decontaminated, the surface will be sealed and abandoned with land use controls or demolished and removed without replacement.*
>
> ***Physical Treatment:*** *Under Alternative 4, approximately 22,023 ex-situ cy^3 of DU-contaminated material excavated from the Firing Site would be treated using physical treatment technologies (e.g., soil sorting and radiological scanning). The soil sorting method that would be used at the IAAAP includes a radionuclide detecting system capable of analyzing and separating soil based on specific radionuclide criteria. The effectiveness of soil sorting is influenced by the types of soil to be treated, the levels of radioactivity present, the moisture content of the soil, and the particle sizes of the soil itself. The Clinton silt loam and Clinton silty clay loam encountered at the Firing Site 12 Area (which represent the majority of soil to be remediated under this alternative) consist of a high percentage (>95%) of fine-grained particles, of which between 16 to 42% is clay-sized material. The estimated average volume reduction expected for this type of soil is 20% based on the results of studies on similar fine-grained soil. Materials meeting the DU RG may be used as backfill, as appropriate. Costs associated with an on-site pilot-scale demonstration of the soil sorting technology are included as a precursor to full-scale remediation activities.*
>
> ***Off-Site Disposal:*** *Soil exceeding the industrial RG would be disposed of by transfer to a properly permitted off-site disposal facility. Approximately 17,616 ex-situ cy^3 of DU-contaminated soil would be shipped off-site for disposal. Transportation of contaminated soil and debris would use Department of Transportation-approved "super sacks," specially lined dump trucks, rail cars, or inter-model containers.*

<u>Remedy Components (structures):</u>

Physical Decontamination: *DU-contaminated surfaces, such as the steel floor grate covering the sump at the Line 1 Building 1-11, would be decontaminated using high-pressure water methods and allowed to dry. Areas would be radiologically surveyed to document the residual radioactivity. If found to be above the industrial RG for structural surfaces, then additional decontamination methods would be employed, including high-pressure water with detergent cleansers, grit blasting, or scabbling until residual radioactivity meets the industrial RG.*

Replacement: *Under this alternative, the contaminated air filter at Line 1 Building 1-63-6 would be removed and replaced. The steel floor grate covering the sump at the Line 1 Building 1-11 would be decontaminated and, if methods fail to successfully decontaminate the grate, would also be replaced. Structural components (i.e., the air filters) that are contaminated with DU would be disposed of in a method consistent with DU-contaminated soil.*

2. SYSTEM DESCRIPTION

The general approach to the remediation activities is to use standard excavation techniques and equipment to remove the contaminated soils and structural components, process the resulting soils and materials through a treatment or sorting processes, then package the remaining contaminated materials for transport and disposal at an off-site disposal facility. The intent of the sorting activities is to minimize the amount of contaminated soils and materials that have to be transported off-site for disposal, and thus reduce the overall project costs.

2.1 Project and Remedial Action Objectives

2.1.1 Site Remediation

An expected outcome of the Selected Remedy is that the FUSRAP areas will no longer present an unacceptable risk to human health and the environment. The Selected Remedy will address the low-level threats associated with DU-contaminated soil and structures by excavation and treatment of DU-contaminated soil and decontamination/removal of DU-contaminated components or structures.

The specified remedial action objectives (RAOs) for the project are based upon the current and expected future industrial/military land use of the IAAAP, in conjunction with human health doses and risks estimated for the IAAAP site worker and construction worker at the FUSRAP areas. The following RAOs have been developed for the project:

- Prevent ingestion, dust inhalation, and external gamma radiation exposures to isotopes of DU in the FSA soil that could otherwise result in cumulative carcinogenic risks (CRs) exceeding 1.0E-04 and radiological doses exceeding 25 millirem per year (mrem/yr) for receptors under the current (industrial) and expected future (industrial) land use scenarios.

- Prevent radiation exposures from DU particles embedded in and/or adhered to structural surfaces or components of the Line 1 buildings that could otherwise result in cumulative CRs in exceedance of 1.0E-04 and a total effective dose equivalent (TEDE) exceeding 25 mrem/yr.

Achievement of the soil and structural RAOs will reduce potential doses and risks to the IAAAP site worker and construction worker to levels below target criteria (25 mrem/yr and 1.0E-04, respectively).

The RAOs provide the basis for establishing RGs. The Selected Remedy will achieve the industrial RGs for DU at the FUSRAP areas (Table 2-1). The risk-based RGs for DU-contaminated soil and DU-contaminated structures individually correspond to a target excess carcinogenic risk of 1.0E-04. In addition, the soil and structural RGs determined for DU are both individually and cumulatively protective of the total dose limit of 25 mrem/yr.

2.2 Soil Sorting

A soil sorting process will be evaluated for use in efforts to reduce the total volume of contaminated materials that need to be sent off-site for disposal. The process expected to be used is a radiological surveying system that identifies and separates the soils with high contaminant concentrations from the soils that can be determined to be below the soil RG, which will be returned to the excavation locations. The methods selected for use during the design activities will need to meet the requirements identified in Section 3.

2.3 Packaging, Transportation, and Disposal

All waste materials generated during the performance of the remedial action will be packaged, transported, and disposed in accordance with the applicable Waste Acceptance Criteria (WAC) established for the particular disposal facility. Due to specific limits on DU disposal, the WAC limitations may drive the processes and configurations available for use during the site remediation activities.

Packaging and transportation of waste must also comply with Department of Transportation requirements, which are included in 10 Code of Federal Regulations (CFR) 71, “Packaging and Transportation of Radioactive Material” and 49 CFR 171-178, “Transportation of Hazardous Materials.” Packaging and transportation requirements and procedures are addressed in the project waste management plan.

2.4 Water Collection, Treatment, and Disposal

Stormwater runoff and surface water that is potentially contaminated with DU during the remediation activities will be collected, treated as needed, and disposed in accordance with the facility requirements. Engineered controls will be put in place to minimize the amount of water that could become contaminated (i.e. minimize surface run-on) and to capture any surface water present within the contamination area during the performance of the remediation activities. All water used for decontamination purposes with the potential of being DU contaminated will also be contained.

The design must include the process that will be used to collect treat and dispose of the associated surface and decontamination water.

3. DESIGN REQUIREMENTS

This section will document the specific requirements that will be used during the development of the remedial design, and remedial action.

3.1 Site Development

3.1.1 Boundaries and Interfaces

The majority of the work will take place in the Firing Site 12 Area. The small quantities of soil and DU identified in the other firing sites will be brought to the Firing Site 12 Area and processed, packaged, and disposed of with the other Firing Site 12 excavated materials.

Design documents will incorporate a strategy for defining contaminated soils for removal using RI and Supplemental Investigation site gamma walk-over survey data as the baseline.

3.1.1.1 Laydown and Staging Areas

Specific laydown, staging, and loading areas have not yet been identified. Areas used for laydown, soil staging, railcar loading, haul routes, etc. will be identified as part of the design activities. Any areas suggested for use that are located outside of the Firing Site 12 Area will be approved by the facility representatives prior to the start of any operations.

3.1.1.2 Utility Locations

Site information indicates that some utilities are available in the Firing Site 12 Area. These utilities include electric power, water, and telephone. The actual condition and configuration of these services are unknown. Any refurbishment and/or connections needed to utilize these services must be included in the design package. Facility assistance will be needed to determine actual existing conditions of the services needed. Existing roads and rail lines are also available, with any upgrades or modifications to be identified in the remedial design package.

3.1.2 Permits

Various permits will be needed in order to perform the remedial activities. All information and coordination needed to complete and get approval for the permits will be included in the design package. The identified permits include an excavation/work permit, underground utility survey, and equipment air permits (if needed).

3.2 Functional and Operational Requirements

3.2.1 Material Excavation and Disposal

The estimated volumes of soil exceeding the RG are presented in Table 3-1. For locations where isolated DU fragments were found, soil volumes were estimated to be 1 cubic yard (yd^3) at each Firing Site grouping.

The total soil volume estimated for the Firing Site 12 Area consists of 100% of the soil to a depth of 1 ft and 25% of the soil between 1 and 2 ft within a 100-m radius of the testing pad at Ground Zero. For distances greater than 100 m from the testing pad (up to a 175-m radius), the total volume includes an estimate of 5% of the soil to a depth of 1 ft. It is possible that more DU fragments will be discovered farther than 175 m from Ground Zero, and therefore that additional soil will be excavated. However, it is expected that this additional soil volume will be much smaller than the estimated volume within 175 m of Ground Zero.

For planning purposes, and as outlined in the Feasibility Study (USACE 2011b), an ex-situ expansion factor of 30% is assumed for the excavated materials. Using this value, it is expected that a total of 22,023 yd^3 of soil will be processed though the soil sorting system in efforts to reduce the volume of material disposed as waste.

A final status survey of the excavated area, which will need to be consistent with the Multi-Agency Radiation Survey and Site Investigation Manual (DoD 2000), will be conducted to ensure that excavation meets the soil RG for DU. The development and execution of the final status survey is not part of this remedial design and remedial action planning process.

3.2.2 DU Monitoring and Segregation

The primary need for DU fragment separation is to remove large materials that are too big to be processed through the soil separation system. These DU fragments will result in a separate waste stream for disposal. Specific processing, packaging. and method of disposal will be required for this material, as determined by the applicable disposal facility WAC.

The Line 1 DU-contaminated structure components will also need to be identified as a waste stream for disposal. These components may be incorporated into the DU waste stream if similar waste disposal criteria are applicable.

3.3 Codes, Standards and Regulations

3.3.1 Record of Decision ARARs

Table 3-2 lists the applicable or relevant and appropriate requirements (ARARs) and associated implementation determinations identified in the ROD (USACE 2011a). The design documents must address these requirements and ensure compliance is incorporated into the project work activities.

3.3.2 DOD, USACE, FUSRAP Standards

The design must be developed in accordance with the following requirements manuals:

- DoD EM 385-1-1, Safety and Health Requirements Manual;
- USACE ER 380-1-18, Engineering Regulation; and
- USACE EM 385-1-80, Radiation Protection Manual.

3.3.3 National Codes and Standards

The following industry standards will be used when establishing the design criteria for the remedial action design package:

- National Electric Code;
- 10 CFR 830, “Nuclear Safety Management,” *Code of Federal Regulations*, Office of the Federal Register;
- 10 CFR 835, “Occupational Radiation Protection,” *Code of Federal Regulations*, Office of the Federal Register;

- 10 CFR 851, “Worker Safety and Health Program,” *Code of Federal Regulations*, Office of the Federal Register;
- 29 CFR 1910, “Occupational Safety and Health Standards,” *Code of Federal Regulations*, Office of the Federal Register;
- 29 CFR 1926, “Safety and Health Regulations for Construction,” *Code of Federal Regulations*, Office of the Federal Register;
- IBC, International Building Code, International Code Council;
- NFPA-101, *Life Safety Code*;
- 49 CFR 171-178, “Transportation of Hazardous Materials;” and
- 10 CFR 71, “Packaging and Transportation of Radioactive Material.”

3.4 Radiation Controls

Radiation controls must be included and addressed that are based on the following information:

- Dose equivalent to representative members of the public shall not exceed 25 mrem in a year TEDE from all exposure pathways, excluding dose from radon and its progeny in air.
- Dose equivalent to representative members of the public via the air pathway shall not exceed 10 mrem in a year TEDE from all exposure pathways, excluding dose from radon and its progeny.
- Release of radon shall be less than an average flux of 20 pCi/m^2/s at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/L of air may be applied at the boundary of the facility.

The slope factors (SFs) for radionuclides are derived based on the following, as outlined in U. S. Environmental Protection Agency (EPA) *Radiation Exposure and Risk Assessment Manual* (EPA 1996):

- The radiological endpoint is fatal cancer;
- Radiological risk estimates are based primarily on human data; and
- Radiological risk estimates are based on the central estimate of the mean.

A dose conversion factor for radiological exposures was used to calculate lifetime committed effective dose equivalents. Radiological doses were calculated to ensure compliance with ARARs to be identified for radiological contamination. Section 2.8.2.1 of the ROD discusses use of Nuclear Regulatory Commission (NRC) regulations as an ARAR. For a licensed site to be released for unrestricted use, 10 CFR 20, Subpart E, requires the radiological dose to be less than 25 mrem/yr. DU consists of U-234, U-235, and U-238 isotopes, of which U-234 and U-238 are in secular equilibrium with more than 99% of the DU being U-238.

3.5 Engineering Requirements

The following requirements and information shall be applicable to the project design.

3.5.1 Civil and Structural

Systems, structures, and components used on site must meet the requirements of the International Building Code (IBC).

Excavation activities must be performed in accordance with the Occupational Safety and Health Administration (OSHA) construction standards and the Clean Water Act – Storm Water Pollution Prevention requirements.

3.5.2 Mechanical and Materials

Potable water shall be furnished in the treatment facility to support equipment cleaning, eyewash and shower fixtures, and fire suppression, as required.

Contaminated surface water, including stormwater runoff, and process water shall be collected, treated, and disposed in accordance with site requirements.

3.5.3 Electrical Power

Electrical service shall be provided to the Firing Site 12 Area to support the operation of the soil sorting system. The electrical service shall be sufficient to power the conveyor systems, as needed, and to provide for process control and communications.

The system shall not be required to continue operation during power outages. However, sufficient battery backup and operating power shall be provided to:

- Allow safe shutdown of the system,
- Provide appropriate alarm notifications,
- Provide for required emergency lighting, and
- Ensure storage of data, as needed, to maintain system processing information.

3.6 Other Requirements

3.6.1 Security

Site-specific security controls must be incorporated into the work control documents. Details will be coordinated with the site security office.

3.6.2 Industrial Safety

Earth work shall be completed in accordance with OSHA Occupational Safety and Health Standards (29 CFR 1910) and Safety and Health Regulations for Construction (29 CFR 1926).

3.6.3 Miscellaneous

One federal-listed threatened or endangered species has been recorded on the IAAAP property – the Indiana bat *(Myotis sodalis).* The Indiana bat has been recorded to feed on the property and may have maternal roosts in the floodplain forests. Other state-listed endangered, threatened, and special concern species observed at the IAAAP are presented in the FUSRAP RI Report (USACE 2008).

4. REFERENCES

DoD 2000. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, EPA 402-R-97-016, Rev. 1, U.S. Department of Defense, August 2000.

EPA 1996. *Radiation Exposure and Risk Assessment Manual (RERAM),* Risk Assessment Using Radionuclide Slope Factors, U.S. Environmental Protection Agency, EPA 402=R-96-016, June 1996.

USACE 2008. Iowa Army Ammunition Plant FUSRAP Remedial Investigation Report for Firing Sites Area, Yards C, E, F, G, and L, Warehouse 3-01, and Area West of Line 5B, U.S. Army Corps of Engineers, St. Louis District, St. Louis, MO, Final, October 2008.

USACE 2011a. Formerly Utilized Sites Remedial Action Program Record of Decision for the Iowa Amy Ammunition Plant, Middletown, IA, U.S. Army Corps of Engineers, St. Louis District Office, September 2011.

USACE 2011b. FUSRAP Feasibility Study Report for the Iowa Army Ammunition Plant, Middletown, Iowa, Final, April 2011.

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5. FIGURES

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Figure 1-1. Contaminated firing site locations.

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6. TABLES

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Table 2-1. Soil and structure remediation goals for DU for FUSRAP areas.

Contaminant of Concern	Soil RG (pCi/g)	Structures RG ($dpm/100cm^2$)
DU	150	23,000[a]

[a] Disintegrations per minute per 100 square centimeters
pCi/g = picoCuries per gram

Table 3-1. Estimated in-situ volume of soil exceeding the remediation goal for depleted uranium.

Location	Surface Soil Volumes 0-1 ft (yd^3)	Subsurface Soil Volumes 1-2 ft (yd^3)	Total Soil Volumes (yd^3)
Firing Sites 1 and 2[a]	1	0	1
Firing Sites 3, 4, and 5[a]	1	0	1
Firing Site 6 Area[a]	1	0	1
Firing Site 12 Area	13,809	3,129	16,938
Total Volume	**13,812**	**3,129**	**16,941**

[a] Only has isolated DU fragments.

Table 3-2. Project applicable or relevant and appropriate requirements.

Requirement	Citation	Description	ARAR Determination
10 CFR 20, Subpart E NRC Radiological Criteria for License Termination	10 *CFR* 20.1403 (b) and (e)	These provisions identify the criteria under which a site is acceptable for license termination under restricted conditions. 10 *CFR* 20.1403(b) requires that there be provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem/yr. 10 *CFR* 20.1403(e) requires that the annual dose to an average member of the critical group is ALARA and would not exceed 100 mrem/yr if land use controls are no longer present.	<u>Chemical-Specific ARAR.</u> These criteria are relevant and appropriate to the cleanup of DU-contaminated soil and structures at the FUSRAP areas. They were used to develop the industrial RGs for soil and structures. The Selected Remedy will comply with these criteria through the excavation and off-site disposal of soil and structural material that exceed the industrial RGs.
Endangered Species Act	16 U.S.C §1538(a)(1)	These provisions prohibit the illegal taking of a federally listed endangered species. Federal agencies are required to ensure that their actions do not jeopardize the continued existence of a listed species or result in destruction of or adverse modification of its critical habitat.	<u>Location-Specific ARAR</u> A federally listed endangered species, the Indiana bat, may be found as a transient species within the FUSRAP areas of the IAAAP. Therefore, these requirements are relevant and appropriate for remedial actions conducted within the FUSRAP areas. The Selected Remedy will comply with these provisions.
10 CFR 20, Subpart B, Radiation Protection Programs	10 *CFR* 20.1101(d)	These provisions impose a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, such that the highest individual dose to the public will not exceed 10 mrem/yr	<u>Action-Specific ARAR</u> The provisions of Section 20.1101(d) are relevant and appropriate to actions involving releases of airborne radioactive materials during remediation. The Selected Remedy will comply with these provisions.

Appendix C

Remedial Action Performance Schedule

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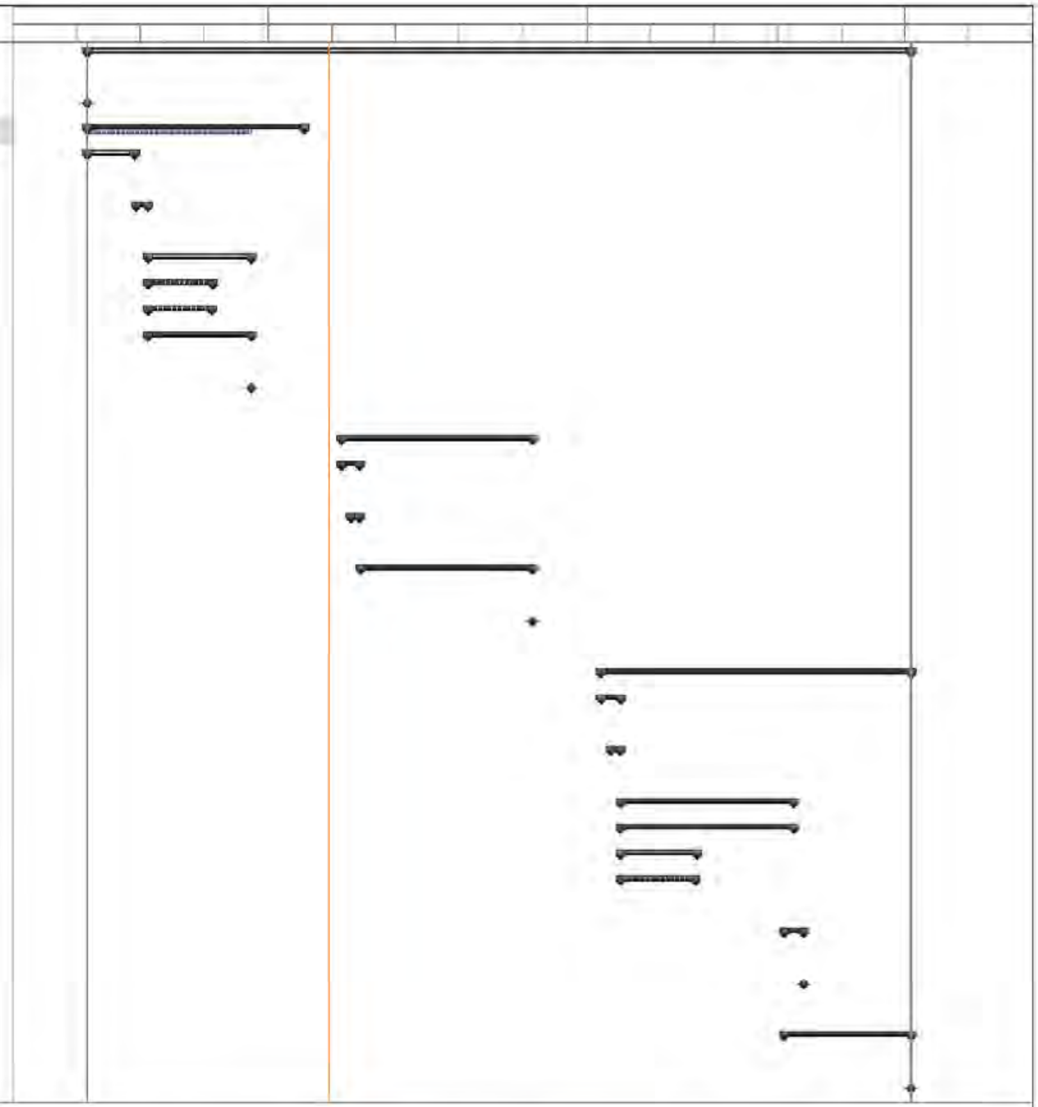
ID	Task Name	Duration
1	**Iowa Army Ammunition Plan - Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation**	**844 days**
2	***Notice to Proceed***	***0 days***
3	**Year 1 - OU-8 Remedial Action**	**223 days**
4	**Year 1: Pre-Construction Planning and Procurement**	**50 days**
10		
11	**Year 1: Mobilization and Site Preparation**	**13 days**
17		
18	**Year 1: Remedial Action Tasks and Activities**	**106 days**
19	**Firing Sites 3, 4, and 5**	**67 days**
31	**Firing Site 6 Area**	**65 days**
43	**Firing Site 12 - Phase A**	**106 days**
55		
56	***Year 1: Field Activities Complete***	***0 days***
57		
58	**Year 2 - OU-8 Remedial Action**	**196 days**
59	**Year 2: Pre-Construction Planning and Procurement**	**20 days**
61		
62	**Year 2: Mobilization and Site Preparation**	**10 days**
64		
65	**Year 2: Remedial Action Tasks and Activities**	**176 days**
78		
79	***Year 2: Field Activities Complete***	***0 days***
80		
81	**Year 3 OU - 8 Remedial Action**	**318 days**
82	**Year 3: Pre-Construction Planning and Procurement**	**20 days**
84		
85	**Year 3: Mobilization and Site Preparation**	**10 days**
87		
88	**Year 3: Remedial Action Tasks and Activities**	**178 days**
89	**Firing Site 12 - Phase C**	**178 days**
101	**Firing Site 12 Structures Remediation**	**79 days**
113	**Line 1 Building Structural Components**	**77 days**
123		
124	**Year 3: Site-Wide Demobilization**	**20 days**
127		
128	***Year 3 - Field Activities Complete***	***0 days***
129		
130	**Remedial Action Completion Report**	**130 days**
142		
143	***Remedial Action Complete***	***0 days***



Project: RA Field Work Schedule
Date: Thu 12/27/12

Task	Project Summary	Inactive Milestone	Manual Summary Rollup
Split	External Tasks	Inactive Summary	Manual Summary
Milestone	External Milestone	Manual Task	Start-only
Summary	Inactive Task	Duration-only	Finish-only
Deadline	Progress		

Page 1

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Appendix D

Agency RD/RA Work Plan
Review Comments and Resolutions

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Comments: FUSRAP Operable Unit 8 (OU-8) Remedial Design / Remedial Action Work Plan for the Iowa Army Ammunition Plant Site Middletown, Iowa,

DATE: February 2013

Comment No.	Page/ Section/ Paragraph	Comment	Initials	Response	Initials
General Comments					
RAWP					
1.	General	Physical sorting to attain volume reduction is a viable technology for radiological waste; however it must be clear that physical sorting does not alter the composition of a hazardous waste through chemical, biological or physical means so as to reduce toxicity, mobility or volume the materials being treated. **It** simply separates the contaminated materials soil and debris into manageable amounts for additional specific disposal.	EPA	Agree with statement. The ROD- approved technology is to use radiological monitoring to physically sort the radiologically- contaminated material with concentrations above the RG from all other materials. This sorting will not alter the composition of the materials. *No changes are suggested to the document(s).*	***NWS***
2.	4-7 / 4.3.1.2	Throughout the report it is mentioned that standard particle sized separation and screening is the technology of choice for this action. However, soil properties that are critical are not given in detail and are not listed or provided in the report. Clay content and type of clay, organic carbon percentage, as well particle size will be important to the success or efficiency of this treatment. Please provide these details. The EPA generally agrees that a pilot test (treatability study) be conducted on the technology with a range of soil types and materials (DU fragments) found at the facility. A subsequent report on the pilot test would confirm the effectiveness of this technology to the site.	EPA	Particle size separation by itself is not the technology of choice. Because of the wide variation of particle sizes for the DU materials and the clay content of the soils, size separation will not be effective as the treatment method. The method of choice is to perform sorting based on radiological monitoring. Size separation will be used as a preprocessing step to remove items too large to be processed through the radiological sorting equipment. A pilot test may be conducted on potential treatment technology to determine the most efficient method for dealing with the actual project site materials prior to implementing any such technology. *No changes are suggested to the document(s).*	***NWS***
3.	12-4/ Table 4-2	Estimated in situ volumes of soil exceeding the RG. This is a useful table. The EPA requests the provision of an additional table or tables summarizing the contaminated soil size fraction, contamination concentration or activity, weight percentage and	EPA	The detailed information requested varies greatly over the entire site area and will not be available until actual excavation of the materials is performed. The RG of 150 pCi/g was added to the table title. Title was changed to:	***NWS***

		percentage of original soil as clean soil after treatment as that information would be useful as well. Please also include the clean- up levels and/or risk level to be utilized in defining the efficiency of the treatment.		*"Table 4-2. Estimated in-situ volume of soil exceeding the RG (150pCi/g) for DU"*	
4.	General	**It** appears that the cleanup is based on DU radiological toxicity alone. Please also provide an explanation of the absence of DU chemical toxicity being a consideration or factor at this site.	EPA	Remediation goals for Firing Sites soil are discussed in *FUSRAP Feasibility Study Report for the Iowa Army Ammunition Plant Middletown, Iowa* (2011), Section 3.2.3. Remediation goals for DU were developed based on consideration of both radiation dose and cancer risk to site workers and construction workers. The soil RG, 150 pCi/g, is based on 1E-4 carcinogenic risk to site workers. The structure RG, 23,000 pCi/g, is also based on 1E-4 carcinogenic risk to site workers. Chemical toxicity was not evaluated for DU in soil primarily because most of the DU present in soil exists as fragments that are not readily bioavailable for human exposures. Additionally, the radiologically risk-based soil RG is more stringent than any RG that would be derived based on the chemical toxicity of DU. To demonstrate this, the RG of 150 pCi/g from the FS Report was converted to an equivalent mass concentration using the equation below, per USEPA's (2000) Soil Screening Guidance for Radionuclides: Technical Background Document, Appendix B: RG (mg/kg) = RG (pCi/g) x 2.8E-12 x A x $T^{1/2}$ Because the activity and mass fractions (%) of U-238 in DU are 90.14% and 99.8%, respectively, it is assumed for the purposes of this evaluation that DU is comprised of only U-238. Based on this assumption, the variables to be used in the above equation are as follows:	***NWS***

				• RG (pCi/g) = 150 pCi/g; • 2.8E-12 = constant applicable to any radionuclide (inclusive of activity and mass conversion factors); • A = atomic mass of U-238 (238.05 g/mole); and • $T^{1/2}$ = half-life of U-238 (4.47E+09 years). When calculated, the mass equivalent of the radiologically risk-based RG is 447 mg/kg. In contrast, USEPA's (2012) preliminary remediation goal (PRG), which is protective of noncarcinogenic effects resulting from industrial worker exposures to the chemical form of uranium (i.e., via soil ingestion, dermal contact and dust inhalation) is 3,100 mg/kg. USEPA's industrial worker PRG is derived using similar exposure assumptions as those used for the IAAAP site worker scenario, and is derived based on a target hazard index of 1.0. In summary, USEPA's PRG for the chemical form of uranium is roughly 7 times less stringent as the soil RG (converted to its mass equivalent) derived in the IAAAP FS Report. Although additional conversions would be needed for the same evaluation of the structural surfaces RG, it is expected that the general outcome would be the same as for the soil RG evaluation. Section 2.2 Remediation Goals is updated to read – " *It should be noted that chemical toxicity was not the basis for the development of DU soil RGs. This is primarily because most of the DU present in soil exists as fragments that are not readily bioavailable for human exposures via the usual chemical exposure pathways (i.e., ingestion, dermal contact, and inhalation of particulates or*	

				volatilized contaminants). Additionally, the radiologically risk-based soil RG is more stringent than any RG that would be derived based on the chemical toxicity of DU. To demonstrate this, the RG of 150 pCi/g from the FS Report (USACE, 2011b) was converted to an equivalent mass concentration in accordance with EPA's, Soil Screening Guidance for Radionuclides: Technical Background Document, Appendix B (EPA, 2000b). When calculated, the mass equivalent of the radiologically risk-based RG is 447 milligrams per kilogram (mg/Kg). In contrast, EPA's preliminary remediation goal (PRG), which is protective of noncarcinogenic effects resulting from industrial worker exposures to the chemical form of uranium (i.e., via soil ingestion, dermal contact, and dust inhalation), is 3,100 mg/Kg. EPA's industrial worker PRG is derived using similar exposure assumptions as those used for the IAAAP site worker scenario, and is derived based on a target hazard index of 1.0. In summary, the mass equivalent to the radiological PRG derived in the IAAAP FS Report is approximately seven times more health-conservative than EPA's PRG for the chemical form of uranium. The associated calculations are shown in Appendix D, Response to EPA Comment #4."	
5.	General	The clean-up levels in the soil and the residuals concentration of DU that remain would be an issue for future ground water contamination. Has a soil to ground water leaching analysis or screening calculations been calculated or determined for this	EPA	The remedial action was planned based on remediation goals established in the ROD. Yes, screening calculations were performed. The Summers model was used to provide an estimate of the uranium concentrations in ground water that could	***NWS***

		site? If not, what is the plan for doing so?		result from the leaching of uranium from shallow soil having a uranium concentration equivalent to the RG (150 pCi/g). The Summers model is very conservative; it does not take into account the effects of advection or dispersion on contaminant concentrations. It simply considers the effects of dilution due to the instantaneous mixing of leachate with ground water directly beneath a potential source. In order to provide a margin of safety, this very conservative model was used in combination with conservative assumptions for the hydraulic parameters and source area dimensions. Based on the results of the modeling, the uranium soil RG is protective of ground water at the site. Leaving soil onsite that has a uranium concentration equivalent to 150 pCi/g would not result in concentrations of uranium in ground water that exceed the health-based action level (i.e., the MCL of 30 ug/L). *No changes are suggested to the document.*	
6.	Appendix B - 4-1 / 4 / References	This is a small issue but worth pointing out. The second reference is incomplete "EPA 1996, Radiation Exposure and Risk Assessment Manual. U.S. Environmental Protection Agency." It lacks an EPA publication number and that raises an issue about what this document is about.	EPA	EPA document number was added to reference. *Radiation Exposure and Risk Assessment Manual (RERAM), Risk Assessment Using Radionuclide Slope Factors, U.S. Environmental Protection Agency, EPA 402-R-96-016, June 1996*	***NWS***
7.	2-1	Remedial goals for soil and buildings are mentioned. No mention is made of the risk (for example 5 x 10-5) posed by these cleanup levels. There is some mention that they are based on 25 mrem/yr standard as an ARAR and that they fell within the risk range, but no specific risk numbers. Please provide those in the paragraph.	EPA	Please see response to Comment 5. Both the soil RG and structures RG are based on 1E-4 carcinogenic risk to site workers. Section 2.2, paragraph modified as follows: *"RGs, also known as derived concentration guideline levels (DCGLs) (EPA, 2000a), were developed for protection of human health. These criteria are based upon potential industrial site worker exposures to residual DU in soil at the FSA and on the surfaces of FUSRAP structures at FS-12 and at Line 1 upon*	***NWS***

				completion of RAs. Radiation dose and excess carcinogenic risk to site workers and construction workers were considered. The soil DCGL and structure DCGL are both based on 1E-4 excess carcinogenic risk to site workers." The guidance "(EPA,2000a)" is citing the reference in section 10 References as follows: "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). U.S. Environmental Protection Agency, U.S. Department of Defense, U.S. Department of Energy, and U.S. Nuclear Regulatory Commission. EPA 402-R-97-016 Revision 1. August." USACE suggests not including the MARSSIM document into this remedial design because it would make the document over twice as large and the MARSSIM document is readily accessible to public.	
8.	7-2/last bullet	Please clarify the plans and location for waste disposal.	EPA	Added the following text to the last bullet list item of Section 7-2: *The TSDF (s) used for project waste disposal will be identified during the field planning and procurement phase of the project as described in section 5.1 of this work plan.*	***NWS***
9.	General	Numerous sections in the work plan allude to gamma count rates but do not indicate the value or how it compares to the background levels.	EPA	The actual gamma count rates do not necessarily equate to a specific radionuclide concentration in the materials or specific background rates. See also response to Comment #10.	***NWS***
10.	4-1/4.1.1/	Indicate the depleted uranium natural occurring	EPA	As depleted uranium is man-made, there is no	***NWS***

	Sentence 5	background concentrations.		"naturally occurring background concentration" for DU. However, previously obtained reference area samples indicate a U-238 soil background of approximately 1.5 pCi/g. Regarding count rates detected during gamma walkover surveys, background levels varied but were typically in the range of 10,000 to 12,000 cpm. Text added: "*…naturally occurring background concentrations. Naturally occurring background gamma radioactivity levels in this area are typically in the range of 10,000 to 12,000 cpm.*"	
11.	4-2/4.1.2/ Sentence 2	The text indicates a small area exhibited gamma count rates that were double the count rate of the immediately surrounding area. Indicate those gamma rate counts.	EPA	The surrounding area exhibited count rates below 12,000 cpm, which is considered background for the area. The elevated location included count rates greater than 16,000 cpm with some of the count rates measuring, around 25,000 cpm. Since the gamma walkover survey data does not represent actual contaminant concentrations, it is better to refer to these comparisons on a relative basis as included in the present text. Added the following sentence, *"The elevated location included count rates greater than 16,000 cpm with some of the count rates measuring, around 25,000 cpm."*	***NWS***
12.	4-2/4.1.2/ Sentence 6	Depict indicated 20 systematic grid locations on Figure 4-5.	EPA	Text changed to address the systematic sampling locations, instead of the systematic "grid". Figure was changed to show sampling locations.	***NWS***
13.	4-2/4.1.2/ Sentence 7	The text indicates no remaining soil sample locations yielded results exceeding the RG. How many soil samples were collected within the grid locations? How many exceeded the DU RG; how many were	EPA	40 soil samples were taken. Two samples for each of 20 sample locations. No samples exceeded the RG. Text change: "*In addition, 40 new soil samples were obtained at*	***NWS***

		less than the RG?		*20 systematic sampling locations spread across the FS-1 and FS-2 area. Two samples were collected from each location, one near the surface at 0 to 15 cm (0 to 6 inches [in.]) and another between 15 and 60 cm (6 to 24 in.) below the ground surface. Samples from 10 of the sampling locations were collected near the location of the elevated concentration area in accordance with a Class 1 MARSSIM survey. The remaining ten sampling locations were collected over the remaining FS-1 and FS-2 area in accordance with a Class 2 MARSSIM survey. The sample locations are shown in Figure 4-5. None of the additional soil samples at the FS-1 and FS-2 area yielded results exceeding the RG.*"	
14.	4-2/4.1.3/ Sentence 1	Indicate the elevated gamma count rate.	EPA	The elevated gamma count rates measured during the gamma walkover survey greater than 16,000 cpm to approximately 185,000 cpm. Text was changed to state, *"One location of an elevated gamma count rate was identified immediately adjacent to the loading dock at FS-5 (Figure 4-6). The elevated gamma count rates measured during the gamma walkover survey ranged from greater than 16,000 cpm to approximately 185,000 cpm. This elevated gamma count rate was attributed ....."*	***NWS***
15.	4-2/4.1.3/ Last Sentence	The text indicates the DU object impacted an area of-2m^2. How deep are the soil impacts in this area?	EPA	Actual depth of impact has not yet been determined. Depth will be determined when the DU fragment and surrounding soil is removed and affected area is sampled. *No changes are suggested to the document.*	***NWS***
16.	4-2/4.1.4/	Indicate the elevated gamma count rates. Does this	EPA	Sentence now reads: "*One location with an elevated*	***NWS***

	Paragraph 1	rate differ from the radiological counts alluded to in Sentence 4? A piece of DU is referred to as a chunk, object and fragment. Do these different descriptions allude to the same piece of DU? How many samples were collected for analysis from this area? Recommend the use of tables for these various results to better understand the assessment of this area. Provide figures that depict the sample locations with results above RGs and/or gamma count rates.		*gamma count rate was identified (approximately 150,000 cpm) ….*" No, the description in the first sentence refers to the measurement taken with the fragment in place while sentence 4 refers to measurements taken after the fragment was removed. Text change to refer to the DU object as a "DU fragment". 36 samples were taken for explosive analysis and 29 samples were taken for chromium and aluminum analysis. Text changed to: "Eight *of 36* samples…" "nine *of 29 samples* exceeded screening levels.."	
17.	4-2/4.1.4/ Paragraph 3, Sentence 2	The text indicates the DU contaminated soil "may" also be contaminated with explosives. Review the results and indicate whether or not the one sample that contained the DU also contained explosives or metals above screening levels; if one sample with DU did contain both, then change sentence from "may" to "is" or "is not" contaminated with explosives or metals. Based on proximity of samples with DU and explosives above levels of concern and the areal extent, recommend removal of both COCs.	EPA	The soil sample associated with the fragment removal was not analyzed for explosives, but that explosives-contaminated soil was identified (through other sample results) within close proximity to the location of the fragment. FUSRAP authority is limited to only DU and that removal of other contaminants would only be incidental to the DU removal. *No changes are suggested to the document.*	***NWS***
Technical Comments					
18.	General throughout document	Units of length and volume for the impacted area are expressed in both metric and English units (Section 4.13 on Page 4-2 is a good example of this mixing of metric and English units for length measurements). Consider using either one system or the other for consistency.	EPA	*Units throughout document will be revised to present measurements in both metric and imperial units.*	***NWS***
19.	4-2/4.1.4/1 and	What is the definition of a "chunk" of DU vs. a fragment or a piece? Consider using a consistent term	EPA	Text in section will be changed to refer to DU fragments. Text changes:	***NWS***

	4-4/4.2.3/1	for DU found during the remediation and/or being more descriptive of the actual terms used.		"An isolated DU *fragment* was…" "The DU *fragment* was *later* removed…" "Soil beneath the DU *fragment*…"	
20.	4-2/4.1.4/2	The text notes that a second area of DU-contaminated soil was identified during a previous investigation of FS-6 in 2000. It further states that this area could not be identified during the 2006-2007 RI field activities. Were GPS coordinates measured in 2000 or 2006-2007? If not, consider stating this in the text.	EPA	Both the 2000 data and the 2006-2007 data included measurement location coordinates. The area of the initial "second" area was the same area further evaluated during the 2006-2007 field activities. *No changes are suggested to the document.*	***NWS***
21.	4-6/4.2.8.2	Consider adding the type of instrument that will be used to conduct the walkover surveys described in the 1st bullet.	EPA	The actual instruments are yet to be determined. Text added to state that they will be determined "*…in accordance with the FSP and are illustrated in FSP Appendix A*."	***NWS***
22.	4-6/4.2.8.w	Consider adding the type of hand-held survey instrument that will be used to conduct the performance monitoring described in the second bullet.	EPA	Same as comment #21.	***NWS***
23.	4-7/4.3.1.1/1	The text states that density-based separation could be very effective if soil properties are favorable, yet does not state the soil conditions favorable for this type of operation. Consider adding text describing the soil conditions favorable for density-based separation and how the on-site soils compare to these conditions.	EPA	Text modified to address the probable condition where very small particles could adhere to the sites clayey materials. Last sentence was modified as follows: "…it is unclear how *the very small DU particles could be separated because of their ability to stick to the clay soils without impacting the material density. It is highly unlikely that consistent radiological concentration separation can be effectively performed using this method*."	***NWS***
24.	4-7/4.3.1.1/2	The text states that it is unclear how the density-separation process would work with clay soils. Consider conducting a bench test with site soils to determine the viability of density-separation.	EPA	This alternative uses equipment that is very application specific and would be costly to setup a bench scale test. It would also be hard to develop a bench scale test that would be representative of all materials located at the site. *No changes are suggested to the document.*	***NWS***

25.	4-7/4.3.1.2/2	The text states that the screening/size separation process can be very effective if there is a significant difference between the size of the DU particles and the soil materials. Why is this a question at this point? Shouldn't the sizes of the DU particles and the soil materials be known after conducting the RI? Consider changing the text to reflect the current state of knowledge about the relative sizes of these two types of materials.	EPA	The size of DU particles range from very small to quite large. The soil materials including soils, clays, rocks, roots, grass and other biologic materials can also range from very small to quite large, and therefore the size separation methods will not effectively separate the DU materials because there is not a significant difference in the relative sizes of the different materials. The size separation techniques will work well for removing the larger materials as a pre-processing step in order to more effectively be able to perform the radiological monitoring and sorting activities. *No changes are suggested to the document.*	***NWS***
26.	4-7/4.3.1.2/2	The text states that there could be the potential for the soil to form aggregates that are so large that they do not pass through the screening equipment. In the first paragraph, the text states that vibration equipment will be used in the system. Please explain why this vibrating equipment would not break the aggregates into smaller pieces that would pass through the screening equipment.	EPA	There may be natural materials that are hard enough that they won't be broken up with the screening equipment. Also materials such as grass, roots, rocks, etc. will not pass through the screening methods to separate them from the DU materials. *No changes are suggested to the document.*	***NWS***
27.	4-8/4.3.2.2/1	Consider adding information on the thickness ranges of soil amenable to the Eberline Services Segmented Gate System.	EPA	Text added to indicate a 2" thickness: "...soil layer deposited on the conveyor *approximately 5 cm (2 in.) thick."*	***NWS***
28.	4-8/4.3.2.3	Consider adding information on the thickness ranges of soil amenable to the ISO-Pacific S3 system.	EPA	Text added: *"...underneath the detector array ranging from 2 cm (1 in.) to 7 cm (3 in.) thick."*	***NWS***
29.	4-9/4.3.2.3/1	After separating the clay from the other materials, is the clayey soil screened further? Consider adding information on this to the text.	EPA	Text added to state wet and clayey materials will be measured and sorted: "…conveyor that can be used to effectively *measure and separate* materials that are wet and have sticky, high clay content characteristics."	***NWS***

30.	4-9/4.3.3/2	Consider adding text defining what "low level waste" consists of.	EPA	Text change as follows: "…low-level *radioactive* waste…"	***NWS***
31.	4-11/4.3.6.2/2	"Occasional" grab samples are mentioned in the text for verification samples. Consider adding text to define the percent of samples or number of samples that are anticipated for verification samples.	EPA	The number of samples to be taken will be determined in the FSP. Removed the sentence referring to MARSSIM based survey as follows: *"For traditional remediation activities, MARSSIM-based surveys are used to determine what material is above the decision criteria and what material is below the decision criteria (EPA, 2000)"* Modified the following sentence as follows: "Using the radiological monitoring/sorting system, these decisions would be made based on gross gamma surveys (no nuclide-specific information) and an occasional grab sample for off-site laboratory analysis for verification *of proper system operations*."	***NWS***
32.	4-12/4.4.1/1	The text states that the areas of high densities of DU materials will be excavated until the DU soil RG is attained. Materials from other areas with lower densities of DU materials will be transported to FS-12 and treated. Consider adding text describing how these materials will be extracted from the ground and transported to FS-12.		Added sentence: *"Soil from these areas will be manually excavated as needed, then packaged and transported to the soil sorting area for processing."*	***NWS***
33.	4-12/4.4.1/1	Consider stating any closure or screening criteria for the radiological surveys.	EPA	Text refers to the RG as the closure criteria. Screening criteria will be in accordance with the FSP. *No changes are suggested to the document.*	***NWS***
34.	5-5/5.3.2.1/4	Consider describing the details of the pilot test mentioned in point #4.	EPA	In Section 5.3 introduction, revised first sentence of 3rd paragraph, to read as follows: "Pilot tests may be conducted for evaluation of *potential soil treatment technology(s). These tests could be performed* during *treatment system* start-up operations." And modified the last sentence of this section to read as	***NWS***

				follows: "*In support of any pilot tests, a pilot test work plan would be developed in conjunction with potential treatment technology vendors that will provide the details of the purpose, timing, and execution of the proposed pilot test.*" Modified the last sentence of the opening paragraph to section 5.3.2 to read as follows: "The RA for this area covers approximately 70,235 m^2 (17.4 acres). With the possibility of incorporating additional targeted sections of the forest area." Modified the second to last sentence of the 3rd paragraph of section 5.3.2 as follows: "a pilot test *may* be conducted …." Removed List Item 4.	
35.	5-7/5.3.4.1/1	Consider adding the type(s) of radiological surveys planned for the Line-1 and FS-12 structures to point #1.	EPA	Details for the structures surveys will be included in the radiation control plan that will be prepared during the pre-construction planning and procurement phase (WP Section 5.1) of the project. Modified the text as follows: "For the FS-12 structures, the contractor shall conduct an initial radiological survey of the identified structures and identify areas of radiological contamination within these structures. *The survey will be conducted in accordance with the radiation control plan and FSP.*"	***NWS***
36.	5-8/5.3.5/1	Consider adding information on the volume of soil to be used for the pilot test and where the test volume for this pilot test will be collected from. Also consider adding information whether the samples selected for the pilot test will be discrete samples or composite samples.	EPA	Modified text as follows: A pilot test may be conducted prior to implementing full-scale waste processing to test the efficiency and cost effectiveness of a soil and DU sorting technology. *Prior to the conduct of any pilot test, a Pilot Test Plan would be prepared as part of project field planning and*	***NWS***

				procurement phase (WP Section 5.1). The Pilot Test Plan will include the details of any pilot test including the identity of the source(s) and quantity of contaminated soil that will be used in the pilot test, and the performance sampling strategy. Prior to mobilizing and setting up the soil sorting technology…	
37.	5-11/5.3.8/3	Consider adding information on the potential for radiation contamination on equipment and the effect of the contamination on demobilization procedures.	EPA	Inserted the following text after the first bullet list item: *"Decontaminating, as necessary, survey equipment, tools, and other items that contacted DU-contaminated material so they meet release criteria prior to being released from the site"*	***NWS***
38.	5-12/5.3.9/1	Consider adding information on the process for certification that the remedy is operational and function along with the person responsible for certifying this.	EPA	The following bullet list item was removed: *Certification that the remedy is operational and functional.* That activity pertains to demonstrating that engineered remediation systems, such as pump-and-treat systems or landfill caps, requiring long-term operations, maintenance and monitoring are operational and functional. It does not apply to the OU-8 removal action because no engineered remedial systems will be constructed that will be placed into long-term operations and maintenance.	***NWS***
39.	6-5/6.2.4/2	Consider adding information to the text on the nature of the dust control measures that will be used.	EPA	Added the following text: *Dust control measures include wetting disturbed areas and soil stockpiles with water, covering stockpiles with plastic sheeting, and minimizing the speed of vehicles operating on disturbed areas.*	***NWS***
40.	7-1/7.3/1	Consider adding text that explains what additional information will be needed to properly profile the waste streams.	EPA	The waste profiling requirements will be identified after a disposal facility is selected during the field planning and procurement phase (Work Plan Section 5.1). Until a disposal facility is selected, the specific	***NWS***

				waste profiling requirements are unknown. Added text: It is anticipated that additional information, *as determined by the Waste Acceptance Criteria (WAC) of the chosen receiving facility*, will be needed to properly profile some waste streams, and waste characterization will be on-going through this remedial/clean-up effort, potentially modifying waste type quantities and their anticipated packaging and disposition pathways.	
41.	7-2/7.4/ 5thbullet	Consider adding text that states where the waste containers will be inspected. Will this be at the gate entering IAAAP or at a separate gate in the FS-12 area?	EPA	Clarified text as shown: Inbound Container Staging Area – Waste containers that have been previously used (i.e., intermodal containers or rail cars) will be surveyed upon arrival at the *inbound container storage area to be located at the FS-12 site* to identify any contamination.	***NWS***
42.	9-1/9.1/2	The total cost of the project is stated in the second paragraph. Consider adding text to cover the contingency that the pilot test does not work out and the DU-contaminated soil must be shipped to an off-site treatment facility. Consider providing a brief table of potential costs for these alternatives.	EPA	The total ROD cost illustrated in the second paragraph is based upon excavation and disposal of the entire estimated quantity of contaminated soil. It assumes that all DU-contaminated soil must be shipped offsite for disposal. The following sentence will be added to the paragraph … *These costs assume that all DU-contaminated soil must be shipped offsite for disposal.*	***NWS***
43.	Figure 1-3	The times for processes after 2013 are all TBD. If it is possible to estimate the completion time for post-2013 events, consider adding estimated dates to the timeline.	EPA	The start and completion dates for out-year processes and events are primarily dependent on government funding and also the results of initial site pilot testing and remedial actions. Physical sorting efficiencies attained through use of a soil sorting technology, and/or through excavation and packaging techniques, will drive both funding levels needed and the duration of the remedial action. Since neither the level of FUSRAP funding, nor the efficiency of physical sorting technologies are known, estimated dates for	***NWS***

				completing various activities are not known at this time. *No changes are suggested to the document.*	
44.	Figures 1-2 and 4-1	Consider labeling roads, railroads, and streams on these figures.	EPA	Additional key components will be added to the figures.	***NWS***
45.	Figures in general	Consider changing the scales to feet if the English unit option (see Comment 1) is chosen.	EPA	Will use metric units	***NWS***
46.	Figures 4-2, 4-3, and 4-4	Both color dots represent the same number of CPM in each respective figure – is this a typographical error? The "red" dots are not identified in the legend, or cannot be discerned due to the dark background of the figures.	EPA	The difference in the colored dots only indicates if the point is within the 100 m radius or not. The difference does not indicate any particular count rate or concentration. *Legend will be clarified.*	***NWS***
47.	Figures 4-5, 4-6, and 4-7	Consider labeling roads and providing the datums for the lines (topographic lines?) on each of these maps.	EPA	Key components will be included.	***NWS***
48.	Figure 4-8 and 4-9	It is difficult to read these figures at 8 1/2 x 11" size. Consider providing it at 11 x 17" size.	EPA	Agree, paper size will be changed to 11 x 17.	***NWS***
49.	Figure 4-10	Is the box labeled "north" a building? Consider removing the box if this is not a building.	EPA	No, figure will be modified to indicate a north arrow.	***NWS***
50.	Figures 4-12 and 4-13	Consider adding a scale and north arrow to these figures.	EPA	Agree, scale and north arrow will be added.	***NWS***
51.	Figure 4-14	Consider labeling the odd shape on the left side of the figure? Consider defining the boxes "grate in building 1-1" and "Disconnected contamination" squares. Are these buildings, survey grids, or just to highlight the notes?	EPA	The “odd shape” is an attempt at showing the stairway that leads down into the sump and could be labeled “stairway”. The boxes with text “Grate in building 1-11” and “Disconnected contamination” are simply meant to be explanatory labels. The label “Grate in building 1-11” was intended to be an “overall” label for the figure which shows an overall plan view of the grate in Building 1-11. The label “Disconnected contamination” was intended to apply to the numbered survey locations in that area (42-46) that are not on the grate itself.	***NWS***

52.	Figure 4-15	Consider adding the direction the photograph was taken to the photo caption.	EPA	Orientation was added.	***NWS***
53.	Table 4.3	In the third section "Soil survey and segregation," one of the cons is that the ISO-PACIFIC S3 system has not been proven to date, yet the effectiveness states that high volume reduction can be achieved. Consider resolving/explaining the notion that the system has "not been proven to date," yet it is highly effective in reducing the volume of the contamination.	EPA	Revised to state: *Has not been used to date for full-scale operations*	***NWS***
54.	Table 4-3	Since material will be transported to Clive, UT from Iowa in all instances, consider adding a con that there may be a problem (train derailment, etc.) that could potentially occur during offsite transport of the contaminated soils.	EPA	The determination to dispose material at the Clive facility has not yet been made. All options will require off-site transportation of contaminated materials, either truck or rail. *No changes are suggested to the document.*	***NWS***
Appendix B: TFR					
55.	Appendix B/ Acronyms	Consider adding DoD, NFPA, ER, EM and U to the list of acronyms.	EPA	Acronyms will be added.	***NWS***
56.	Appendix B/1-3/1.3/3 and 4	The number of yards of DU-contaminated material is listed as "approximately 22,023 cubic yards (paragraph 3) and 17,616 cubic yards (paragraph 4), which seems very precise. Are these numbers an approximation or an estimate (or both/neither)? Consider altering the text appropriately, if needed.	EPA	Numbers are an approximation as documented in the ROD. Intent of the document is to state the requirements as specified in the agreed upon project governing documents. *No changes are suggested to the document.*	***NWS***
57.	Appendix B/1-3/1.3/3	The paragraph states that the estimated volume reduction for the site soils (Clinton silt loam and Clinton sandy clay loam) is 20%, yet the treatment costs are based on much higher volume reductions. Consider adding text to reconcile these differences.	EPA	ROD cost estimate is for complete disposal of all excavated soils; Any volume reduction may result in a reduced overall project cost. Statement in text is an estimate of the volume reduction needed to offset the additional capital and operational cost incurred by performing the soil sorting operations. This information is as presented in the ROD.	***NWS***

				No changes are suggested to the document.	
58.	Appendix B/2-2/2.3/1	The text implies that the waste facility is unknown, but the previous tables suggest that Clive, Utah is the destination. If that is the case, consider stating that facility's WAC in this paragraph.	EPA	The selected disposal location has not yet been determined. *No changes are suggested to the document.*	***NWS***
59.	Appendix B/3-1/3.1.1/1	Consider stating the processes that will be used during intrasite transport to FS-12 in order to prevent soil contamination from spreading.	EPA	The intent of this document is to identify the needs and requirements of the project, not to specify the methods that will be employed during the cleanup activities. Specific details for intra-site handling and transportation will be developed during the RA planning and procurement phase as described in WP Section 5.1. These details will depend on the contractors and subcontractors chosen to perform the work. *No changes are suggested to the document.*	***NWS***
60.	Appendix B/3-1/3.1.1.2/1	Does the estimated weight of trucks loaded with soil exceed the load-bearing capacity of the existing roads? Consider adding text to clarify this.	EPA	Soil quantities from other firing sites will be very small and will not impact road capacities. Transportation loads from FS 12 for soils that will be transported for disposal will be evaluated prior to the start of operations. Specific details for intra-site handling and transportation will be developed during the RA planning and procurement phase as described in WP Section 5.1. These details will depend on the contractors and subcontractors chosen to perform the work. *No changes are suggested to the document.*	***NWS***
61.	Appendix B/3-2/3.3.2/1	Consider adding text to state that ER 30-1-18 and EM-385-1-80 are USACE documents.	EPA	Reference to USACE will be added to listed documents.	***NWS***
62.	Appendix B, Figure 1-1	Consider labeling roads, streams, and railroad tracks.	EPA	Key components will be added.	***NWS***

Comments: FUSRAP Operable Unit 8 (OU-8) Remedial Design / Remedial Action Work Plan for the Iowa Army Ammunition Plant Site Middletown, Iowa,

63.	Appendix B, Table 1	Consider defining "pCi/g" in notes below the table.	EPA	FUSRAP practice is to define inside table if first use, not in a footnote. If previously defined in the text then not redefined in table. No change suggested.	***NWS***
64.	Appendix B, Table 2	Consider defining ft, yd^3, and DU in notes below the table.	EPA	Please see response to #63.	***NWS***
Appendix C: Drawings					
65.	Appendix C, Sheet G-1	Consider providing a north area on the figure.	EPA	Agree, *North Arrow will be added*.	***NWS***
66.	Appendix C, Sheet G-2	Consider labeling the concentric circles at the North Test Site. Consider providing an explanation of what the large black dots represent. Consider defining what type of lines are "abandoned" in the legend.	EPA	Agree, *additional labels will be added*.	***NWS***
67.	Appendix C, Sheets C-1 through C-7	Consider defining what the black dots and small arrow represent. Are the grey areas buildings? Consider adding the datum for the lines that appear to be topographic contours.	EPA	Agree, *additional labels will be added.*	***NWS***
68.	Appendix C, Sheets C-6	Consider adding a note that the thick black line represents the haul route, if this is the case.	EPA	*Note will be added.*	***NWS***
69.	Appendix C, Sheet P-1	Consider describing what the concentric circles are in the upper left portion of the drawing. Consider describing where the equipment decontamination area will be.	EPA	General depiction of process areas. *Additional labels will be added*.	***NWS***
70.	Appendix C, Sheet P-1	Consider labeling the roads on this diagram.	EPA	*Additional labels will be added.*	***NWS***
71.	Appendix C, Sheet P-3	Consider describing where the equipment decontamination area will be.	EPA	*Equipment decon will be added.*	***NWS***
72.	Appendix C, Sheet E-1	Consider adding a legend to this diagram.	EPA	*Legend will be added*	***NWS***
73.	Appendix C, Sheet E-2	Consider adding a note describing what "DSW" indicates.	EPA	*DSW (Disconnect Switch) will be labeled.*	***NWS***

Appendix D: Schedule					
74.	Appendix D-3	Consider adding time for evaluation of the pilot test to the Gannt chart. Also, consider adding a time scale to the Gannt chart.	EPA	*Pilot Tests* – Schedule line ID items 19 and 28 used to illustrate pilot test activities were both removed since there is uncertainty as to the timing of pilot testing activities. As discussed in RTC's 34 and 36; timing, schedule and details of any pilot testing will be determined during the Remedial Action pre-construction planning and procurement activities and captured in a pilot test plan. *Time Schedule* – see response to 43 above; due to uncertainty in FUSRAP funding levels and Physical sorting efficiencies, a time scale will be extremely difficult to determine.	***NWS***
FSP					
75.	3-1/3/3	In the first bullet point, the text states that no excavation will take place at Yards C, G, and L or FS-14.1f these sites do not contain DU-contaminated soil, consider adding this to the text. If they contain DU-contaminated soil, how will it be collected to move it to FS-12?	EPA	Text modified as follows: Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) at Firing Sites 1 and 2 (FS-1, FS-2); Firing Sites 3, 4, and 5 (FS-3, FS-4, FS-5); the Firing Site 6 Area (FS-6); and the Firing Site 12 Area (FS-12). Excavation will not be conducted at Yards C, G, and L or Firing Site 14 (FS-14*) where DU was not detected above screening levels during the remedial investigation.*	***NWS***
76.	4-2/4.5/1	Consider adding a note to Section 4 whether a person with radiation experience is required to be a part of the field team.	EPA	The following sentence was added to the end this section: *A person with radiation experience will be onsite to support the radiological surveys.*	***NWS***
77.	5-1/5.1/1	Consider adding text clarifying the qualifications for a person to conduct the radiological surveys.	EPA	The following sentence was added at the end of paragraph 1: *The minimum qualifications of the field team leader conducting the radiological surveys will include 40-hour HAZWOPER and 3 years of radiological survey*	***NWS***

				field experience.	
78.	5-2/5.1.3/1	Consider describing how the XRF samples will be homogenized.	EPA	The first and second bullets were modified into three bullets as follows: • Collect a representative soil sample from the radiological survey point and place *into a stainless steel container*, • Homogenize the soil sample *with a stainless steel utensil (break up large chunks of soil)*, • *If necessary, perform a radiological field screen of the sample two times and compare the results to prevent anomalies and ensure the sample is homogenized,*	***NWS***
79.	5-5/5.2.1/2- third bullet	Consider describing the procedure for decontaminating a sampling tool that has excessive radiation.	EPA	The third bullet was modified as follows: • Use a pre-cleaned or decontaminated stainless steel scoop or spoon to collect a grab sample and composite it in a stainless steel bowl *(see Section 6.2.2 for decontamination instructions).* To address excessive radiation during decontamination, the bullet list in Section 6.2.2 was modified as follows: • Remove all visible dirt/debris or sample residue from sampling equipment *using nonabrasive methods* and *wi*pe handheld equipment with a dry towel. • *If nonabrasive methods are not effective in removing excessive radiation, then abrasive methods (i.e., scrub brush) will be used.*	***NWS***
80.	5-5/5.2.1/2- fourth bullet	Consider describing what constitutes a sufficient volume of soil to satisfy sampling requirements.	EPA	The 4th bullet was modified as follows: Depending on the analytes of interest, collect a sufficient volume of soil to satisfy the *volume*	***NWS***

				requirements *of the selected analytical laboratory*.	
81.	5-5/5.2.1/2-fifth bullet	Consider providing an example of the sample identification scheme.	EPA	Fifth bullet changed to the following: "*Label the sample using a unique identification number to identify the samples for collection and delivery to the laboratory. The identification number will be in the following format XXXX######, where XXXX is the site designator code (e.g., IAAP) and ###### is a unique sequential sample number generated from the FUSRAP database*."	***NWS***
82.	5-5/5.2.1/2-seventh bullet	Consider describing how sampling equipment will be decontaminated after use and between sampling locations.	EPA	The seventh bullet was modified as: • Decontaminate sampling equipment after use and between sampling locations *(see Section 6.2.2 for decontamination instructions).* The second sentence of Section 6.2.2. was modified to: When possible, disposable sampling equipment will be used for collecting environmental samples. If disposable equipment is not available, decontamination procedures for both chemical and radiological sampling equipment *after use and between sampling locations* will include…	***NWS***
83.	5-5/5.2.3/1	Since the disposal facility is known, consider checking with them on whether a Standard Proctor compaction test is required and include that information in this section.	EPA	The disposal facility is not known at this time and will be determined as described in the Work Plan, Section 5.1 during pre-construction planning and procurement. Once the vendor is determined, then the WAC requirements will be known and integrated into work plan documents.	***NWS***
84.	7-1/7.1/3— first bullet	Consider adding the types of weather information expected in the field logbook (temperature (For C), wind conditions, precipitation (type and amount).	EPA	The first bullet was revised as: Weather *(conditions including daily high and low temperatures in F, cloudy or clear skies, approximate wind speed, and precipitation),*	***NWS***
85.	7-1/7.1/3-	Consider including time of day (in parentheses) after	EPA	The fourth bullet was revised as:	***NWS***

	fourth bullet	Equipment calibration results.		Equipment calibration *results (and the time of day calibration was performed),*	
86.	7-1/7.1/4	Consider providing examples of field forms in this document.	EPA	Field forms will be included in the applicable procedures. The following sentence was modified in Section 5 on pages 5-1: Field work procedures *and field forms* will be compiled into a manual that will be present at the site during all field activities.	***NWS***
87.	7-1/7.2/1	Consider adding a note to describe the direction/orientation of the photograph to each photographic record.	EPA	The second sentence in this section was revised as: The location, time, *direction/orientation of the photograph* and a brief description will be recorded in the field logbook.	***NWS***
88.	7-2/7.3.2\1/1	Consider providing an example of the sample numbering system.	EPA	See response to comment #81.	***NWS***
QAPP					
89.	3-1/3/3 – first bullet	Consider adding the RG for DU-contaminated soils in this bullet.	EPA	The RGs were added to the first bullet and to the 7th bullet. • Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) *(150 pCi of U-238 activity per gram of soil)* etc. • Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG *(23,000 disintegrations per minute (dpm) gross alpha and beta activity per 100 cm^2 of surface area*) for structures.	***NWS***
90.	5-2/5.1.1.3/2	This paragraph states that the completeness goal is 100%. The DQO in Section 6.3.1 of the QAPP states that the completeness goal is 90%. Consider reconciling these two sections.	EPA	The 90% completeness is the actual goal. The first line referring to 100% will be deleted.	***NWS***

91.	6-1/6.2/3	Consider stating the frequency that field equipment and instrumentation will be calibrated.	EPA	Specific equipment is not known at this time; however, once determined, the manufacturer's instructions will be followed for proper calibration. The minimum calibration will be followed as stated in the QAPP: All field and laboratory instrumentation will be calibrated prior to and during continued use, and will have a prescribed routine maintenance schedule.	***NWS***
92.	6-4/6.3.3/2	It is not clear where the background value for the Ludlum 43-89 was derived. Consider adding text to clarify this.	EPA	The background value for the Ludlum 43-89 was kept consistent with the background value used in the RI Work Plan.	***NWS***
93.	10-2/10.3/1	Consider including examples of data management and tracking documents.	EPA	Added the following text to the last sentence of the section 10.3 introduction: "The following data management process will be followed throughout the collection, management, storage, analysis, and presentation of the data *as described in the sections below*."	***NWS***
94.	10-3/10.3.5/1	Consider stating the level of data validation that will be required for this project.	EPA	The following text was added: *All verification samples will require definitive level (Level 4) data validation. All other samples will be considered screening level and use Level 3 validation.*	***NWS***
95.	11-1/11/1	Consider providing an example of a DQCR that will be used for this project.	EPA	The following sentence was added: *An example DQCR will be included in the appropriate field plans as described in Section 5 of the RAWP.*	***NWS***
WMP					
96.	2-4/2.2.2/2	Consider detailing the Perma-Fix procedures that will be used to reduce the average DU content of the soils.	EPA	The waste facility is not known at this time. The waste disposal facility treatment and WAC requirements will be determined during the RA Planning and Procurement Phase as described in section 5.1 of the Work Plan.	***NWS***

97.	5-2/5.1.1/1-first bullet	Consider including an example of the identification number that will be assigned to disposal containers for offsite shipment.	EPA	The identification number system will be determined during the RA Planning and Procurement Phase as defined by Section 5.1 of the Work Plan. This system will be dependent on the waste facility(s) and contractors chosen to execute the RA.	***NWS***
98.	9-3 Table 4-1	Consider changing yards to cubic yards and providing notes defining yd, lb and hr.	EPA	In the second column of Table 4-1, yards was changed to *cubic yards* and *pound* was added. Notes were not included in the table as directed. All acronyms are defined in the Acronym section and where they are first called out.	***NWS***
APP.					
99.	10-5/10.4.5/1	Consider adding "where exposure to radiation is not expected" to the end of the sentence.	EPA	Agree – *sentence changed as requested.*	***NWS***
100.	10-8/ 10.8.2/ last bullet	Consider changing this sentence which implies that there are cosmetics intended for personal consumption by employees.	EPA	Sentence was changed to state: *Foods, drugs, or cosmetics intended for personal use by employees at work.*	***NWS***
101.	10-10/ 10.12 / 1	Consider changing the end of the first sentence to read "provided by the radiation contractor, who will be (Name) in charge of radiation controls on site."	EPA	Sentence was changed to read: *A Radiation Safety Plan will be provided by the radiation contractor, TBD.*	***NWS***
102.	12-4	Consider adding the directions to the hospital (Table 10-2) to this diagram.	EPA	*Directions to the Great Rivers hospital were added.*	***NWS***
SSHP					
103.	8-1/8.1/1	Consider expanding the text on how real-time monitoring of airborne contamination will occur.	EPA	The text was changed as follows: *Areas with airborne radioactive contamination in excess of 10 CFR 20 Attachment B, Table 1, Column 3 concentrations or where an individual present without respiratory protection in the area could exceed an intake of 0.6% of the ALI per week (12 DAC-hrs/week) are posted "Caution- Airborne Radioactivity Area." Respiratory protection may be required in these areas*	***NWS***

				based on measured or expected concentrations and/or duration of activity. The Radiation Protection Manger (RPM) will establish personnel air sampling requirements, as necessary, and determine the need for respiratory protection based upon actual site conditions and the activity being conducted.	
FSSP					
104.	6/2.0/1	In line 2, consider adding "objects containing" after "man-made".	EPA	Added *"objects containing."*	***SAIC***
105.	B-1/line 4	Consider adding more explanation about how the number of samples is determined using MARSSIM techniques.	EPA	Added *"as described in Section 5.6 of the FSSP."* to the end of the first sentence.	***SAIC***
106.	B-1, line 12	It is unclear where Figure 5 is. Consider adding more explanatory text.	EPA	Figure 5 changed to *"Figure B-1."*	***SAIC***
107.	D-10	In Table D-11, consider adding a column to describe the matrix that is being sampled.	EPA	*Column added to indicate if medium is soil or structural surface*	***SAIC***
RAWP					
108.	9-1/9.2/1	There are no tabs for the appendices. Consider adding these in the draft final version.	EPA	Tabs will be added for the appendices for the Final Draft print version	***NWS***
FSP					
109.	5-2/.1.3.1	Consider adding a note below the formula that Udep is depleted uranium.	EPA	Comment incorporated.	***NWS***
110.	5-4/5.1.4 and subsequent sections	Here and in subsequent sections in the text the 2 in square centimeters is not superscripted. Consider correcting this in all formulas in which it is shown as "cm^2".	EPA	Comment incorporated.	***NWS***
111.	9-1/9	In this, and subsequent, reference lists, some of the documents are italicized and some are not. Consider making this consistent within each of these reference tables.	EPA	Comment incorporated. All titles are italicized.	***NWS***

Comments: FUSRAP Operable Unit 8 (OU-8) Remedial Design / Remedial Action Work Plan for the Iowa Army Ammunition Plant Site Middletown, Iowa,

APP					
112.	APP, 10-4/ 10.2/1	The header "1.2" is repeated. The first sentence states that "For non-emergency medical needs, the nearest hospital for emergency care is Great River Medical Center. Is this for both emergencies and non-emergencies? If it's for both, please state this. Consider changing "is" to "are" in the last sentence of this paragraph.	EPA	The header has been corrected. The first sentence was changed as follows: For *emergency* and non-emergency medical needs, the nearest hospital is Great River Medical Center.	***NWS***
SSHP					
113.	SSHP, 9-1	Define SMAC 24 and EKG.	EPA	Definitions added: *EKG: Electrocardiogram* *SMAC-24 was updated to Comprehensive Metabolic Panel*	***NWS***
FSSP					
114.	FSSP, 17/4.3.5/2	Consider changing ≤ to the words "less than or equal to."	EPA	Changed to *"less than or equal to."*	***SAIC***
115.	FSSP, 18/Tables	Consider adding definitions of all abbreviations and acronyms used in the tables.	EPA	FUSRAP practice is to define inside table if first use, not in a footnote. If previously defined in the text then not redefined in table. No change suggested.	***SAIC***
116.	FSSP, 28/5.10.2	Fix the "Error! Reference source not found." statement.	EPA	Sentence changed to *"Additionally, compliance will be reviewed during the DQA of the survey data, as discussed in Section 7.1."*	***SAIC***
117.	FSSP	Appendix A/A-2/Tables A-1 and A-2: Consider defining DU, cm^3, and cpm in a note below the table.	EPA	FUSRAP practice is to define inside table if first use, not in a footnote. If previously defined in the text then not redefined. *No changes are suggested to the document.*	***SAIC***
118.	FSSP Appendix D	Consider adding definitions of all abbreviations and acronyms used in the tables.	EPA	FUSRAP practice is to define inside table if first use, not in a footnote. If previously defined in the text then not redefined. *No changes are suggested to the document.*	***SAIC***

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Comments: Remedial Design/Remedial Action Work Plan Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation

DATE: February, 2013

Comment No.	Page/ Section/ Paragraph	Comment	Initials	Response	Initials
RAWP					
1.	Page 1-1, Section 1.1, second paragraph, second sentence	Spell out Depleted Uranium the first time.	LLW	DU is defined in Section 1, second sentence. No change to the document was made.	***NWS***
2.	Page 1-2, 1st bullet	"Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities." FUSRAP needs to work with IAAAP and AO to complete the information called for in the AO Work instruction for Land Use Controls. This statement alone is not adequate.	LLW	As requested, additional information about LUCs is provided in Section 5.3.9 in response to Comment 4.	***NWS***
3.	Page 5-6, Section 5.3.4	Will the 23, 0000 dpm/100 cm squared be acceptable for sale of items/furniture, unrestricted reuse, sale and/or disposal? If not this is unacceptable. The unrestricted use of the furniture/items must be ensured or disposed of as part of this project.	LLW	Text will be added: "*Any equipment, furniture or miscellaneous items will be surveyed and released for unrestricted use if the materials meet the clearance requirements set in the Army Radiation Safety Program, Pamphlet 385-24.*"	***NWS***
4.	5-12	Add bullet for coordinating LUC IAW the AO Work Instruction.	LLW	Added a bullet item in Section 5.3.9 before the last bullet.	***NWS***

				The RA Report will contain - *Information about site conditions and post-RA land use controls developed in accordance with Environmental Work Instruction E0-1-012 Incorporating Land Use Controls in Project Planning.*	
5.	6-2	There is no specific mention of items, equipment or furniture. This needs to be included and stated that the decontamination will be to a level acceptable for re-use, sale and routine disposal. If not the items must be disposed of as part of this project.	LLW	The statement regarding release of components as shown in comment 3 is also added to section 6.2.2. *Any equipment, furniture or miscellaneous items will be surveyed and released for unrestricted use if the materials meet the clearance requirements set in the Army Radiation Safety Program, Pamphlet 385-24.*	***NWS***
FSSP					
6.	Final Status Survey Plan	Turn off line numbering feature.	LLW	Line numbering feature will be turned off for the Final Draft.	***SAIC***
General Comment					
7.	General question	Will routine Test Fire activities be allowed at other FS locations during the DU removal at FS-12?	JOHN CARROLL AO	Routine operations at other firing sites will continue as needed to support facility operations. Remedial activities at FS 12 will be conducted around the base and area closures per the IAAAP operating standards. *No change suggested to the document(s).*	***NWS***
8.	No Comment	Reviewed and had no comment.	RODGER ALLISON	Thank you.	***NWS***

Fields of Opportunities

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR
KIM REYNOLDS, LT. GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
CHUCK GIPP, DIRECTOR

November 7, 2012

SHARON COTNER
DEPARTMENT OF THE ARMY
ST LOUIS DISTRICT CORPS OF ENGINEERS
8945 LATTY AVENUE
BERKELEY MISSOURI 63134

Re: Draft Remedial Design/Remedial Action Work Plan, Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Removal, Middletown, Iowa dated September 2012

Dear Ms. Cotner:

The Iowa Department of Natural Resources, Contaminated Sites Section, (IDNR) has received and reviewed the above referenced work plan including the Field Sampling Plan, Quality Assurance Project Plan, Waste Management Plan, Accident Prevention Plan, Site Safety and Health Plan, and the Final Status Survey Plan. Because the remedial design/remedial action work plan deals only with radiological issues IDNR is required to defer all applicable or relevant and appropriate requirement reviews (except disposal) to the Radiological Health Bureau of the Iowa Department of Public Health.

In response to disposal issues, IDNR has no comments or concerns. The waste management plan for the depleted uranium fragments and depleted uranium contaminated soil and structures does not conflict with IDNR disposal requirements for radioactive waste found in IAC-567-109, *Special Waste Authorization*.

If you have any questions or need further information please feel free to call or e-mail at (515) 281-4171 or dan.cook@dnr.iowa.gov.

Sincerely,

D Cook

Daniel Cook
Environmental Specialist Senior
Contaminated Sites

c: Sandeep Mehta — U. S. EPA Region 7, 901 North 5th Street, Kansas City, Kansas 66101

Melanie Rasmusson — Iowa Department of Public Health, Bureau of Radiological Health
321 E 12th Street, Des Moines, IA 50319

Iowa DNR Field Office 6

Iowa Department of Public Health
Promoting and Protecting the Health of Iowans

Mariannette Miller-Meeks, B.S.N., M.Ed., M.D.
Director

Terry E. Branstad
Governor

Kim Reynolds
Lt. Governor

November 16, 2012

Sharon R. Cotner
FUSRAP Program Manager
Department of the Army
St. Louis District, Corps of Engineers
8945 Latty Avenue
Berkeley, MO 63134

RE: Draft Remedial Design/Remedial Action Work Plan Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation
Revision B, dated September 2012

Ms. Cotner:

The Iowa Department of Public Health has completed a review of the aforementioned draft remedial design/ remedial action work plan. Our review was limited to the development of the human health remedial goals for soil and structural surfaces considering carcinogenic effects from exposure to depleted uranium. The work plan indicates that soil and structural surface cleanup will be accomplished to achieve a total effective dose equivalent of no greater than 22.5 mrem/yr to site workers. This total effective dose equivalent is 90 percent of 25 mrem/yr. A dose of 25 mrem/yr is the total effective dose equivalent criteria for unrestricted use found in the department's administrative rules (IAC 641—40.29 (136C)). If the remedial work is completed as outlined in the draft plan, any depleted uranium left on site should be at a level that would not adversely impact human health.

Thank you for giving the Iowa Department of Public Health an opportunity to review and comment on the draft plan. If you have any questions regarding this letter, please contact me at (515) 281-3478 or Mr. Stuart C. Schmitz, M.S.,P.E. at (515) 281-8707.

Regards,

Melanie Rasmusson

Melanie Rasmusson, MBA, Chief
Iowa Department of Public Health | Bureau of Radiological Health
321 E 12th Street | Des Moines, IA 50319 | PH: 515.281.3478 Mobile: 515.371.2255
melanie.rasmusson@idph.iowa.gov

cc:	Sandeep Mehta	U.S. EPA Region 7, 901 North 5th St., Kansas City, KS 66101
	Daniel Cook	Iowa Dept. of Natural Resources, Wallace Bldg, Des Moines, IA

FINAL

FIELD SAMPLING PLAN
IOWA ARMY AMMUNITION PLANT
OPERABLE UNIT 8,
DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

FINAL

FIELD SAMPLING PLAN
IOWA ARMY AMMUNITION PLANT
OPERABLE UNIT 8,
DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

Prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:

North Wind Services, LLC
Under Contract No. W912P9-12-D-0510

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ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
ANSI	American National Standards Institute
APP	Accident Prevention Plan
ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CoC	chain of custody
cpm	counts per minute
cm^2	square centimeter
DOD	Department of Defense
dpm	disintegrations per minute
DU	depleted uranium
EPA	U.S. Environmental Protection Agency
FS	Firing Site
FSP	Field Sampling Plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPS	global positioning system
HAZWOPER	hazardous waste operations and emergency response
IAAAP	Iowa Army Ammunition Plant
KPA	Kinetic Phosphorescence Analyzer
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
NCP	National Contingency Plan
OU	operable unit
pCi/g	pico Curies per gram
pCi/L	pico Curies per Liter
PM	Project Manager
ppm	parts per million
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action

RG	remediation goal
ROD	Record of Decision
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
TCLP	toxicity characteristic leaching procedure
USACE	United States Army Corps of Engineers
WAC	waste acceptance criteria
WMP	Waste Management Plan
XRF	X-ray fluorescence

Field Sampling Plan
Iowa Army Ammunition Plant Operable Unit 8,
Depleted Uranium Contaminated Soil and Structure Remediation
Middletown, Iowa

1. INTRODUCTION

This Field Sampling Plan (FSP) establishes the guidelines for field surveys and data gathering methods to implement the remedial design/remedial action (RD/RA) for Operable Unit (OU)-8, Iowa Army Ammunition Plant (IAAAP), near Middletown, Iowa. The RD/RA will address soil and structures that are contaminated due to the use of depleted uranium (DU) by the U.S. Atomic Energy Commission (AEC) and its successors at OU-8. This FSP has been prepared in accordance with the IAAAP Federal Facilities Agreement (EPA, 2006) by the United States Army Corps of Engineers (USACE), St. Louis District Formerly Utilized Sites Remedial Action Program Office (FUSRAP) Project Office.

The primary purpose of this FSP is to provide general guidance for field surveys and data gathering methods to ensure that these activities are carried out in accordance with applicable regulatory standards and accepted professional practices. This FSP provides guidance to obtain data that are scientifically valid and defensible, of known and acceptable quality and sufficient quantity to evaluate the presence and levels of contamination in various media, and are used to direct remedial actions. Additional details about the field activities, including the remedial action objectives and project management, are provided in the RD/RA Work Plan (USACE, 2013a).

This FSP has been developed in conjunction with the Quality Assurance Project Plan (QAPP; USACE, 2013b), the Waste Management Plan (WMP; USACE, 2013c) and the Accident Prevention Plan/Site Safety and Health Plan (APP/SSHP; USACE, 2013d). All field work will be conducted in accordance with applicable procedures. All procedures will be compiled into a manual that will be present at the site during all field activities. A Final Status Survey Plan (USACE, 2013e) has been prepared to guide completion of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM; EPA, 2000) final status surveys for the soil areas outlined in the RD/RA Work Plan; therefore, no details for the final status surveys are included in this FSP.

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2. SITE BACKGROUND

The IAAAP is a government-owned, contractor-operated facility located approximately 10 miles west of Burlington, Iowa and the Mississippi River. The IAAAP consists of approximately 19,000 acres, of which approximately one-third is occupied by active or formerly active munitions production or storage facilities. The remaining property is either forested (7,766 acres) or leased for agricultural use (7,107 acres).

Since 1941, the primary activity at IAAAP has been to load, assemble, and pack a variety of conventional ammunition and fusing systems for the U.S. Department of Defense (DOD). From 1947 to 1975, portions of the IAAAP facility were under the control of the AEC for weapons-assembly operations. The IAAAP was listed on the National Priorities List in 1990.

Historical AEC activities resulted in contamination of soil at outdoor firing sites where tests of DU surrogates for weapon components were performed. DU is present as metallic uranium and as chemical weathering products of metallic uranium in soil. Soil contaminated with metallic DU and with weathered DU poses a risk to human health and the environment.

AEC performed manufacturing operations that resulted in DU contamination of structure components in two buildings in the Line 1 portion of IAAAP. Contaminated components are located in Building 1-11 and Building 1-63-6.

The FUSRAP Record of Decision (ROD; USACE, 2011) presents the selected remedy for the remediation of soil and structures at specific (i.e., former AEC) areas at IAAAP. The specific areas for which this selected remedy applies include Line 1 Structures; the Firing Sites Area (consisting of five subareas); Yards C, G, and L; and Warehouse 3-01. The selected remedy addresses soil and structures that are radiologically contaminated as a result of AEC operations. USACE is authorized by Congress as the lead agency implementing the selected remedy under the authority of FUSRAP.

The selected remedy is the final remedy for the FUSRAP areas of the IAAAP (OU-8). Six other OUs have been defined at IAAAP. They are being addressed by other U. S. Army programs.

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3. DESCRIPTION OF SELECTED REMEDY

The selected remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; 42 USC § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] §300.430(a)(1)(iii)(A)). This decision is based on the Administrative Record file located at the Burlington, Iowa Public Library and at the USACE, St. Louis District FUSRAP Project Office.

No principal threat wastes, as defined by the NCP, are present at the FUSRAP areas of IAAAP. The principal contaminant of concern for the FUSRAP areas is DU. The selected remedy for DU-contaminated soil is removal by excavation and physical treatment prior to off-site disposal. Additionally, DU will be removed from structures using decontamination and/or removal and off-site disposal.

The main components of the selected remedy for soil (ROD – Alternative 4) include:

- Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) at Firing Sites 1 and 2 (FS-1, FS-2); Firing Sites 3, 4, and 5 (FS-3, FS-4, FS-5); the Firing Site 6 Area (FS-6); and the Firing Site 12 Area (FS-12). Excavation will not be conducted at Yards C, G, and L or Firing Site 14 (FS-14) where DU was not detected above screening levels during the remedial investigation.

- Physical treatment of DU and DU-contaminated soil excavated from FS-1 and FS-2; FS-3, FS-4, and FS-5; FS-6; and FS-12 via soil sorting.

- Disposal of materials exceeding the DU RG at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate.

- Site restoration, including backfilling, grading, and re-vegetation.

- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.

- Five-year reviews for FUSRAP areas where contaminants remain above levels acceptable for unlimited use and unrestricted exposure to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use will be verified during each 5-year review.

The main components of the selected remedy for structures (ROD – Alternative S3) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures.

- Disposal of DU-contaminated materials at a properly permitted off-site facility.

- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.

- Five-year reviews for structures if they exceed levels appropriate for unlimited use and unrestricted exposure to ensure continued protectiveness of human health under industrial land use. Industrial land use will be verified during each 5-year review.

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4. PROJECT ORGANIZATION AND RESPONSIBILITIES

This section describes the organization and responsibilities of key field positions, including interfaces and lines of communication between personnel. The project organizational chart is presented in Figure 4-1. Key field positions include:

- Project Manager (PM),
- Field Project Engineer,
- Site Safety and Health Officer (SSHO), and
- Site Quality Assurance (QA)/Quality Control (QC) Supervisor.

Overall responsibilities for all supporting field personnel are also described.

The responsibilities of the key field positions are described in this section. All positions, other than the USACE PM, will be filled by a combination of contractor and subcontractor staff. The assignment of personnel to each position will be based on a combination of:

- Experience in the type of work to be performed,
- Experience working with USACE personnel and procedures,
- A demonstrated commitment to high quality and timely job performance, and
- Staff availability.

4.1 Project Manager

The PM will be the primary point of contact for all work performed and will be responsible for the management and execution of this work in accordance with the contract; approved work plans; and all federal, state, and local laws and regulations. The PM will ensure that all site activities are performed in a safe manner.

4.2 Field Project Engineer

The Field Project Engineer will be assigned to the site on a full-time basis during site work activities. As directed by the PM, the Field Project Engineer will have the responsibility and authority to direct work performed under the Work Plan and this FSP. This individual is responsible for:

- Ensuring proper technical performance of excavation operations, field surveys, and data gathering/sampling activities;
- Obtaining approval and documenting variances from the Work Plan during field activities;
- Adhering to required field procedures;
- Coordinating field personnel activities;

- Coordinating management and transportation of waste;
- Checking all field documentation; and
- Ensuring that field work is performed in a safe manner.

4.3 Site Safety and Health Officer

The SSHO will be assigned to the site on a full-time basis during site work activities. As delegated by the Health and Safety Officer and in accordance with the APP/SSHP, the SSHO will have the responsibility and authority to modify and/or halt work or remove personnel from the site if working conditions that may affect safety and health change.

4.4 Site Quality Assurance/Quality Control Supervisor

The Site QA/QC Supervisor will be assigned to the site on a full-time basis during site work activities. This individual will be responsible for implementation and documentation of all project QA/QC protocols during field activities. In this capacity, the Site QA/QC Supervisor will direct and implement the various components of the contractor's QA/QC program. This individual is responsible for:

- Documentation of QAPP instructions to field personnel,
- Documentation of field QC activities, and
- Completion of Daily Quality Control Reports.

The Site QA/QC Supervisor reports to the PM but will also inform the QA/QC Manager and Field Project Engineer of all quality information and decisions, and will work in concert with the SSHO.

4.5 Supporting Field Personnel

Field personnel will perform the activities specified in the Work Plan as directed by the Field Project Engineer or designee. These individuals will be responsible for ensuring appropriate preparation and planning prior to conducting activities to reduce delays in start-up. Field personnel are responsible for ensuring that all materials and equipment are available for the tasks and all field documentation is complete and legible. Field personnel will communicate regularly with the Field Project Engineer on matters relating to the status of tasks, additional needs to complete the tasks, and issues related to properly completing the tasks. A person with radiation experience will be onsite to support the radiological surveys.

5. FIELD SURVEYS AND DATA COLLECTION ACTIVITIES

Data quality objectives and specific details for the field surveys and data collection activities to be performed are provided in Section 6 (*Performance and Compliance Monitoring*) of the Work Plan (USACE, 2013a). The activities required to complete the remedial action include radiological surveys of soils and structures; and soil, sediment, and water sampling. QA/QC criteria for successful implementation of these work elements are provided in the QAPP (USACE, 2013b).

Field work procedures and field forms will be compiled into a manual that will be present at the site during all field activities. Types of procedures will include:

- Radiological control support, field work, and instrumentation as part of the Radiation Safety Program (see the APP/SSHP [USACE 2013d]);
- Sampling of soil, sediment, water, and waste;
- Air monitoring;
- Equipment decontamination;
- Sample handling, packaging, and shipping;
- Documentation and record keeping; and
- Waste management, disposal, and transportation.

5.1 Radiological Surveys

Radiological surveys will be conducted to determine the presence, if any, of DU contamination above the RGs stated in the Work Plan (USACE, 2013a). Radiological surveys will include gamma walkover scans, gamma surveys of individual excavations, and surveys of structures. The minimum qualifications of the field team leader conducting the radiological surveys will include 40-hour hazardous waste operations and emergency response (HAZWOPER) and 3 years of radiological survey field experience.

Gamma walkover scans will be utilized for radiological surveys of any land/soil areas to be investigated. Beta scans, fixed-point alpha/beta measurements, and total surface contamination measurements will be utilized for the radiological survey of any structures investigated. QA/QC criteria for the collection, handling, and shipping of radiological survey samples and for the use of radiation survey equipment are provided in the QAPP (USACE, 2013b).

A radiation survey instrument will be selected based on the type of survey (Appendix A). All instruments will be calibrated and maintained as stated in the QAPP.

5.1.1 Gamma Walkover Surveys

Locations for gamma walkover surveys are identified in the Work Plan (USACE, 2013a). General area scans for gross gamma radiation will be performed to identify locations of elevated external radiation that suggest possible residual DU contamination. DU emits sufficient gamma radiation to identify the presence of residual contamination and estimate the concentrations potentially present.

A Ludlum Model 44-10 2" NaI gamma scintillation detector instrument (or equivalent) coupled with a global positioning system (GPS) will be used for gamma walkover scans. The surveyor will advance at a speed of approximately 2 feet per second (0.6 meters per second) while passing the detector as close as reasonable to ground surface. Approximate spacing of 3 to 5 feet (0.9 to 1.5 meters)will be used between survey paths. Scanning results will be recorded in counts per minute (cpm). Detectors may be mounted on the back of a vehicle to conduct the scans.

The initial investigation level for the gamma scans will be set at 1.5 times the background count rate for the given area. The investigation level may be adjusted by the survey supervisor, with USACE concurrence based on the deviation of count rates encountered as the survey progresses. This investigation level will depend on the relevant background count rate in each specific area. Locations exceeding the investigation level will be investigated and, as appropriate, marked for excavation.

There may be locations where safety considerations or other restrictions prevent access for normal scanning activities; reasonable efforts to scan such locations will be made. Alternative and innovative approaches (e.g., employing extension poles, mounting detectors on platforms with wheels or skids, placing detectors in protective sleeves, and using excavating equipment to position and move detectors) will be considered.

5.1.2 Gamma Survey of Individual Excavations

Locations for individual excavations requiring gamma surveys are identified in the Work Plan (USACE, 2013a). Gamma scans of the bottom and sides of individual excavations (i.e., a small excavation made using a backhoe or similar equipment, or using manual methods) will be conducted to determine if DU-contaminated soil has been removed. A Ludlum Model 44-10 2" NaI gamma scintillation detector instrument (or equivalent) will be used for surveying soil exposed in excavations. The detector will be located as close as reasonable to the exposed soil surface, and will be moved across the surface at a rate of approximately 2 feet per second (0.6 meters per second). Scanning results will be recorded in cpm. The initial investigation level for the gamma scans will be set at 1.5 times the background count rate for the given area. The investigation level may be adjusted by the survey supervisor, with USACE concurrence based on the deviation of count rates encountered as the survey progresses. This investigation level will depend on the relevant background count rate in each specific area. Locations exceeding the investigation level will be investigated and, as appropriate, marked for excavation.

After an individual excavation has been expanded sufficiently to remove all DU-contaminated soil, the limits of that excavation will be marked with survey stakes and the location of each stake will be documented using a GPS instrument; the coordinates will be recorded in a field logbook.

5.1.3 XRF Survey

Field screening for metals using a portable X-ray fluorescence (XRF) unit may be used to supplement the radiological survey. The following steps are performed at a specific survey point:

1. Collect a representative soil sample from the radiological survey point and place into a stainless steel container,

2. Homogenize the soil sample with a stainless steel utensil (break up large chunks of soil),

3. If necessary, perform a radiological field screen of the sample two times and compare the results to prevent anomalies and ensure the sample is homogenized,

4. Collect an XRF reading in accordance with the manufacturers' instructions, and

5. Use the following formula to convert concentration (parts per million [ppm]) to activity (pico Curies per gram [pCi/g]) of DU (formula from 10 CFR 20, Appendix B, Footnote 3).

$$1 \text{ ppm Udep x } \left(\frac{1\frac{\text{ug}}{\text{g}}}{\text{ppm}}\right) \text{x } \left(3.6\text{E}-7\ \frac{\text{Ci}}{\text{g}}\text{Udep}\right) \text{x } \left(1\text{E}12\,\frac{\text{pCi}}{\text{Ci}}\right) \text{x } \left(1\text{E}-6\,\frac{\text{g}}{\text{ug}}\right) = \ 0.36\ \frac{\text{pCi}}{\text{g}}\text{Udep}$$

Udep = depleted uranium

The XRF manufacturers' instructions should be followed for sample preparation and calibration, with care taken to adhere to relevant portions of the method description.

5.1.4 Radiological Survey of Structures

Locations for radiological surveys of structures are identified in the Work Plan (USACE, 2013a). Radiological monitoring of structures will be conducted to determine the presence, if any, of DU contamination. Radiological monitoring will include scanning for total beta surface activity and fixed point measurements for total alpha and beta surface activity using portable radiological survey equipment, and collection of swipe samples for measurement of removable alpha and beta activity. Total radioactivity levels will be measured to determine if surfaces meet the RG. Total and removable radioactivity levels will be measured to determine if removed structural components and other residuals generated during structures remediation meet the screening levels for clearance identified in *The Army Radiation Safety Program* (Department of the Army, 2011). Any material that exceeds the screening levels for clearance will be managed as radioactive waste.

Uranium emits alpha, beta, and gamma radiation, which can be used to identify the presence of residual contamination and estimate the concentrations potentially present. Beta scans will be used because alpha radiation is a less reliable indicator of true surface activity levels due to greater attenuation. A Ludlum Model 2360 coupled with a Ludlum 43-89 (or equivalent) will be used for performance of the beta scans. Scan speed with these detectors will be approximately 1 to 2 inches per second (2.5 to 5 centimeters per second). Distance from the detector probe to the surface being scanned will be approximately 1/4 inches (0.6 centimeters). If the investigation level is reached during scanning, the surveyor will pause to allow the instrument response to stabilize. A biased fixed-point measurement and smear should be performed where elevated activity is noted (and confirmed) during the scan survey.

Scanning results will be recorded in cpm, which along with the appropriate instrument geometry and calibration information will be used to convert the data to disintegrations per minute (dpm)/100 square centimeters (cm^2) for comparison to RGs.

Screening beta scans will generally be performed over accessible areas. For the purposes of this plan, accessible is defined as "areas where safety considerations or other restrictions do not prevent access for normal scanning activities." The beta scan surveys will be biased to areas with the highest potential for contamination based on the professional judgment of the survey supervisor.

Total alpha and beta surface activity (fixed-point) measurements will be conducted as necessary based on the results of the beta scans. Fixed-point gross activity measurements will be made with 30-second static counts using a Ludlum 43-89 (or equivalent). The results of the survey for alpha and beta will be recorded in cpm and converted to dpm/100 cm^2 upon completion of the survey.

Removable activity is measured by smearing an area of approximately 100 cm^2 with a dry filter paper; alpha and beta activity on the smear sample are then measured. Removable alpha and beta surface activity samples (smears) will be collected at each fixed-point measurement location. The smear will be collected, counted for radioactivity, and documented prior to conclusion of the survey.

Activity will be calculated using the following equations:

$$ncpm = gcpm - bcpm$$

Where:

ncpm = net counts per minute

gcpm = gross counts per minute

bcpm = instrument background counts per minute.

$$dpm/_{100cm^2} = \frac{ncpm}{\varepsilon 1 * \varepsilon 2 * DA} * \frac{100\ cm^2}{100\ cm^2}$$

Where:

DA = detector area

$\varepsilon 1$ = instrument efficiency (cd-1)

$\varepsilon 2$ = surface efficiency (unitless).

The effects of self-absorption may produce considerable error in the reported surface activity levels. A surface efficiency (εs) of 0.5 (unitless) for beta and 0.25 for alpha will be used based on recommendations found in NUREG-1507, Section 5.3.2 (NRC, 1998). A discussion of minimum detectible concentrations for use in the site survey process is presented in the QAPP (USACE, 2013b).

5.1.5 Instrument Use and Quality Assurance

Survey instruments used for radiological measurements will be:

- Selected based on the survey instrument's detection capability for DU;
- Calibrated in accordance with American National Standards Institute (ANSI) N323A, *Radiation Protection Instrumentation Test and Calibration – Portable Survey Instruments* (ANSI, 1997);
- Calibrated with a National Institute of Standards and Testing source to obtain a quantitative measurement; and
- Operated and maintained by qualified personnel in accordance with the Health Physics Program procedures (e.g., physical inspection, background checks, response/operational checks, etc.).

Radiological field instrumentation used for this site survey will have been calibrated in accordance with ANSI N323A within the past 12 months (or more frequently if recommended by the manufacturer).

Daily quality checks will be conducted on each instrument, as stated in the QAPP. Only data obtained using instruments that satisfy these performance requirements will be accepted for use during this survey.

The instruments selected for this site are shown in Appendix A. Sources will be stored and handled as specified by procedures and shipped in accordance to Department of Transportation regulations.

5.2 Soil, Sediment, and Water Sampling

All sampling, analytical, QA, and data management activities associated with sample collection will be performed in accordance with the *Sampling and Analysis Guide for the St. Louis Sites* (USACE, 2000) and the *USACE Kansas City and St. Louis District Radionuclide Data Quality Evaluation Guidance for Alpha and Gamma Spectroscopy* (USACE, 2002).

5.2.1 Soil and Sediment Samples

Soil and sediment sampling may be performed using a number of sampling techniques, including sampling by scoop or sampling with a hand auger. Contamination is not expected to be encountered at a depth greater than 2 feet (0.6 meters) below ground surface (bgs); therefore, surface soil samples will be collected and composited over a depth interval of 0 to 6 inches (0 to 1.3 centimeters) bgs. Subsurface soil samples may be collected and composited over depth intervals of 6 inches (0.3 centimeters) or greater. Sediment sampling may be conducted as needed from ditches and drainages containing water or water transported sediment.

The following general steps will be followed for soil and sediment sampling:

1. Don clean gloves and, using a stainless steel spoon or other approved utensil, remove surface vegetation and debris from the immediate area around the marked sampling point. Note that when sampling for only DU, use of stainless steel equipment is not necessary.

2. Record the appropriate information and observations about the sample location in the field logbook.

3. Use a pre-cleaned or decontaminated stainless steel scoop or spoon to collect a grab sample and composite it in a stainless steel bowl (see Section 6.2.2 for decontamination instructions).

4. Depending on the analytes of interest, collect a sufficient volume of soil to satisfy the volume requirements of the selected analytical laboratory.

5. Label the sample using a unique identification number to identify the samples for collection and delivery to the laboratory. The identification number will be in the following format: XXXX######, where XXXX is the site designator code (e.g., IAAP) and ###### is a unique sequential sample number generated from the FUSRAP database.

6. Complete all chain-of-custody (CoC) documents and record the sampling event in the field logbook.

7. Decontaminate sampling equipment after use and between sampling locations (see Section 6.2.2 for decontamination instructions).

5.2.2 Water Samples

The types of liquid waste streams requiring sample collection include decontamination water and storm water. All liquid waste streams will be evaluated, sampled, and/or treated as necessary in accordance with the USACE, IAAP Water Treatment System – Standard Operating Procedure, Current Version.

5.2.3 Geotechnical Samples

Collection of geotechnical samples may be necessary to properly assess soil properties prior to sending soil through the radiological sorting system, and for preparing a waste profile to support disposal as waste. These data may include determination of parameters such as grain-size distribution (sieve and hydrometer) and Atterberg limits. Soil properties, including a Standard Proctor compaction test (American Society for Testing and Materials [ASTM] D-698), may also be required for waste disposal.

5.2.4 Air Monitoring

Non-occupational air monitoring will be conducted by collecting perimeter air samples at one location to measure the potential for contaminant migration away from the site in the direction of the prevailing winds during active removal, treatment, and loading actions.

5.2.5 Laboratory Analysis

USACE will contract with laboratories accredited under the DOD Environmental Laboratory Accreditation Program and will be compliant with the DOD Quality Systems Manual, Version 4.2 (DOD, 2010). Analytical names and methods are presented in Table 5-1. Specific details regarding sample containers, preservation, and holding times will be determined by the contracted analytical laboratory.

5.2.6 On-Site Laboratory

The on-site laboratory will be set up for gamma spectroscopy, gross alpha, and gross beta using Gas Flow Proportional Counting, and total uranium by Kinetic Phosphorescence Analyzer (KPA). The laboratory will be used for immediate turnaround screening level analyses supporting ongoing remediation activities. The laboratory methods employed for analysis have been accredited through the DOD Environmental Laboratory Accreditation Program (Cert# L2274) at the primary St. Louis FUSRAP laboratory.

Gamma spectroscopy will identify isotope of interest activity concentrations in soil samples. Gamma spectroscopy samples will be collected in marinelli beakers and analyzed by the laboratory, as received.

Gross alpha and gross beta analysis for air samples and/or smears will be performed using Gas Flow Proportional Counting. Samples will be analyzed for gross alpha and gross beta activity concentration, as received.

Water samples will be analyzed for total uranium using the KPA. The water samples will be prepared prior to analysis for total uranium by using a 0.45μ syringe filter to remove interfering material. The KPA will have two calibration ranges: a low range of approximately 0.5 pico Curies per Liter (pCi/L) to 7 pCi/L and a high range of approximately 25 pCi/L to 350 pCi/L.

5.2.7 Sample Packaging and Shipping

Sample packaging and shipping will be conducted in accordance with applicable laboratory procedures. Samples will be shipped in laboratory-supplied shipping containers to maintain sample integrity. All samples will be preserved as appropriate prior to transportation to the analytical laboratory.

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6. CONTAMINANT CONTROL AND DECONTAMINATION PLAN

6.1 Pre-Use Radiological Surveys

Following mobilization, a pre-use radiological survey will be conducted on equipment and materials (i.e., heavy equipment, waste containers, and the radiological sorting system). This will include internal surveys of the waste containers if the containers were previously used at other sites prior to mobilization.

The radiological survey will include surface contamination measurements to ensure contamination levels are less than the allowable total residual surface contamination levels stated in the Radiation Safety Program (Department of the Army, 2011).

Pre-use radiological surveys will be performed to ensure limits are not exceeded prior to use. If the radiological survey results are below these contamination levels, the surveyed equipment and materials can be used onsite. If contamination levels exceed the acceptable total residual surface contamination limits in the Radiation Safety Program (Department of the Army, 2011), either: (1) establish a controlled area and perform decontamination, or (2) request replacement equipment or materials from the vendor.

6.2 Decontamination Activities

6.2.1 Equipment and Materials

During field activities, equipment and materials used for excavation and hauling soils will be decontaminated to a level sufficient to prevent cross-contamination of subsequent work areas. Decontamination procedures will include:

- Remove all visible dirt/debris from equipment,
- Wipe handheld equipment with a dry towel, and
- Return equipment or material for use.

6.2.2 Sampling Equipment

When possible, disposable sampling equipment will be used for collecting environmental samples. If disposable equipment is not available, decontamination procedures for both chemical and radiological sampling equipment after use and between sampling locations will include:

- Remove all visible dirt/debris or sample residue from sampling equipment using nonabrasive methods and wipe handheld equipment with a dry towel; and
- If nonabrasive methods are not effective to remove excessive radiation, then abrasive methods (i.e., scrub brush) will be used.

Chemical sampling equipment will be decontaminated as follows:

1. Select appropriate decontamination solution (i.e., Alconox);
2. Set up a decontamination station to collect contaminated media and decontamination solutions;
3. Disassemble sample equipment, as necessary;

4. Remove gross contamination by brushing, scraping, wiping, and/or low or high-pressure water spray;

5. Wash equipment in decontamination solution; remove all visible soil, oil, and grease; and

6. Rinse equipment with tap water followed by isopropyl alcohol (if organic contamination is a concern) or distilled, deionized, or purified water.

Radiological sampling equipment may be simply scanned and swiped to ensure there is no residual removable radioactivity from previous sampling. The following additional steps will be performed for radiological sampling equipment to return the sampling equipment for future use:

- Perform a surface contamination measurement on sampling equipment, and

- Ensure surface contamination levels are less than 20 dpm/swipe.

6.3 Completion Radiological Surveys

Following completion of all field work, field decontamination procedures for all equipment and materials identified to leave the site will include:

1. Remove all visible dirt/debris from equipment,

2. Wipe handheld equipment with a dry towel, and

3. Perform a radiological survey of total surface contamination measurements to ensure contamination levels are less than the screening levels for clearance stated in the Radiation Safety Program (Department of the Army, 2011).

If the radiological survey results are below these contamination levels, the surveyed equipment and materials will be demobilized offsite. If contamination levels exceed these levels, the decontamination and radiological survey will be repeated until the criterion is met or the equipment/material will be disposed of as radiological waste.

7. SAMPLE AND DOCUMENT CUSTODY

Sample custody procedures for this project emphasize careful documentation of sample collection and sample transfer. Any necessary changes or corrections to forms, labels, or logbooks will be made by striking out the error with a single straight line and re-entering the correct information. The new entries will be initialed and dated by the person making the change. The following sections describe the records generated to document field activities; custody procedures; sample identification protocols; and sample container, preservation, and handling procedures.

7.1 Field Logbooks

Field logbooks used to record field activities will be bound, waterproof, and have serial numbered pages. Typically, one field logbook will be maintained; however, any number of logbooks may be maintained if the need arises and the Field Project Engineer determines it is necessary.

Only the Field Project Engineer may authorize the start of a new logbook. The project name, project number, Field Project Engineer name, telephone number, and office address will be listed on the inside cover of all field logbooks. The logbook will be used to document daily field activities in sufficient detail to allow field personnel to reconstruct events that transpired during the project. Field logbooks will be maintained by site personnel to record the following information:

- Weather (conditions, including daily high and low temperatures in degrees Fahrenheit (°F), cloudy or clear skies, approximate wind speed, and precipitation);
- Personnel on site;
- Field activities and significant events;
- Equipment calibration results (and the time of day calibration was performed); and
- Sample numbers, locations, problems encountered, and sample handling and preservation methods.

In addition to the field logbook, field forms will be completed as support documentation for the field activities. Any of the above information listed on a field form will not be duplicated in the field logbook. All field logbooks will be kept in the possession of field personnel responsible for completing the logbooks, or in a secure place when not being utilized during field work. Logbook entries must be dated, legible, made in black indelible ink, and contain accurate documentation. Language used will be objective, factual, and free of personal opinions. Upon completion of the field activities, all logbooks will become part of the final project file.

7.2 Photographic Records

Photographs may be used to supplement written descriptions of field activities. The location, time, direction/orientation of the photograph, and a brief description will be recorded in the field logbook. Photographs will be recorded on digital media and backed up to secondary media on a daily basis. The first photograph of a new location series will include the site name or location identifier, as appropriate. Photographs will be stored as individual JPG files. All photograph files will be named with site name or location identifier, date of photograph, and sequential photo number.

7.3 Sample Documentation

7.3.1 Sample Numbering System

In order to identify and accurately track the various samples, all samples collected will be designated with a unique number in accordance with the naming guidance for the USACE, St. Louis District Office database system. This number will serve to identify the site, sampling location, sample media, sampling depth, and QA/QC qualifiers.

7.3.2 Sample Labels

Sample labels are required for properly identifying samples. All field samples will be labeled with the label affixed to the container before or shortly after it is filled and prior to transportation to the laboratory. The sample label will include the following information:

- Sample identification number,
- Location identification,
- Date and time of sample collection,
- Initials of person collecting the sample,
- Analysis requested,
- Preservation method, and
- Any other information pertinent to the sample.

7.3.3 Chain-of-Custody

To preserve the integrity of environmental samples, the sampler must maintain and document the custody of the samples from the time of sample collection to completion of analysis. A sample is considered to be under a person's *custody* if the sample is in the person's physical possession or direct view, if the sample is secured so that no one can tamper with the sample, or if the sample is secured in an area restricted to authorized personnel only. In addition, an overriding consideration for data resulting from laboratory analyses is the ability to demonstrate that the samples were obtained from the locations stated and that they reached the laboratory without alteration. CoC forms will be used to record the transfer of samples from one person's custody to another (e.g., from sampler to laboratory).

The CoC form will be initiated in the field by the person collecting the sample. When custody of the samples is transferred, or when samples are relinquished to a commercial carrier (e.g., FedEx), the person relinquishing the samples will sign, date, and note the time of transfer on the CoC form. In return, the new custodian must sign, date, and note the time received on the CoC form. The commercial carrier is not required to sign the CoC if the shipment is sealed prior to delivery to the shipper. The CoC form will be placed inside the cooler used for transport of samples. The field sampler will retain a copy of the form for the project files.

When possible, the CoC forms will be generated electronically on a computer and printed for signature. In the event that generation of the CoC electronically is not possible or practical, a laboratory CoC form will be used. Electronic images or hardcopies of each CoC will be retained by the field team for reference only. All entries on the CoC form must be recorded in indelible, black ink.

Any necessary changes to the CoC will be made by striking out the error with a single straight line and re-entering the correct information. The new entries will be initialed and dated by a sampler. It is common for multiple personnel to work together to collect, package, and ship samples. In such a case, any single member of the immediate sampling team is considered “the sampler” for purposes of completing CoC forms or other documentation.

7.4 Storage/Archival of Samples

The laboratory will have procedures describing long-term storage/archival of samples and documentation on the storage conditions of all samples, sample extracts, and digestates. These entities will not be placed in long-term storage/archival until acceptance of the final data package by USACE, and will remain in storage in predetermined physical and environmental conditions commensurate with their intended purpose.

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8. WASTE MANAGEMENT

All waste generated as a result of field activities will be managed in accordance with the WMP for this project (USACE, 2013d).

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9. REFERENCES

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40 CFR 300, 2000, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Office of the Federal Register.

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USACE, 2013c. "Remedial Design/Remedial Action Waste Management Plan, Iowa Army Ammunition Plant, Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation, Middletown, Iowa (FINAL)," Revision 0, U.S. Army Corps of Engineers, February 2013.

USACE, 2013d. "Remedial Design/Remedial Action Accident Prevention Plan/Site Safety and Health Plan, Iowa Army Ammunition Plant, Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation, Middletown, Iowa (FINAL)," Revision 0, U.S. Army Corps of Engineers, February 2013.

USACE, 2013e. "Final Status Survey Plan for FUSRAP Areas at the Iowa Army Ammunition Plant, (FINAL)," U.S. Army Corps of Engineers, Revision 0, February 2013.

10. FIGURES

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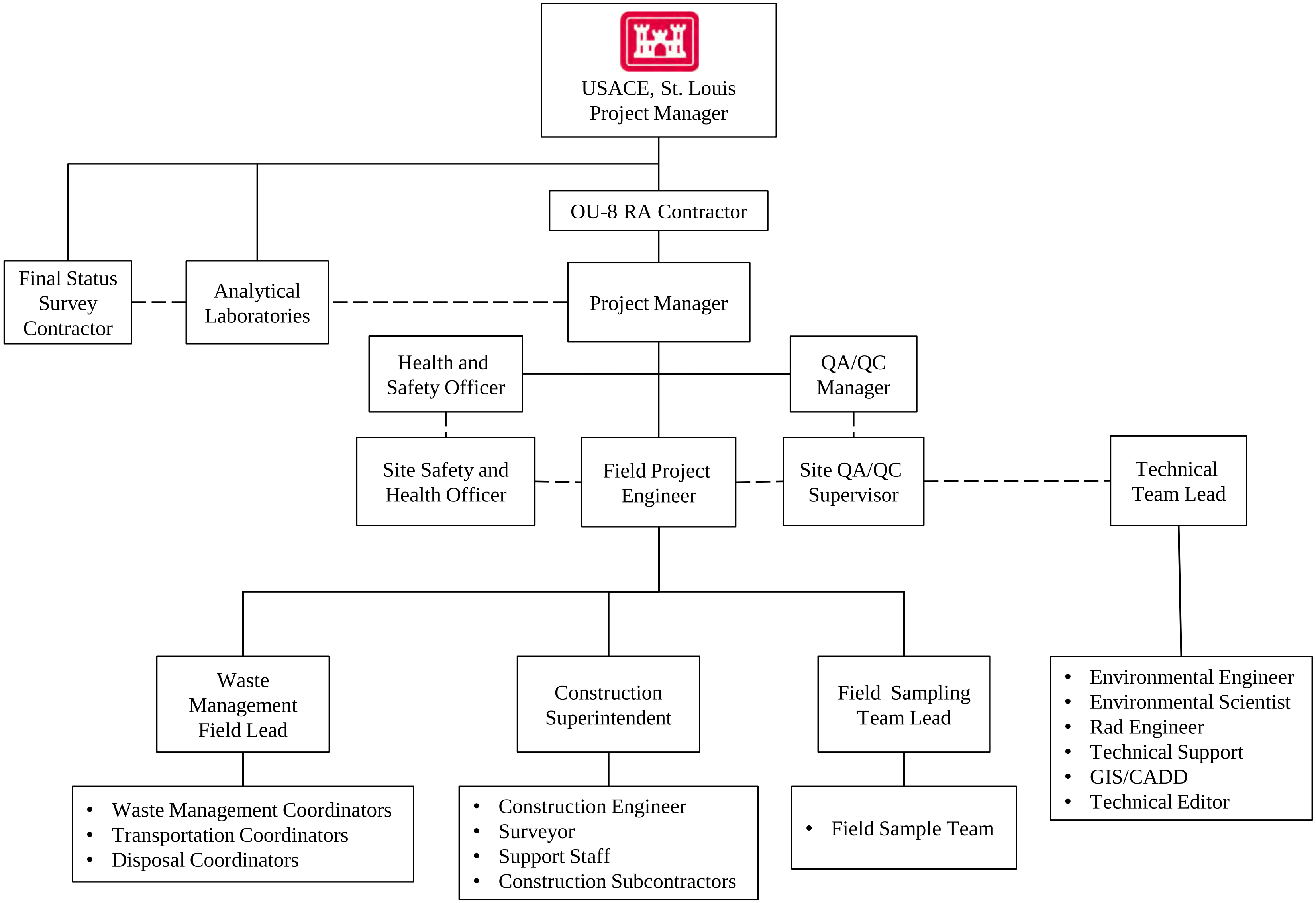

Figure 4-1. Project organization chart.

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11. TABLES

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Table 5-1. Analytes and method number.

Analysis	Method Number	Media	Data Use
Toxicity Characteristic Leaching Procedure (TCLP) Resource Conservation and Recovery Act (RCRA) Metals, plus Zinc	Environmental Protection Agency (EPA) 6010/7470 TCLP	Soil/Aqueous	Waste Acceptance Criteria (WAC) Compliance
Volatiles	EPA 8260	Soil/Aqueous	WAC Compliance
Semi Volatiles	EPA 8270	Soil/Aqueous	WAC Compliance
Herbicides	EPA 8081	Soil/Aqueous	WAC Compliance
Pesticides	EPA 8151	Soil/Aqueous	WAC Compliance
Reactive Cyanide	EPA 9014	Soil/Aqueous	WAC Compliance
Sulfide	EPA 9034	Soil/Aqueous	WAC Compliance
Paint Filter Liquid Test	EPA 9095	Soil/Aqueous	WAC Compliance
Standard Proctor Method	ASTM D-698	Soil	WAC Compliance
Isotopic Uranium (gamma spec and alpha spec for Uranium 234, 235, and 238)	EPA 901.1 Modified/AWWA7120-B	Soil	Demonstrate attainment of soil remediation goal, WAC Compliance and Correlation to Field Screening
RDX	EPA 8321B or 8330B	Aqueous	Operational
Gamma Spec, Gross Alpha and Gross Beta	Gas Flow Proportional Counting (On-Site Laboratory)	Soil (Gamma Spec) Air, Smears (Gross Alpha and Gross Beta)	Correlation to Field Screening
Total Uranium	Kinetic Phosphorescence Analyzer (On-Site Laboratory)	Aqueous	Correlation to Field Screening

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Appendix A

Radiological Instruments

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Potential Radiological Instruments Associated with IAAAP FUSRAP Fieldwork and Verification

Ludlum 2929 (Alpha/Beta scaler) with 43-10-1 (Alpha/Beta sample counter)

Used for counting smears to measure levels of removable contamination. Detects alpha and beta.

Ludlum 2360(Alpha/Beta scaler,ratemeter) with 43-89 probe (Alpha/Beta Scintillator)

Used for surface activity scans and measurements on structures, personnel frisking, equipment release. Detects alpha and beta.

Potential Radiological Instruments Associated with IAAAP FUSRAP Fieldwork and Verification



Ludlum 239-1F floor monitor

Ludlum 2360(Alpha/Beta scaler,ratemeter) with 43-37 probe (gas proportional detector)

Used for surface activity scans over a large smooth surface (floor monitor). Detects alpha and beta.

Ludlum 2221(scaler, ratemeter) with 44-9 probe (pancake G-M detector)

Used for screening soil samples and contamination control surveys. Detects alpha/beta/gamma.

Potential Radiological Instruments Associated with IAAAP FUSRAP Fieldwork and Verification

Ludlum 2221(scaler,ratemeter) with 44-10 probe (2"x 2", NaI Scintillator)

Used for gamma walkover surveys (GWS) and screening soil samples. Detects low level wide energy gamma.


Ludlum 12s & Ludlum 19 (Micro R)

Used for general area and on contact radiation surveys. Detects low level gamma.

Potential Radiological Instruments Associated with IAAAP FUSRAP Fieldwork and Verification

Air Monitoring

Occupational: Breathing Zone (BZ) air samples collected with pump model 224-PCXR4
Uses 37mm, 0.8µm mixed cellulose ester (MCE) filter

Non-occupational: Perimeter air samples collected with pump model AVS-28A
Uses 47mm, 0.45µm mixed cellulose ester (MCE) filter

Table A-1. Radiological instruments, manufacturers and model numbers.

Instrument	Manufacturer	Model #
Gamma photon detector	Canberra	GC3020
Segmented 2" lead shield with table	Nuclear Lead Co.	NA
Amp (G-spec)	Canberra	9615
HVPS (G-spec)	Canberra	9645
ADC (G-spec)	Canberra	9633
AIM (G-spec)	Canberra	556A
Electronics Rack (G-spec)	Canberra	5015
DSA1000 -optional electronics for G-spec-	Canberra	DSA1000
Dewar	Canberra	D30
Kinetic Phosphorescence Analyzer (kPA)	Chemchek	KPA11A
U-nat liquid sources for kPA calibration	Eckert & Ziegler	NA
Balance	Ohaus	Adventurer Pro AV3102C
Balance Weights		
Gas Flow Proportional Counter	Tennelec	Series 5HP
Th230 electroplated daily check source	North American Scientific	I071
Tc99 electroplated daily check source	North American Scientific	I069
Th230 calibration source	Eckert & Ziegler	SRS71905-524
Sr90 calibration source	Eckert & Ziegler	SRS71908-524
Mixed Gamma plus Am241 calibration source	Eckert & Ziegler	SRS83104-524
Mixed Gamma plus Am241 daily check source	Eckert & Ziegler	SRS75838-524
CPU for data processing	NA	NA
CPU for instrumentation	NA	NA

FINAL

QUALITY ASSURANCE PROJECT PLAN IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

FINAL

QUALITY ASSURANCE PROJECT PLAN IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

Prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:

North Wind Services, LLC
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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
APP	Accident Prevention Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm^2	square centimeter
CoC	chain of custody
cpm	counts per minute
DOD	U.S. Department of Defense
dpm	disintegrations per minute
DQCR	daily quality control report
DU	depleted uranium
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
FS	Firing Site
FSP	Field Sampling Plan
FUSRAP	Formerly Used Sites Remedial Action Plan
GIS	geographical information system
GPS	Global Positioning System
IAAAP	Iowa Army Ammunition Plant
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectible concentration
MDCR	minimum detectable count rate
MDL	method detection limit
NCP	National Contingency Plan
OU	operable unit
pCi/g	picocuries per gram
PM	Project Manager
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RD/RA	remedial design/remedial action
RG	remediation goal

RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
USACE	United States Army Corps of Engineers
WMP	Waste Management Plan

Quality Assurance Project Plan
Iowa Army Ammunition Plant Operable Unit 8,
Depleted Uranium Contaminated Soil and Structure Remediation
Middleton, Iowa

1. INTRODUCTION

This Quality Assurance Project Plan (QAPP) provides guidance for quality assurance (QA)/quality control (QC) requirements for environmental data and supporting information gathered as part of implementing the remedial design/remedial action (RD/RA) for Operable Unit (OU)-8 at the Iowa Army Ammunition Plant (IAAAP) near Middletown, Iowa. The RD/RA addresses soil and structures that are contaminated due to the use of depleted uranium (DU) by the U.S. Atomic Energy Commission (AEC) and its successors at OU-8. This QAPP has been prepared in accordance with the IAAAP Federal Facilities Agreement (EPA, 2006a) by the United States Army Corps of Engineers (USACE), St. Louis District Formerly Utilized Sites Remedial Action Program Office (FUSRAP) Project Office.

This QAPP complies with key elements of the Environmental Protection Agency (EPA) *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006b), the *Sampling and Analysis Guide for the St. Louis Sites* (USACE, 2000), and the *USACE Kansas City and St. Louis District Radionuclide Data Quality Evaluation Guidance for Alpha and Gamma Spectroscopy* (USACE, 2002).

Additional details about the field activities, including the remedial action objectives, the RD/RA, and project management are provided in the RD/RA Work Plan (USACE, 2013a). This QAPP has been developed in conjunction with the Field Sampling Plan (FSP; USACE, 2013b), the Waste Management Plan (WMP; USACE, 2013c), and the Accident Prevention Plan (APP)/Site Safety and Health Plan (SSHP; USACE, 2013d). A Final Status Survey Plan (USACE, 2013e) has been prepared to guide completion of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM; EPA, 2000) final status surveys for the soil areas outlined in the RD/RA Work Plan; therefore, no details for the final status surveys are included in this QAPP.

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2. SITE BACKGROUND

The IAAAP is a government-owned, contractor-operated facility located approximately 10 miles west of Burlington, Iowa and the Mississippi River. The IAAAP consists of approximately 19,000 acres, of which approximately one-third is occupied by active or formerly active munitions production or storage facilities. The remaining property is either forested (7,766 acres) or leased for agricultural use (7,107 acres).

Since 1941, the primary activity at IAAAP has been to load, assemble, and pack a variety of conventional ammunition and fusing systems for the U.S. Department of Defense (DOD). From 1947 to 1975, portions of the IAAAP facility were under the control of the AEC for weapons-assembly operations. The IAAAP was listed on the National Priorities List in 1990.

Historical AEC activities resulted in contamination of soil at outdoor firing sites where tests of DU surrogates for weapon components were performed. DU is present as metallic uranium and as chemical weathering products of metallic uranium in soil. Soil contaminated with metallic and weathered DU poses a risk to human health and the environment.

AEC performed manufacturing operations that resulted in DU contamination of structure components in two buildings in the Line 1 portion of IAAAP. Contaminated components are located in Building 1-11 and Building 1-63-6.

The FUSRAP Record of Decision (ROD; USACE, 2011) presents the selected remedy for the remediation of soil and structures at specific (i.e., former AEC) areas at IAAAP. The specific areas for which this selected remedy applies include Line 1 Structures; the Firing Sites Area (consisting of five subareas); Yards C, G, and L; and Warehouse 3-01. The selected remedy addresses soil and structures that are radiologically contaminated as a result of AEC operations. USACE is authorized by Congress as the lead agency implementing the selected remedy under the authority of FUSRAP.

The selected remedy is the final remedy for the FUSRAP areas of IAAAP (OU-8). Six other OUs have been defined at IAAAP. They are being addressed by other U.S. Army programs.

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3. DESCRIPTION OF SELECTED REMEDY

The selected remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; 42 USC § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] §300.430(a)(1)(iii)(A)). This decision is based on the Administrative Record file located at the Burlington, Iowa Public Library and at the USACE, St. Louis District FUSRAP Project Office.

No principal threat wastes, as defined by the NCP, are present at the FUSRAP areas of IAAAP. The principal contaminant of concern for the FUSRAP areas is DU. The selected remedy for DU-contaminated soil is removal by excavation and physical treatment prior to off-site disposal. Additionally, DU will be removed from structures using decontamination and/or removal and off-site disposal.

The main components of the selected remedy for soil (ROD – Alternative 4) include:

- Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) (150 pico Curies per gram [pCi/g] of U-238 activity per gram of soil) at Firing Sites 1 and 2 (FS-1, FS-2); Firing Sites 3, 4, and 5 (FS-3, FS-4, FS-5); the Firing Site 6 Area (FS-6); and the Firing Site 12 Area (FS-12). Excavation will not be conducted at Yards C, G, and L or Firing Site 14 (FS-14).
- Physical treatment of DU and DU-contaminated soil excavated from FS-1 and FS-2; FS-3, FS-4, and FS-5; FS-6; and FS-12 via soil sorting.
- Disposal of materials exceeding the DU RG of at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate.
- Site restoration, including backfilling, grading, and re-vegetation.
- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.
- Five-year reviews for FUSRAP areas where contaminants remain above levels acceptable for unlimited use and unrestricted exposure to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use will be verified during each 5-year review.

The main components of the selected remedy for structures (ROD – Alternative S3) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG (23,000 disintegrations per minute [dpm] gross alpha and beta activity per 100 square centimeters [cm^2] of surface area) for structures.
- Disposal of DU-contaminated materials at a properly permitted off-site facility.
- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.
- Five-year reviews for structures if they exceed levels appropriate for unlimited use and unrestricted exposure to ensure continued protectiveness of human health under industrial land use. Industrial land use will be verified during each 5-year review.

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4. PROJECT ORGANIZATION AND RESPONSIBILITIES

This section describes the organization and responsibilities of key quality positions, including interfaces and lines of communication between personnel. The project organizational chart is presented in the FSP (USACE, 2013b). The responsibilities of key quality positions are described in this section and include the Project Manager (PM), QA/QC Manager, Site QA/QC Supervisor, and Field Project Engineer. Overall quality responsibilities for all supporting field personnel are also described.

4.1 Qualifications of Field Work Personnel

The personnel responsible for conducting field work will have experience with the activities conducted. They will have read this document, as well as the FSP (USACE, 2013b), WMP (USACE, 2013c), and the APP/SSHP (USACE, 2013d). They will be cognizant of the importance and level of QC that must be maintained. The level of completeness hinges on proper implementation of the Work Plan and FSP; therefore, sampling activities will be monitored by the PM and Field Project Engineer throughout implementation of the RD/RA activities.

4.2 Project Manager

The PM will be the primary point of contact for all work performed and will be responsible for the management and execution of this work in accordance with the contract; approved work plans; and all federal, state, and local laws and regulations. The PM shall ensure that all site activities are performed in a safe manner.

4.3 QA/QC Manager

The QA/QC Manager is responsible for project QA/QC in accordance with the requirements set forth in this QAPP and appropriate management guidance. This individual, in coordination with the Site QA/QC Supervisor, will be responsible for participating in the following activities:

- Project field activity readiness reviews;
- Approving, evaluating, and documenting the disposition of corrective action documentation;
- Overseeing and approving any required project training; and
- Designing audits followed by supervision of these activities.

4.4 Site QA/QC Supervisor

The Site QA/QC Supervisor will be assigned to the site on a full-time basis during on-site work activities. This individual will be responsible for implementation and documentation of all project QA/QC protocols during field activities. In this capacity, the Site QA/QC Supervisor will direct and implement the various components of the contractor's QA/QC program. This individual is responsible for:

- Documentation of QAPP instructions to field personnel, and
- Documentation of field QC activities.

The Site QA/QC Supervisor reports to the PM but will also inform the QA/QC Manager and Field Project Engineer of all quality information and decisions and will work in concert with the Site Safety and Health Officer (SSHO).

4.5 Field Project Engineer

As directed by the PM, the Field Project Engineer will have the responsibility and authority to direct work performed under the Work Plan and this QAPP. This individual is responsible for:

- Completion of Daily Quality Control Reports (DQCRs);
- Ensuring proper technical performance of excavation operations, field surveys, and data gathering/sampling activities;
- Obtaining approval and documenting variances from the Work Plan during field activities;
- Adhering to required field procedures;
- Coordinating field personnel activities;
- Coordinating management and transportation of waste;
- Checking all field documentation; and
- Ensuring that field work is performed in a safe manner.

The Field Project Engineer reports directly to the PM with the exception of QA/QC matters, whereby the Field Project Engineer reports directly to the QA/QC Manager or Site QA/QC Supervisor.

4.6 Supporting Field Personnel

Field personnel will be directed by the Field Project Engineer (or designee) to perform the activities specified in the Work Plan. These individuals will be responsible for ensuring appropriate preparation and planning prior to conducting activities to reduce delays in start-up. Field personnel are responsible for ensuring all materials and equipment are available for the tasks and all field documentation is complete and legible. Field personnel will communicate regularly with the Field Project Engineer on matters relating to the status of tasks, additional needs to complete the tasks, and issues related to properly completing the tasks.

5. QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT OF DATA

Measurement of QA objectives includes data quality indicators and QC samples. Data quality indicators will be used as appropriate and include quantitative (i.e., precision, accuracy, and completeness) and qualitative (i.e., representativeness, comparability, and sensitivity) QA/QC measurements. QC samples will include laboratory QA/QC samples. Variances from the QA objectives will result in the implementation of appropriate corrective measures and an assessment of the impact of corrective measures on the usability of the data in the decision-making process.

5.1 Data Quality Indicators

5.1.1 Quantitative QA/QC Measurements

5.1.1.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Precision can be assessed by replicate measurements of known laboratory standards and analysis of duplicate field samples. Precision will be determined as the relative percent difference (RPD) between duplicate sample results.

Replicate measurements of known standards (e.g., laboratory control samples analyzed in duplicate) are routinely monitored by the laboratory by comparing the RPD with established control limits. Control limit criteria are established by applying three standard deviations from the mean RPD of historical data. Precision criteria for duplicate laboratory control samples for each parameter will be defined by the laboratory. Precision will also be assessed by replicate analysis of duplicate field samples. In general, one field duplicate sample will be collected for every 20 samples. Precision criteria will be determined by the laboratory method and will be in accordance with the DOD Quality Systems Manual, Version 4.2 (DOD, 2010).

5.1.1.2 Accuracy

Accuracy is the degree of agreement between a measurement against an accepted reference or true value. An evaluation of the accuracy of a measurement system provides an estimate of bias. The accuracy of an analytical method is evaluated by analyzing known reference standards. The percent recovery achieved by analysis of known reference standards of spiking compounds will be used to define the accuracy for the compounds of interest. One known reference standard is analyzed for every batch of 20 samples. The percent recovery of an analyte is calculated by dividing a true or known value (i.e., accepted reference value) into an observed value and multiplying by 100.

The specific criteria ranges of accuracy for each measured parameter are based on historical laboratory analytical data. Acceptable accuracy measures are also dependent on the sample matrix. Accuracy criteria (i.e., percent recovery) for each parameter will be defined by the laboratory. The measurement of these data QA objectives are assessed for the laboratory control samples. The accuracy and precision criteria for surrogate samples will be defined by the laboratory.

The accuracy of field measurements will be assessed through pre-measurement calibrations and verifications.

5.1.1.3 Completeness

Completeness is defined as the percentage of valid analytical results obtained from measurement systems compared with the total number of analytical results requested.

The impact of rejected or missing data on project decisions will be evaluated on a case-by-case basis. During assessment of the data, an evaluation of samples needed to make decisions with respect to project objectives will be made. In general, analytical completeness of the data is considered when no less than 90% of the total requested analytical results are deemed valid.

5.1.2 Qualitative QA/QC Measurements

5.1.2.1 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Although representativeness is a qualitative measurement, it is evaluated through a multistep process beginning with a qualitative check of precision and accuracy data.

In the case where duplicate samples are co-located, which will be utilized as a means to assess field representativeness, satisfactory representativeness will first be assessed by the agreement between analytical results for co-located field duplicate samples against the precision criteria. In the event that RPDs exceed 50%, the data will be evaluated for appropriateness to use in RPD comparisons by the following criteria:

- For analytes with both sample concentrations greater than five times the reporting limit (RL), the duplicates sample results should agree within 50% RPD for soil samples and 25% RPD for water samples; and
- For analytes with either or both sample concentrations less than five times the RL, duplicate sample results should agree within ±2 times the RL for soil and water samples.

Results for analytes not meeting these criteria will be evaluated in light of project objectives and, if professional judgment warrants, qualified as estimated in all associated samples during the review process.

5.1.2.2 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability also involves a multistep evaluation and can be related to accuracy and precision, as these quantities are measures of data reliability. Data are comparable if site considerations, collection techniques, measurement procedures, methods, and RLs are equivalent for the samples within a sample set. A qualitative assessment of data comparability will be made from applicable data sets.

5.1.2.3 Sensitivity

Sensitivity is defined as the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Method detection limits (MDLs) were determined, as outlined in 40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants," and are defined as the minimum concentration of a substance that can be identified, measured, and reported with a 99% confidence that the analyte concentration is greater than zero, and is determined from analysis of a sample in a given matrix containing the analyte. Laboratory RLs are generally three to five times higher than the laboratory MDLs. The laboratory will report all values above the MDL. Values above the MDL and less than the RL are qualified as estimated and flagged with the code "J".

5.2 Quality Control Samples

5.2.1 Laboratory QA/QC Samples

USACE will contract laboratories that meet the criteria presented in the DOD Quality Systems Manual, Version 4.2 (DOD, 2010). Laboratory QA/QC samples will be defined by the selected analytical laboratory and be based on the analytical methods. Types of QA/QC samples may include method or preparation blanks, surrogate spikes, and laboratory control samples, as appropriate for the analytical method.

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6. SAMPLE COLLECTION AND INSTRUMENTATION

The attainment of quality data that are legally defensible and from which sound decisions can be made involves many critical steps. One such step is sampling and related activities that provide representative media upon which all subsequent steps, analysis, and evaluation will be based. Therefore, the proper performance of sampling procedures, along with accurate QA/QC documentation, is critical for the production of representative samples.

6.1 Sample Collection

Collection of all samples (e.g., chemical, radiological, and geotechnical) will follow standard protocols set forth by Iowa Department of Natural Resources, EPA, USACE, and the United States Army Environmental Center. Detailed procedures for the collection of samples and field measurements are provided in the FSP. This includes sample collection for analysis of chemical analytes, radiological analytes, and geotechnical properties.

6.2 Instrument Calibration and Preventative Maintenance

All field and laboratory instrumentation will be calibrated prior to and during continued use, and will have a prescribed routine maintenance schedule. The calibration and maintenance history of the project-specific field and laboratory instrumentation is an important aspect of the project's overall QA/QC program. As such, all calibration and maintenance will be implemented by trained personnel following the manufacturer's instructions to ensure the equipment is functioning within the tolerances established by the manufacturer.

Laboratory calibration and maintenance requirements are presented in a Laboratory Quality Management Action Plan or equivalent. The laboratory is responsible for the calibration and maintenance of its analytical equipment. All instruments will be maintained in accordance with the manufacturer’s recommendations and approved laboratory practice.

Field instrumentation, sampling equipment, and accessories will be calibrated and maintained per manufacturer's recommendations and established field practice. Calibration and maintenance will be the responsibility of the Field Project Engineer and SSHO. All documentation pertinent to the calibration and/or maintenance of field equipment will be maintained in a field logbook. Entries made into the logbook regarding the status of any field equipment will contain, but are not limited to, the following information:

- Date and time of calibration,
- Name of person conducting calibration,
- Type of equipment being serviced and identification number (e.g., serial number),
- Reference standard used for calibration (e.g., pH of buffer solutions, sources),
- Calibration and/or maintenance procedure used, and
- Other pertinent information.

Equipment that fails calibration and/or becomes otherwise inoperable during the field investigation will be removed from service and segregated to prevent inadvertent use. Such equipment will be properly tagged to indicate that it is not to be used until the problem can be remedied. Equipment requiring repair or recalibration must be approved for use by the Field Project Engineer or SSHO prior to placement back into service. Equipment that cannot be repaired or recalibrated will be replaced. The Field Project Engineer or SSHO will review calibration and maintenance records on a regular basis to ensure that required maintenance is occurring. Details for calibration and maintenance of radiological instrumentation are stated in Section 6.3.2.

6.3 Radiological Instrumentation

Radiological surveys will be conducted to determine the presence, if any, of radiological contamination. Radiological surveys will include gamma walkover scans, scanning for total beta surface activity, fixed-point measurements for total alpha and beta surface activity using portable radiological survey equipment, and collection of smears for measurement of removable alpha and beta activity.

Gamma walkover scans will be utilized for radiological survey of any land/soil areas to be investigated. Beta scans, fixed-point alpha/beta measurements, and loose surface contamination measurements will be utilized for the radiological survey of any structures investigated. Additional details for the radiological surveys are included in the Work Plan and FSP.

6.3.1 Data Quality Objectives

Data quality objectives for radiological samples include the following and will be used as appropriate:

- Approximately 5% QA/QC samples (duplicates and splits).
- QA/QC of fixed point and removable activity measurements will be conducted at a frequency of at least one in 20.
- Precision within 30%.
- 90% usable data after validation.
- Minimum detectable activity (MDA) for gamma spectroscopy will be less than 1 pCi/g of K-40, less than 5 pCi/g U-238, and less than 2 pCi/g U-235.
- MDA for alpha spectroscopy will be 1.0 pCi/g for U-238, U-235, and U-234.
- Target MDA of 50% of the RG for all survey instrumentation.
- Randomly located samples will be collected in each designated area.
- All radiological survey instruments will be operated and maintained by qualified personnel in accordance with manufacturer instructions.
- Radiological field instruments used for site reconnaissance surveys will be QC checked at the beginning of each survey day to determine acceptance and usability of data collected. The established acceptance criteria will be source checks within ±20% of the known value.
- Gamma walkover data will be electronically recorded and visually displayed on maps.

- Beta fixed point minimum detectible concentration (MDC) will be 3,000 dpm/100 cm^2 or less than 50% of the RG.
- Alpha fixed point MDCs will be 300 dpm/100 cm^2 or less than 50% of the RG.
- Beta scan MDCs will be 4,000 dpm/100 cm^2 or less than 80% of the RG.
- Ludlum 3030 alpha removable contamination MDA will be 60 dpm/100 cm^2 or less than 10% of the RG.
- Ludlum 3030 beta removable contamination MDA will be 600 dpm/100 cm^2 or less than 10% of the RG.
- To validate scan, total, and removable MDC/MDA values, the actual radiological instruments used will have site-specific background and efficiency values ±20% of the values used in modeling. If instrument background and efficiency values fall outside this range, new site-specific MDC/MDAs will be calculated.

6.3.2 Calibration and Maintenance

Calibration protocols and measurements will be documented in the field logbook. Handheld detectors will be calibrated daily during field activities. Daily calibration will include pre-operational checks, background checks, and source checks to ensure consistency of response. The results of calibration will be recorded and documented in the field log book.

Pre-Operational Checks

Pre-operational checks will be performed prior to each use and whenever instrument response becomes questionable. Pre-operational steps include:

- Verifying instrument has current calibration,
- Visually inspecting instrument for physical damage that may affect operation,
- Performing satisfactory battery check (manufacturer's operating instructions will be used to define satisfactory battery check), and
- Checking cable connection and cable integrity.

Daily Background Checks

- Background checks will be performed at the same location in a reproducible geometry at the beginning and end of each survey day and any time the instrument response appears questionable,
- Site-specific instrument background will be established upon arrival at the site by determining the mean value of 10 one-minute background counts,
- The established acceptance criteria will be source checks within ±20% of the known value, and
- Multiple instruments of the same type to be used on the same global positioning system (GPS) gamma walkover survey must have mean background values that agree within 10%.

Daily Source Checks

- Source checks will be performed at the same location in a reproducible geometry at the beginning and end of each survey day and any time the instrument response appears questionable.
- Source check acceptance criterion is established as ± 20% of the known calibrated value.
- Ludlum Model 2360 ratemeter/scaler coupled with a Ludlum Model 43-89 (ZnS plastic scintillator) hand held probe will be checked with a Th-230 and SrY-90 sources.
- Ludlum Model 2929 scaler coupled with a Ludlum Model 43-10-1 smear counter will be checked with Th-230 and SrY-90 sources.
- Ludlum Model 44-10; 2 x 2 NaI Gamma Scintillation detector will be checked with a Cs-137 source.

6.3.3 Static and Scan Minimum Detectable Concentrations

NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC, 1998), and NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (EPA, 2000) provide methodology for calculation of MDCs. The steps for calculating MDCs follow the approach detailed in NUREG-1507. The steps include:

- Calculating the minimum detectable count rate (MDCR) by selecting a given level of performance, scan speed, and background level of the detector; and
- Selecting a surveyor efficiency, if applicable.

For determining the MDCs, the average beta background value for the Ludlum 43-89 was assumed to be 160 counts per minute (cpm). The observable background counts (*b'*) is defined as the number of background counts observed within the observation interval (*i*). The observation interval was selected as the time that 25% of the probe is over a 4-inch × 4-inch (100 cm^2) area of interest. The equation used for calculating *b'* is as follows:

$$b' = (background\ count\ rate)\ x\ (observation\ interval)\ x\ (1\ min\ /\ (60\ \text{sec})) = counts\ /\ interval$$

The minimum detectable number of net source counts in the interval is given by s. Therefore, for an ideal observer, the number of source counts required for a specified level of performance can be arrived at by multiplying the square root of the number of background counts by the detectability value associated with the desired performance (d'):

$$si = d'\ \sqrt{bi}$$

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, *d'*, is defined as the index of sensitivity and is dependent on the selected decision errors for Type I (alpha) and Type II (beta) errors. A true positive error (1–beta) of 95% and a false positive error (alpha) of 60% were selected to be consistent with NUREG- 1507. The value of 1.38 was obtained from Table 6.1 in NUREG-1507 (Table 6.5 in MARSSIM).

$$MDCR = si * (60/i) = cpm$$

Finally, the scan MDCs for structure surfaces may be calculated:

$$Scan\ MDC = \frac{MDCR}{\sqrt{p}\ \varepsilon i\ \varepsilon s \frac{probe\ area}{100cm2}}$$

Where:

MDCR = minimum detectable count rate (cpm)
ε*i* = instrument efficiency (cd^{-1})
ε*s* = surface efficiency (unitless)
P = surveyor efficiency (unitless, typically assumed to be 0.5).

The Counter Detection Limit (L_D) – 95% confidence level is calculated for each instrument by using the following equation:

$$L_D = 3 + 3.29\sqrt{(R_B)(T_S)\left(1 + \frac{T_S}{T_B}\right)}$$

Where:

L_D = *a priori* detection limit (minimum significant activity level)
R_B = background count rate (cpm)
T_B = background count time (minutes)
T_S = sample count time (minutes).

The detection limit, L_D, is the *a priori* (before the fact) activity level that an instrument can be expected to detect 95% of the time. It is the smallest amount of activity that can be detected at a 95% confidence level. It should be used to calculate the minimum detection capability of an instrument.

The fixed point measurement MDA is calculated as follows:

$$MDA\ (dpm/100\ cm2) = \frac{LD}{[DA]\ [\varepsilon i][\varepsilon s][T]} * \frac{100\ cm2}{100\ cm2}$$

Where:

DA = detector area (cm^2)
L_D = *a priori* detection limit (minimum significant activity level)
ε*i* = instrument efficiency (cd^{-1})
ε*s* = surface efficiency (unitless)
T = count time (minutes).

For the smear counting, a Ludlum 2929/43-10-1 or equivalent will be used. MDA for the smear counter will be calculated as follows:

$$Smear\ MDA\ (dpm/100cm2) = \frac{LD}{(T)(\varepsilon i)}$$

Where:

L_D = *a priori* detection limit (minimum significant activity level)

$\boldsymbol{\varepsilon}i$ = instrument efficiency (cd^{-1})
T = count time (minutes).

The calculations of MDCs for selected instrumentation proposed for IAAAP are:

Surface: Steel structural beams
Background (R_B) = 160 cpm β, 1 cpm α
Probe dimensions: 3.0 inches × 6.5 inches
Probe active area: 125 cm^2
Scan Speed = 2 inches/sec
Fixed point measurement time (T_S) = 30 seconds
Background count time (T_B) – 10 minutes
$\boldsymbol{\varepsilon}i$ = 0.27 β , 0.16 α
$\boldsymbol{\varepsilon}s$ = 0.5 β, 0.25 α(MUREG-1507, Section 5.3.2)
P = 0.50
d' = 1.38.

<u>Scan Measurement – beta(β)</u>

$$I \ = \ 5.0 \text{ inches}/2 \text{ in sec} - 1 \ = \ 2.5 \text{ seconds}$$

$$bi \ = \ (160 \text{ cpm})\ (1\text{min}/60\text{sec})\ (2.5 \text{ sec}) = 6.67 \text{ counts/observation interval}$$

$$si \ = \ 1.38\sqrt{6.67} = 3.6\ net\ source\ counts$$

$$MDCR = 3.6(60/2.5) = 86\ cpm$$

$$Scan\ MDC = \frac{86\ cpm}{\sqrt{0.50}(0.27)(0.5)(1.25)} = 721\ dpm/100cm2$$

<u>Fixed Point Measurement – beta/gamma (β)</u>

$$L_D \ = \ 3 + 3.29\sqrt{(160)(0.5)\left(1 + \frac{0.5}{10}\right)} = 33\ counts$$

$$MDA = \ \frac{33}{[125]\ [0.27][0.50][0.5]} * \frac{100\ cm2}{100\ cm2} = 391\ dpm/100\ cm2$$

<u>Fixed Point Measurement – alpha (α)</u>

$$L_D \ = \ 3 + 3.29\sqrt{(1)(0.5)\left(1 + \frac{0.5}{10}\right)} = 5\ counts$$

$$MDA = \ \frac{5}{[125]\ [0.16][0.25][0.5]} * \frac{100\ cm2}{100\ cm2} = 200\ dpm/100\ cm2$$

7. SAMPLE AND DOCUMENT CUSTODY

Verifiable sample and document custody is an integral part of all field and laboratory operations. Traceable steps will be taken in the field and laboratory to document activities performed; quality of work; and that all samples have been properly collected, identified, preserved, and secured. Details and procedures related to field documentation, including field logbooks, photographic record, and sample documentation, are presented the FSP.

Laboratory sample and document custody will be identified in a Laboratory Quality Management Action Plan (or equivalent), which will be made available upon request. Documentation to be received from the laboratory will include a cooler receipt checklist (to document the condition of shipping coolers and enclosed sample containers upon receipt at the analytical laboratory) and a letter of receipt (to confirm sample receipt and log-in information).

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8. PERFORMANCE AND SYSTEMS AUDITS

Performance and systems audits may be conducted to verify documentation and implementation of the QA program, assess the effectiveness of the QAPP, identify any nonconformance, and verify correction of identified deficiencies. The QA/QC Manager will be responsible for initiating audits, selecting the audit team, and overseeing audit implementation.

8.1 Performance Audits

Performance audits are utilized to quantitatively assess the accuracy of measurement data through the use of performance evaluation and blind check samples. Performance audits of the laboratory will be performed in accordance with the procedures and frequencies established by the DOD Quality Systems Manual, Version 4.2 (DOD, 2010). The performance audit will be conducted by the QA/QC Manager (or designee) in accordance with the procedures outlined in this section. The QA/QC Manager will evaluate the need for additional performance audits with due consideration given to the recommendations of the PM.

8.2 Systems Audits

If deemed necessary, a systems audit on field work performance will be conducted by the QA/QC Manager. The Field Project Engineer is responsible for supervising and checking that samples are collected and handled in accordance with the approved work plans and that documentation of work is adequate and complete. The PM is responsible for overseeing that project performance satisfies QA/QC objectives as set forth in the QAPP. Reports and technical correspondence will be peer-reviewed by an assigned qualified individual (independent to the project) before being finalized.

The laboratory will regularly conduct internal audits per their Laboratory Quality Management Action Plan, or equivalent.

8.3 Audit Procedures

This procedure provides requirements and guidance for performing internal and external audits to verify compliance with the elements of the QAPP.

8.3.1 Audit Notification

The PM and, if appropriate, other audited entities (e.g., Field Project Engineer, Laboratory Supervisor) will be notified by the QA/QC Manager of an audit at a reasonable time before the audit is performed. This notification will be in writing and will include information such as the general scope and schedule of the audit and the name of the audit team leader.

8.3.2 Pre-audit Conference

A pre-audit conference will be conducted at the audit site with the appropriate manager or designated representative (e.g., Field Project Engineer, Laboratory Supervisor, etc.). The purpose of the conference will be to confirm the audit scope, present the audit plan, discuss the audit sequence, and plan for the post-audit conference.

8.3.3 Audit

The audit is implemented by the audit team to include:

- Checklists prepared by the audit team and approved by the QA/QC Manager will be sufficiently detailed to document major audit components,
- Selected elements of the QAPP will be audited at a level of detail necessary to evaluate the effectiveness of implementation, and
- Conditions requiring immediate corrective action will be reported immediately to the QA/QC Manager.

8.3.4 Post Audit Conference

At the conclusion of the audit, a post-audit conference will be held with the Field Project Engineer, Laboratory Supervisor, or their designated representative to present audit findings and clarify/respond to any outstanding questions. Audit findings will be concisely stated by the audit team leader on a list of findings. The findings will be acknowledged by signature of the PM or designated representative upon completion of the post-audit conference.

8.3.5 Audit Report

An audit report will be prepared by the audit team leader and signed by the QA/QC Manager. The report will include:

- Description of the audit scope;
- Identification of the audit team;
- Persons contacted during pre-audit, audit, and post-audit activities;
- A summary of audit results, including an evaluation statement regarding the effectiveness of the QAPP elements that were audited;
- Details of findings and program deficiencies; and
- Recommendations for correcting the findings to the QA/QC Officer, with a copy to the PM and others, as appropriate.

8.3.6 Audit Responses

The PM or designated representative will respond to the audit report within 2 days of receipt. The response will clearly state the corrective action for each finding, including action to prevent recurrence and the date the corrective action will be completed.

8.3.7 Follow-Up Action

Follow-up action will be performed by the QA/QC Manager or designated representative to:

- Evaluate the adequacy of the PM's response,
- Assess that corrective action is identified and scheduled for each finding, and
- Confirm that corrective action is accomplished as scheduled.

Follow-up action may be accomplished through written communications, re-audit, or other appropriate means. When all corrective actions have been verified, a memorandum will be sent to the PM signifying the satisfactory close-out of the audit.

8.3.8 Audit Records

Original records generated for all audits will be retained within the central project files. Records will include audit reports, written replies, the record of completion for corrective actions, and documents associated with the conduct of audits, which support audit findings and corrective actions, as appropriate.

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9. CORRECTIVE ACTION

The ultimate responsibility for maintaining quality rests with the PM. The routine operation of QA falls upon the Field Project Engineer, QA/QC Manager, and the Site QA/QC Supervisor. Any nonconformance with the established QC procedures will be expeditiously identified and controlled. No additional work dependent on any nonconforming activity will be performed until the identified nonconformance is corrected.

9.1 Field Corrective Action

The Field Project Engineer will review the procedures being implemented in the field for consistency with the established protocols. Sample collection, preservation, and labeling will be checked for completeness. Where procedures are not strictly in compliance with the established protocol, the deviations will be field documented and reported to the QA/QC Manager. Corrective actions will be defined and documented by the Field Project Engineer and PM. Upon implementation of the corrective action, the Field Project Engineer will provide the QA/QC Manager with a written memorandum documenting field implementation. The memorandum will become part of the project file.

9.2 Laboratory Corrective Action

The laboratory QA department will review the data generated to ensure that all QC samples have been run as specified in their protocols prior to submittal of the data package. Data generated with laboratory control samples that do not fall within control limits are considered suspect, and the analysis will be repeated or results will be reported with qualifiers if re-analysis is not possible. Data deemed unacceptable following implementation of the required corrective action measures will not be accepted by the PM, and follow-up corrective actions will be implemented. Details of laboratory corrective actions are provided in the Laboratory Quality Management Action Plan or equivalent.

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10. DATA MANAGEMENT

The data management process includes planning, collecting, tracking, verifying, validating, analyzing, presenting, and storing collected data. Activities will generate data, including sample locations, measurements of field parameters, and results of sample analysis and data reviews. Important records regarding the collection and analysis of the samples and data will also be generated. The data management process requires the proper flow of data from field collection and processing by the analytical laboratory to those involved in the project evaluation and decision making.

10.1 Data Types

Data acquisition activities fall into the following categories:

- **Mapping Data:** Data will consist of surveying sample points collected to identify discrete locations for sampling locations. The primary issue associated with mapping data is that of ensuring the various data sets that include spatial location information are consistent relative to each other. The base coordinate system for the characterization work is State Plane feet, and all data produced will be delivered in State Plane feet. Topographical data (i.e., mean sea level readings, depth to samples, etc.) will be delivered in feet.

- **Radiological Survey Data:** Data will include field gamma surveys, radiation wipe count data, and field radiation monitoring data recorded in appropriate field logbooks and survey sheets. All logbooks and survey sheets will be maintained in a controlled location (e.g., field office) and will be organized in a filing system for ease of use and retrieval.

- **Field Survey Data:** Field surveys may produce electronic data (logged on field computers or system instruments) and hand-entered data written in field logbooks (i.e., grid sketches, location survey data, and survey results). Electronic data will be downloaded from field computers or system instruments a minimum of once daily to provide a data backup in the event of computer loss or failure. Hand-written data may be entered into electronic format as needed during or after the completion of field activities. Field notes and logbooks will be managed appropriately and will be stored in the field office when not in use.

- **Laboratory Data:** The laboratory will provide the analytical results in electronic data deliverable (EDD) files in accordance with the DOD Quality Systems Manual, Version 4.2 (DOD, 2010). The EDDs will be stored in the project file.

- **Critical Project Records:** Records such as survey reports, chain-of-custody (CoC) forms, laboratory data packages, and validation results will be maintained in the project file.

10.2 Data Management System

To maintain field and analytical data integrity, all data collected will be managed in a centralized data management system using a consistent set of tools for importing and selecting data, creating reports, generating graphs, and making geographical information system (GIS) maps of various types. This type of relational database environment will provide a complete audit trail of data management from the time of collection through analysis and validation. This will ensure that data are consistent with defined conventions by providing automatic checks for unit standardization, resolve duplication of data resulting from reanalysis, and eliminate inconsistency from reporting of results from duplicate methods and dilution of samples. In addition, this database will allow for tracking of the status of samples. Below is a list of data types that are scheduled to be loaded in the database:

- Environmental sample data, including data in the field and from laboratory analysis.

- Pertinent field parameter data collected by field personnel will be provided to the data manager in a format developed by the project team that will enable it to be either entered manually or loaded electronically based on the amount of data collected.

- The laboratory data will be provided by the laboratory and will consist of sample result data. This data will be electronically loaded into the database.

- Radiological sample data will include data collected in the field and from laboratory analysis. Also included in the radiological sample data are data collected from gamma walkovers and building surveys.

10.3 Data Management and Tracking Process

The data management and tracking process will include all steps from sampling and analysis planning through the archiving of information and data. Each step or variation of the sampling and analytical process will be documented. Standardized formats for electronic transfer and reporting will be used. The following data management process will be followed throughout the collection, management, storage, analysis, and presentation of the data, as described in the sections below.

10.3.1 Sampling and Analysis Planning

Prior to initiating field work, the data coordinator will assist field personnel with generating field sampling forms and other paperwork. This process will increase the accuracy of the final database and ensure the appropriate amount of information is recorded in the field. The project database will be populated with field and analytical parameters and associated sampling and laboratory information.

10.3.2 Field Sampling and Data Collection

Prior to beginning field sampling, field personnel will be trained in the project-specific field data recording requirements for field logbooks, CoC forms, etc. The master field document will be the field logbook, with the primary purpose to record each day's field activities; personnel on each field team; and any administrative occurrences, conditions, or activities that may have affected the field work or quality for any given day.

To the extent possible, pre-printed field forms will be generated. As data are collected in the field, the logbooks will be completed with the required information. The field logbooks will be signed and dated by the data recorder and will specify the field methods and procedures utilized, as outlined in the FSP (USACE, 2013b).

Applicable information from the logbooks and data forms will be manually entered into the database and checked for accuracy. Completed logbooks and appropriate field forms will be submitted to the project file upon completion of the project.

10.3.3 Chain of Custody Documentation

Sample containers will be tracked from the field collection activities to the analytical laboratory following proper CoC protocols outlined in the FSP.

10.3.4 Analytical Laboratory Document and Data Submission

Laboratories will prepare and submit analytical and QC data reports in compliance with the requirements of the QAPP. An EDD will be provided. The data coordinator receiving laboratory deliverables will submit the originals to the project file. Results will be transferred to the database electronically following applicable data verification and validation.

10.3.5 Data Verification and Validation

All data packages received from the analytical laboratory will be reviewed and verified by data management personnel using pre-packaged software within the relational database. All verification samples will require definitive (Level 4) data validation. All other samples will be considered screening level and will use Level 3 validation.

10.3.6 Data Centralization and Storage

Once data for a given sample or group of samples are complete and entered into the database, the data coordinator will check that logbooks, other field records, and all analytical data are complete and properly stored. Each piece of information will be documented as to its source, and hard copy information will be appropriately indexed and filed.

Once loaded, the database will be secured from physical corruption (i.e., hardware or software failure) or from unauthorized access and illegal updating. In the field, all electronic data stored solely on field instruments or computers will be downloaded and backed-up on removable storage media (i.e., a compact disc or DVD) on a daily basis during work periods to ensure that computer loss or failure will not destroy or corrupt project data.

10.3.7 Data Summarization and Reporting

Project data will be screened for potential data errors, compared to RGs, and summarized in both tabular and graphical form to facilitate data interpretation. Data reduction and summation will be accomplished using quality-controlled and documented reporting programs. Data summaries will be generally produced using predefined report formats available within the data management system. Data presented on maps, figures, or tables will be transferred electronically if possible to avoid introducing typographical errors.

10.3.8 Records Management and Document Control

Hard copies of all original project-related information will be indexed, catalogued into appropriate file groups and series, and archived. This information may include, but is not limited to:

- Sample identification documents and field logbooks;
- CoC forms and records;
- Inventory of investigative-derived wastes;
- Project deliverables (i.e., test plan, operations manual, design drawings and specifications, etc.);
- Analytical laboratory data, calculations, graphs, control charts (to include instrument identification numbers, calibrations, and measurements), and software;

- Reports and correspondence material;
- Records of deviation from the work plans;
- Photographs; and
- Data validation forms.

The data manager will archive the project data to the appropriate electronic media. A data archive information package will be prepared that describes the data system, file format, and method of archive. Sufficient documentation will accompany the archived data to fully describe the source, contents, and structure of the data to ensure future usability. Computer programs used to manipulate or report the archived data will also be included in the data archive information package to further enhance the data's future usability.

11. QUALITY ASSURANCE REPORTS TO MANAGEMENT

The Field Project Engineer will report to the PM on a daily basis regarding the progress of field work and QC issues associated with the field activities. The details will be provided in a DQCR. An example DQCR will be included in the appropriate field plans, as described in Section 5 of the RD/RA Work Plan (USACE, 2013a).

The laboratory maintains detailed procedures for laboratory record keeping in order to support the validity of all analytical work. Each submitted data set report will contain the laboratory's written certification that the requested analytical method was run and that all QA/QC checks were within the established control limits on all samples. The laboratory Program Administrator will provide QA reports of their external and internal audits on request. If any QA problems are encountered, the laboratory Program Administrator will issue a written report to the PM.

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12. REFERENCES

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FINAL

WASTE MANAGEMENT PLAN
IOWA ARMY AMMUNITION PLANT
OPERABLE UNIT 8,
DEPLETED URANIUM CONTAMINATED SOIL
AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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Middletown, Iowa

February 2013

Prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:

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ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOT	U.S. Department of Transportation
DU	depleted uranium
FS	Firing Site
FSP	Field Sampling Plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
IAAAP	Iowa Army Ammunition Plant
LLW	low-level waste
MLLW	mixed low-level (radioactive) waste
NCP	National Contingency Plan
NNSS	Nevada Nuclear Security Site
NRC	Nuclear Regulatory Commission
OU	operable unit
pCi/g	pico Curies per gram
PM	Project Manager
PPE	personal protective equipment
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RG	remediation goal
ROD	Record of Decision
SAP	Sampling and Analysis Plan
TSDF	treatment, storage and/or disposal facility

USACE	U.S. Army Corps of Engineers
WAC	waste acceptance criteria
WMP	Waste Management Plan

Waste Management Plan
Iowa Army Ammunition Plant Operable Unit 8,
Depleted Uranium Contaminated Soil and Structure Remediation
Middletown, Iowa

1. INTRODUCTION

1.1 Purpose

This Waste Management Plan (WMP) provides a management and planning tool for identifying and managing waste streams generated from the remedial action (RA) for contaminated soil and structures at the Iowa Army Ammunition Plant (IAAAP) Operable Unit (OU)-8. This WMP is a supporting document to the Remedial Design (RD)/RA Work Plan (USACE, 2013a). It identifies the anticipated waste streams, describes methodologies for waste management and transportation, and identifies disposal pathways for each anticipated waste stream.

1.2 Scope

This WMP addresses management of waste generated as a result of the IAAAP OU-8 RA. The RA will include the following waste management activities:

- Waste planning (e.g., identify waste streams that will be generated and shipping and disposal routes);
- Radiological and chemical characterization of waste, including preparing a Sampling and Analysis Plan (SAP); researching and compiling process knowledge; reviewing data for regulatory classification (e.g., Resource Conservation and Recovery Act [RCRA], U.S. Department of Transportation [DOT], etc.) and treatment, storage, and/or disposal facility (TSDF) waste acceptance criteria (WAC) compliance; and developing TSDF waste profiles;
- Defining packaging and storage requirements;
- Preparing shipping paperwork and coordinating transportation of waste for disposal;
- Maintaining compliance with applicable regulations (e.g., RCRA, DOT, and Nuclear Regulatory Commission [NRC]); and
- Field implementation of this WMP.

The contractor will perform additional activities, including developing and reviewing supporting documentation (e.g., Work Plan, work packages, procedures, plans, training documents, and quality assurance); conducting assessments; evaluating non-conformances; and developing corrective action plans that support waste management. All documentation created in support of waste management, shipping, and disposition will be maintained by the contractor, and copies will be provided to the U.S. Army Corps of Engineers (USACE) upon request and at the completion of the project.

1.3 Site Background

The IAAAP is a government-owned, contractor-operated facility located approximately 10 miles west of Burlington, Iowa and the Mississippi River. The IAAAP consists of approximately 19,000 acres, of which approximately one-third is occupied by active or formerly active munitions production or storage facilities. The remaining property is either forested (7,766 acres) or leased for agricultural use (7,107 acres).

The primary activity at IAAAP since 1941 has been to load, assemble, and pack a variety of conventional ammunition and fusing systems for the U.S. Department of Defense. From 1947 to 1975, portions of the IAAAP facility were under the control of the U.S. Atomic Energy Commission (AEC) for weapons-assembly operations. The IAAAP was listed on the National Priorities List in 1990.

Historical AEC activities resulted in contamination of soil at outdoor firing sites where tests of depleted uranium (DU) surrogates for weapons components were performed. DU is present as metallic uranium and as chemical weathering products of metallic uranium in soil. Soil contaminated with metallic and weathered DU poses a risk to human health and the environment.

AEC performed manufacturing operations that resulted in DU contamination of structure components in two buildings in the Line 1 portion of IAAAP. Contaminated components are located in Building 1-11 and Building 1-63-6.

The Formerly Utilized Sites Remedial Action Program (FUSRAP) Record of Decision (ROD; USACE, 2011a) presents the selected remedy for the remediation of soil and structures at specific (e.g., former AEC) areas at IAAAP. The specific areas for which this selected remedy applies include Line 1 Structures; the Firing Sites Area (consisting of five subareas, as discussed below); Yards C, G, and L; and Warehouse 3-01. The selected remedy addresses soil and structures that are DU-contaminated as a result of AEC operations. USACE is authorized by Congress as the lead agency implementing the selected remedy under the authority of FUSRAP.

The selected remedy is the final remedy for the FUSRAP areas of IAAAP (OU-8). Six other OUs have been defined at IAAAP. They are being addressed by other U. S. Army programs.

1.4 Description of the Selected Remedy

The selected remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; 42 USC § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] §300.430(a)(1)(iii)(A)). This decision is based on the Administrative Record file located at the Burlington, Iowa Public Library and at the USACE, St. Louis District FUSRAP Project Office.

No principal threat wastes, as defined by NCP, are present at the FUSRAP areas of IAAAP. The principal contaminant of concern for the FUSRAP areas is DU. The selected remedy for DU-contaminated soil is removal by excavation and physical treatment prior to off-site disposal. Additionally, DU will be removed from structures using decontamination and/or removal and off-site disposal.

The main components of the selected remedy for soil (ROD – Alternative 4) include:

- Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) at Firing Sites 1 and 2 (FS-1, FS-2); Firing Sites 3, 4, and 5 (FS-3, FS-4, FS-5); the Firing Site 6 Area (FS-6); and the Firing Site 12 Area (FS-12). Excavation will not be conducted at Yards C, G, and L or Firing Site 14 (FS-14).

- Physical treatment of DU and DU-contaminated soil excavated from FS-1 and FS-2; FS-3, FS-4, and FS-5; FS-6; and FS-12 via soil sorting.

- Disposal of materials exceeding the DU RG at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate.

- Site restoration, including backfilling, grading, and re-vegetation.

- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.

- Five-year reviews for FUSRAP areas where contaminants remain above levels acceptable for unlimited use and unrestricted exposure to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use will be verified during each 5-year review.

The main components of the selected remedy for structures (ROD – Alternative S3) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures.

- Disposal of DU-contaminated materials at a properly permitted off-site facility.

- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.

- Five-year reviews for structures if they exceed levels appropriate for unlimited use and unrestricted exposure to ensure continued protectiveness of human health under industrial land use. Industrial land use will be verified during each 5-year review.

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2. WASTE MANAGEMENT

This section identifies the waste types that are expected to be generated during the OU-8 RA and describes the waste management activities. Figure 2-1 summarizes the waste management process. The first column shows the RA activity and the second column identifies the waste materials that will be generated during that activity. On-site processing steps listed in the third column will produce waste streams (fourth column) based on the radioactive and hazardous nature of the waste. Packaging and transportation alternatives selected are summarized in the fifth and sixth columns, and the final disposal venue is listed in the last column.

2.1 Expected Waste Types

Waste materials that may be generated during the RA for DU-contaminated soil and structures at the firing sites and Line 1 structures include:

- DU-contaminated soil from firing sites;
- DU-materials;
- Debris from clearing and grubbing prior to excavation;
- Debris such as used personal protective equipment (PPE), sampling waste, and structural components; and
- Stormwater and decontamination fluids.

Soils may undergo physical treatment onsite to segregate excavated soil into fractions that have radioactive content that are either above or below the RG concentration.

Throughout the RA process, any stormwater or decontamination water that is generated as a result of contact with contaminated materials will be handled as follows:

- Collect and containerize the water;
- Contained water will be evaluated, sampled and/or treated as necessary, in accordance with the USACE, IAAP Water Treatment System - Standard Operating Procedure, Current Version.

Waste profiles will be developed for each waste stream produced during characterization. Waste is anticipated to be characterized as low-level waste (LLW), hazardous waste, mixed low-level waste (MLLW), or industrial waste. It is not expected that hazardous or MLLW will be generated in significant quantities during the OU-8 RA. However, since generation of those waste types cannot be ruled out, they are included in the overall process flow diagram and in the descriptions in Sections 2.1.1 through 2.1.4.

Virtually all of the soil, debris, residuals from managing stormwater, and decontamination waste are expected to be either LLW or soils below the RG that can be used as backfill.

2.1.1 Low-Level Waste

At the firing sites, excavated soils may undergo a mechanical process of soil sorting that will remove large (greater than an approximately 3-inch [0.6 meters] diameter) miscellaneous items and will segregate the remaining soil into fractions of soils above and below the RG. Soils that exceed the RG and are not hazardous, as defined by 40 CFR 261.20, will be managed as LLW.

In addition, components removed from the Line 1 structures that exceed the RG will be added to this waste stream. Any solids generated from the separation of stormwater and decontamination residuals that exceed the RG will also be added to this LLW stream.

Structures, components, furnishings, soil, and debris that meet the screening levels for clearance specified in *The Army Radiation Safety Program* (Department of the Army, 2011) can be released as clean items for reuse or disposal at an approved landfill.

DU material may be generated as a discrete waste stream as a result of the physical separation processes designed to isolate dense particles and segregate soil based on radiation levels. In addition, accumulation of DU material may result from manual collection and excavation processes at the firing sites. DU material may be managed as LLW separately from other waste streams, or it may be incorporated into the DU-contaminated soil waste stream. The disposal approach will be selected during pre-construction activities based on vendor-proposed costs and the status of state-imposed restrictions on disposal.

2.1.2 Hazardous Waste

Soils, building structures, components, and investigation derived materials that contain metals or other constituents that can be classified as hazardous, as defined by 40 CFR 261.20, will be labeled appropriately. It is not expected that hazardous waste will be generated in significant quantities during the OU-8 RA.

2.1.3 Mixed Low-Level Waste

Materials that exceed the RG and are classified as hazardous waste, as defined by 40 CFR 261.20, will be labeled as MLLW. It is not expected that MLLW will be generated in significant quantities during the OU-8 RA.

2.1.4 Industrial Waste

The industrial waste stream may consist of debris, structural components, and plant matter. These materials, which are neither radioactive nor hazardous, will be segregated for disposal as industrial waste. All non-hazardous debris and/or equipment with no residual radioactive material concentrations above the screening levels for clearance specified in the Radiation Safety Program (Department of the Army, 2011) may be considered industrial waste. Other regulated waste types (e.g., polychlorinated biphenyls, asbestos, and infectious materials) are not present at the OU-8 remedial activity sites based on process knowledge and site characterization. Therefore, all waste that is neither radioactive waste nor RCRA hazardous waste will be categorized as industrial waste.

2.2 Disposal Options

The facility selected for disposal of each waste stream governs waste characterization requirements (i.e., waste profiling), waste packaging, and waste transportation. This section lists the TSDFs identified as possible destinations for project wastes. Final disposition of waste will be determined based on logistical and cost considerations at the time of generation.

2.2.1 Low-Level Waste

LLW can be disposed only at facilities licensed for disposal of low-level radioactive waste by NRC or by states that have a cooperative agreement with NRC.

Two TSDF facilities have been identified for disposal of project LLW:

- Energy Solutions, Clive, Utah, bulk waste disposal facility; and
- Perma-Fix Environmental Services, Atlanta, Georgia (Perma-Fix of Florida for treatment, with subsequent disposal at the Nevada National Security Site [NNSS]) or the Energy Solutions Clive, Utah facility.

Two other facilities were evaluated and found unsuitable for disposal of project LLW.

- US Ecology, Grandview, Idaho. DU dispersed in soil is limited to a maximum of 169 pico Curies per gram (pCi/g), which is only slightly above the project RG; therefore, disposal of DU-contaminated soil from IAAAP is not feasible.
- Waste Control Specialists, Andrews, Texas. Disposal of DU is prohibited by the current (July 25, 2012) permit revision and they are currently not accepting waste from government facilities.

2.2.1.1 Disposal at Energy Solutions, Clive Utah

Disposal at the Energy Solutions Clive, Utah, facility must be in accordance with the Energy Solutions WAC (Energy Solutions, undated). If the Energy Solutions facility is selected as the disposal venue, then waste management activities (i.e., waste characterization and profiling, waste containers, transportation, and shipping schedule) for the OU-8 project must comply with the facility WAC requirements.

Two additional requirements apply if the Energy Solutions facility is selected as the disposal venue. First, the Utah Department of Environmental Quality – Division of Radiation Control has established a Generator Site Access Permit Program. The requirements are included in Utah Administrative Code (UAC), Rule R313-26, *Generator Site Access Permit Requirements for Accessing Utah Radioactive Waste Disposal Facilities* (http://www.rules.utah.gov/publicat/code/r313/r313-026.htm). An on-line application is available via a web link from http://www.radiationcontrol.utah.gov/GSA/index.htm.

Second, the State of Utah has imposed a moratorium on disposal of waste that contains greater than 5% by weight DU. It is not expected that DU-contaminated soils or sediments from the OU-8 RA will exceed the 5% DU criterion, with the exception of DU materials removed from contaminated soil and managed as a separate waste stream. Additional information about disposal of DU materials is provided in Section 2.2.2.

In order to comply with the State of Utah moratorium on disposing waste that contains greater than 5% DU, the facility has established the following limits for DU waste:

- DU waste that has individual uranium isotopes (U-234, U-235, U-238) listed on the waste manifest cannot have a U-238 concentration that exceeds 16,500 pCi/g, and
- DU waste that is manifested without listing the uranium isotopes cannot exceed 18,000 pCi/g.

2.2.1.2 Management by Perma-Fix Environmental Solutions and Disposal

Perma-Fix can dispose waste at either the Clive facility or NNSS depending on cost. The waste will be accepted and managed by Perma-Fix to meet the selected disposal facility WAC.

NNSS is licensed to accept low-level radioactive waste; however, it has rigorous certification requirements for waste generators that make direct disposal to NNSS for this project cost prohibitive. It is more cost effective to use Perma-Fix to manage waste that will be shipped to NNSS than for the project to become certified to ship waste to NNSS. Perma-Fix is certified to ship both LLW and MLLW to NNSS.

Treatment by Perma-Fix and subsequent disposal must be in accordance with the NNSS WAC (DOE, 2012). If the Perma-Fix/NNSS alternative is selected as the disposal venue, then waste management activities (i.e., waste characterization and profiling, waste containers, transportation, and shipping schedule) for the OU-8 project must comply with the NNSS WAC requirements.

2.2.2 DU-Material

The State of Utah has established a moratorium on disposal of materials that contain greater than 5% by weight DU (see UAC, Rule R313-25-8). The WAC for the Clive, Utah, facility that correspond to 5% DU is 16,500 pCi/g U-238 if individual uranium isotopes (U-234, U-235, and U-238) are listed on the waste manifest, and 18,000 pCi/g if the waste is manifested as DU without listing individual uranium isotopes. The state moratorium prohibits disposal of DU material (i.e., 100% DU) at the Clive, Utah, facility at this time.

If DU material is generated as a separate waste stream, it will be containerized and shipped to the Perma-Fix facility in Florida. It will be treated using approved Perma-Fix procedures to reduce the average DU content, and then shipped to the Clive facility or NNSS for disposal.

In the event that the state moratorium on disposal of waste that contains greater than 5% DU is rescinded before RA field activities commence, then DU material will be managed as a component of the LLW stream, and it can be managed via either of the alternatives available for the LLW stream.

2.2.3 Hazardous Waste

Hazardous waste may be generated during OU-8 RA activities. The disposal alternative identified for hazardous waste includes shipment to a properly permitted hazardous waste TSDF. Hazardous waste will be transported for disposal at the Environmental Quality Company, Wayne Disposal, Inc. facility in Belleville, MI:

Wayne Disposal, Inc. Site #2 Landfill
49350 North I-94 Service Drive
Belleville, MI 48111
Telephone: 800-592-5489
Fax: 800-592-5329
Website: http://www.eqonline.com/Locations/Wayne-Disposal-Inc.aspx.

2.2.4 Mixed Low-Level Waste

MLLW may be generated during OU-8 RA activities. The disposal alternatives identified for LLW (Section 2.2.1) are also available for disposal of MLLW. The requirements identified for disposal of LLW also apply to disposal of MLLW.

2.2.5 Industrial Waste

The IAAAP Inert Disposal Area, or an off-site non-hazardous solid waste landfill, has been identified as disposal landfills for industrial waste. The local information for the solid waste landfill is as follows:

Des Moines County Regional Landfill
13758 Washington Road
West Burlington, Iowa 52655
Telephone: 319-753-8722
Website: http://www.wastewrap.org/landfill.html.

The use of local landfills identified for receipt of industrial waste, whether on-site or off-site, will be determined by the IAAAP OU-8 Project Manager (PM). Necessary documentation (i.e., the bill of lading with name of the receiving facility, the name of the transporter, net waste weight, etc., and a certificate of disposal [or similar document]) will be maintained by the contractor.

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3. WASTE CHARACTERIZATION AND CATEGORIZATION

Waste will be characterized, and waste profiles prepared, based on a combination of process knowledge, historical data, and chemical and radiological analysis of samples. Using this characterization information, a waste profile will be developed for each waste stream. It is anticipated that additional information will be needed to properly profile some waste streams, and waste characterization will be ongoing through this remedial/clean-up effort, potentially modifying waste type quantities and their anticipated packaging and disposition pathways.

3.1 Process Knowledge

Process knowledge and historical data are available from site characterization information documented in the *Iowa Army Ammunition Plant FUSRAP Remedial Investigation Report for Firing Sites Area, Yards C, E, F, G, and L, Warehouse 3-01, and Area West of Line 5B* (USACE, 2008) and *FUSRAP Feasibility Study Report for the Iowa Army Ammunition Plan* (USACE, 2011b). The results of this characterization effort were used to determine the various waste streams and quantities that will be generated during the remedial/clean-up activities at IAAAP OU-8.

3.2 Sampling and Analysis

In addition to process knowledge, gamma screening and analytical data are used to characterize and categorize waste and to prepare waste profiles. Analytical data include chemical and radiological data from fixed labs and field-measured radiation data.

A SAP that addresses waste characterization sampling is included in the Field Sampling Plan (FSP) (USACE, 2013b). The FSP delineates the procedures for collecting, packaging, and transporting samples for radiological and chemical analysis. All laboratories performing waste analyses must meet requirements identified in the selected TSDF(s) WAC (e.g., laboratory certification by a state or other organization).

3.2.1 Soil Surveying

The soil sorting system will utilize gamma scanning to separate the soils into two fractions: (1) soils above the RG and (2) soils below the RG. Calibration of the gamma screening to correlate with the RG will be performed during the pilot study. Wastes will be stockpiled or containerized, as applicable, while the pilot testing is conducted and dispositioned based on the results of confirmatory sampling described in Section 3.2.2, as well as in the FSP.

3.2.2 Soil Sampling and Laboratory Analysis

Prior to using the soil sorting system, soil samples may be collected and analyzed for soil characterization purposes. Details regarding the collection and analysis of soil samples are included in the FSP.

During the pilot test phase of the project, soil samples will be collected from the output of the soil sorting system and submitted to an analytical laboratory for radiological analysis. Radiological analysis data will be used to confirm that the soil is below the RG.

During the full-scale operation phase, samples will be collected and analyzed to comply with TSDF WAC requirements.

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4. WASTE PACKAGING AND STORAGE

After excavation, soil piles awaiting processing within the soil sorting system will be managed to prevent the spread of contamination by using proper contamination controls. Runoff from the soil piles during any precipitation events will be collected for treatment, and sediment transport will be prevented using stormwater pollution prevention measures. Access to soils pending processing will be restricted by fencing or other barriers, and signs will be placed indicating the materials are unprocessed DU-contaminated soils. Once the soils are processed, the contaminated soils will be packaged and handled as detailed in the following sections. Table 4-1 summarizes examples of the packaging options with advantages and disadvantages of each packaging option. Packaging specifics will be selected and defined during the RA pre-construction procurement and planning phase.

4.1 Container Management

Waste containers may consist of both bulk and non-bulk containers. Container selection will be based on the selected TSDF WAC requirements, logistical considerations, and cost. Both bulk packaging and non-bulk packaging must meet the applicable requirements contained in 49 CFR 173.24, *General Requirements for Packaging and Packages* and in 49 CFR 173.410, *General Design Requirements*. Examples of container options may include intermodal containers, super-sacks, 55-gallon drums, and roll-off containers.

Waste generated at this site is expected to meet the definition of Low Specific Activity-I per 49 CFR 173.403. According to DOT regulations, shipments may be made in IP-1 packaging for solid waste (soil), specified in 49 CFR 173.427, Table 8, with no limit on total activity (49 CFR 173.427, Table 9).

Prior to use, all containers will be surveyed for contamination and inspected to confirm that their condition is suitable for use. In general, the containers will be staged and processed, as shown in Figure 4-1. Containers will remain closed while stored except while waste is being added or removed. Containers will be handled in such a manner that will not jeopardize the integrity of the container.

4.1.1 Container Inspections

All containers used for waste must be inspected upon receipt and prior to use to confirm that they are in an acceptable condition for their intended purpose. An example Pre-Use Inspection form is provided in Appendix A. Inspection criteria will vary with the packaging requirements and container type. The containers will be lined or made of a material that will not react with the waste.

4.1.2 Container Labeling

Appropriate labels and relevant information will be marked on each container with an indelible marker and must be legible and clearly visible for inspection. The following information will be included:

- A unique container identification number.
- Contents/Type of waste.
- For RCRA waste, the words “Hazardous Waste” and the appropriate RCRA waste code.
- For LLW and MLLW, each container must have a durable, clearly visible label bearing the radiation symbol and the words “CAUTION, RADIOACTIVE MATERIAL” or “DANGER, RADIOACTIVE MATERIAL.” The label must also include “Depleted Uranium,” an estimate of the quantity of

radioactivity, the date, and radiation levels (to permit individuals handling or using the containers or working near the containers to take precautions to avoid or minimize exposures).

- Date of generation.

4.1.3 Container Closure

All containers will conform to the TSDF WAC and will be closed in accordance with manufacturer's closure instructions such that there are no openings through which waste could leak out or precipitation could enter the package. Seals must be in place and the load secured (blocked and braced as appropriate) such that dust-laden air will not be forced out of containers on movement. Containers must be clean with no waste material, or other material that could be mistaken for waste material, on the outer surface.

4.2 Designated Storage Areas

After excavated soils are sorted, soils above the RG will be containerized and stored in the >RG staging area. All areas will be demarcated by either a high-visibility rope or similar measures that clearly identify the boundary of the storage area. All areas will be further demarcated by the appropriate signs.

Appropriate signage will also include the telephone numbers and the names of the PM and the Field Project Engineer. Precautions will be taken to ensure that waste containers are tarped or protected from the weather as much as possible, staged in an area out of the traffic pattern, and placed on pallets in an area not subject to ice accumulation or surface water ponding. Loaded bulk containers (i.e., intermodal containers) will be staged outside and tarped/covered until shipment. On-site container transfers will be conducted in accordance with OU-8 RA safety requirements.

Designated areas will include the following pre-packaging staging areas:

- Rad-Con Evaluation Staging Area (for initial staging of waste). Additional radiological surveys will be performed in this area to determine if soils, structures, decontamination residues, ion exchange media, and PPE are below the RG or screening levels for clearance specified in the Radiation Safety Program (Department of the Army, 2011)

- LLW Staging Area. This is for items that do not meet the RG or screening levels for clearance specified in the Radiation Safety Program (Department of the Army, 2011), and have been determined to be non-hazardous per RCRA.

- MLLW Staging Area – This is for items that do not meet the RG or screening levels for clearance specified in the Radiation Safety Program (Department of the Army, 2011), and have been determined to be RCRA hazardous waste.

- Industrial Waste Staging Area – This is for items that meet the RG and screening levels for clearance specified in the Radiation Safety Program (Department of the Army, 2011), and have been determined to be non-hazardous per RCRA.

Containers with liquid wastes will be stored on spill containment. Adequate aisle space will be maintained to facilitate container inspection and to allow personnel to add waste to the containers as needed. All containers will be inspected at least monthly to ensure that container integrity is maintained.

4.3 Preparedness and Prevention

All designated waste areas must be maintained and operated in a manner that minimizes the possibility of a fire, explosion, or any unplanned event. Fire extinguishers (Type ABC, 10 pounds minimum) will be available at the entrance to the designated areas or located immediately nearby. Spill kits will be available based upon the hazard and type of waste. Two-way radios will be available for emergency communication if cell phone communication is deemed insufficient.

Aisle space between containers must be sufficient to allow the unobstructed movement of personnel and fire protection, spill control, and decontamination equipment to any area of the facility in the event of an emergency. The IAAAP Emergency Response Teams, Fire Department, and Police will be contacted to communicate the layout of the facility, properties of waste in management areas, and possible evacuation routes.

4.4 Contingency Plan

A Contingency Plan will be prepared, if required. The plan will meet the requirements of the IAAAP Emergency Management Plan.

4.5 Personnel Training

Project personnel will be required to read and understand this WMP. Potential hazards for each day's waste management and packaging activities will be reviewed as part of the daily pre-job briefing. Project personnel handling and packaging waste must receive function-specific training meeting the requirements of 49 CFR Part 172, Subpart H. Copies of all training records will be maintained at the job site and available for USACE review upon request.

4.6 Waste Area Inspections

Weekly inspections of the designated areas will be documented. Inspections will identify leaking or deteriorating containers and verify that containers are closed and appropriately labeled. Unusual circumstances will be reported immediately to the PM or Field Project Engineer so that corrective measures can be taken. The completed inspection forms will be maintained on site. An example inspection form is provided in Appendix B.

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5. TRANSPORTATION

All waste transportation for off-site disposal will be compliant with DOT regulations (49 CFR Parts 100-185). USACE will be the shipper of record. The contractor will interface with the USACE OU-8 PM for shipment notifications to the U.S. Army Site Office and/or IAAAP. The designated shipper will prepare and sign the DOT required shipping papers, perform the necessary driver's briefings for exclusive use shipments, and provide for the 24-hour emergency contact service. Shipper qualifications will include current certifications per 49 CFR 172, Subpart H.

5.1 Transportation Planning

Preliminary transportation planning has been completed that includes the best possible understanding of waste types and potential receiving TSDF(s). Table 4-1 provides this preliminary information in tabular form. A flow diagram that documents the flow of waste from the soil sorting area is included as Figure 5-1.

As waste characterization activities progress, proper shipping names and subsequent DOT-compliant packaging determinations will be finalized and verified to establish marking and labeling requirements in compliance with 49 CFR 172, Subparts D and E.

5.1.1 Waste Manifest Forms

Waste manifests must be completed and submitted to the disposal facility prior to offsite transportation in accordance with the facility WAC. The *Instructions for Completing the NRCs Uniform Low-Level Radioactive Waste Manifest* (NRC, 1998) will be used when preparing the shipping paperwork. In addition, any requirements from the disposal facility WAC will be followed to ensure acceptance at the disposal facility.

The shipper of the radioactive waste will provide the following information regarding the waste shipment on the uniform manifest:

- The name, facility address, and telephone number of the licensee shipping the waste;
- An explicit declaration indicating whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment;
- The name, address, and telephone number, or the name and Environmental Protection Agency identification number for the carrier transporting the waste;
- The date of the waste shipment;
- The total number of packages/disposal containers;
- The total disposal volume and disposal weight in the shipment;
- The total radionuclide activity in the shipment;
- The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
- The total masses of U-233, U-235, and plutonium in special nuclear material, and the total mass of uranium and thorium in source material.

In addition, for each container of waste, the following information is required:

- An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment.
- A physical description of the disposal container, including the manufacturer and model of any high integrity container.
- The volume displaced by the disposal container.
- The gross weight of the disposal container, including the waste.
- For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container.
- Physical and chemical descriptions of the waste.
- The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent.
- The approximate volume of waste within a container.
- The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name.
- The identities and activities of individual radionuclides contained in each container; the masses of U-233, U-235, and plutonium in special nuclear material; and the masses of uranium and thorium in source material. For discrete waste types (i.e., activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container will be reported.
- The total radioactivity within each container.

The information requirements for manifesting of bulk shipments include:

- The approximate volume and weight of the waste;
- A physical and chemical description of the waste;
- The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight, plus the identity of the principal chelating agent;
- The identities and activities of individual radionuclides contained in the waste; the masses of U-233, U-235, and plutonium in special nuclear material; and the masses of uranium and thorium in source material; and
- For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

An authorized representative of the waste generator will certify by signing and dating the shipment manifest that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of DOT and NRC.

5.1.2 On-Site Transportation

On-site waste transportation activities include the packaging and loading of waste containers and the execution of shipments. The on-site transportation route for shipments leaving IAAAP is provided in Drawing C-6 of the *OU-08 Depleted Uranium Contaminated Soil and Structures Remedial Design*, included as part of this Work Plan package (see Appendix C in USACE, 2013a). This route is the primary route for both incoming and outgoing truck traffic. Outgoing shipments will be loaded and secured, compliant with DOT load securement requirements, before leaving the designated load staging areas. Container transportation within and between designated load staging areas, truck scales, etc., will be conducted in accordance with IAAAP safety requirements and conditions outlined in the IAAAP Hazardous Materials Transportation Safety Manual for on-site container transfers.

5.1.3 Off-Site Transportation

Transportation of waste shipments may be by public highway, as regulated by 49 CFR Subtitle C, “Hazardous Materials Regulations,” specifically Part 177, “Carriage by Public Highway,” or by rail, as regulated by 49 CFR Subtitle C, “Hazardous Materials Regulations,” specifically Part 174, “Carriage by Rail.”

5.1.3.1 Public Highway

The following general requirements pertain to transportation of LLW by public highway:

- All waste packages must be secure to: (1) prevent rain or snow from entering the manifested waste package, and (2) prevent waste from being exposed to the environment at any time during transit;
- Shippers must comply with the training requirements applicable to radioactive waste management;
- Shipments of LLW and MLLW will be only by “exclusive-use vehicles” in compliance with DOT;
- The carrier will be a participant in the Motor Carrier Evaluation Program and will have the necessary emergency response, training, and security plans in place meeting the requirements of 49 CFR Part 172, Subparts G, H, and I, respectively; and
- A certified shipper will be supervising the shipment of all wastes from the site.

A licensed highway transport company will be contracted to transport the waste in compliance with all applicable regulations.

5.1.3.2 Rail Transport

The following general requirements pertain to transportation of LLW by rail:

- Waste must be packaged to avoid spillage and scattering of loose material,
- Minimum separation distances must be maintained,

- Radiation levels must be below DOT regulations for the type and quantities of materials, and
- Shipments of LLW and MLLW will be only by "exclusive-use vehicles" in compliance with DOT.

A rail transport company will be contracted to transport the waste in compliance with all applicable regulations.

5.2 Emergency Planning

5.2.1 On-Site Transportation Incidents

These activities are to be conducted within the security of the IAAAP site. In the case of a dropped or breached container, or an on-site transportation incident, the contractor Field Project Engineer will notify the IAAAP Protective Force, contractor PM, and USACE OU-8 PM.

The USACE OU-8 PM then performs the necessary Army and IAAAP management notifications. All work in the immediate area of the incident will cease until approval to return to work has been received from the USACE OU-8 PM.

5.2.2 Off-Site Transportation Incidents

The carrier will follow their emergency response plan for notifications to the Iowa Emergency Management Agency, the Iowa Department of Natural Resources, and/or the respective state agency in which the incident occurs. Carriers will perform emergency response activities as outlined in their plan and as directed by emergency response personnel. Direction will be provided at each driver briefing for each shipment greater than a limited quantity of hazardous material that the 24-hour emergency contact number listed on the shipping papers is to be contacted in case of an incident.

The 24-hour emergency contact number must be the number of the person offering the material for transport or the number of an agency or organization capable of, and accepting responsibility for, providing the detailed information concerning the hazardous material (per 49 CFR 172.604). The contractor is the offerer on behalf of IAAAP and will notify the IAAAP OU-8 PM in the case of an offsite transportation incident.

6. DOCUMENTATION AND RECORDS MANAGEMENT

All records generated from the IAAAP OU-8 Project will be maintained in accordance with the applicable requirements of the contract Statement of Work. Records will have a reasonable level of protection to prevent loss and degradation. Records will be maintained in a fire-rated file cabinet when not in use. When records are ready for final disposition, they will be turned over to the IAAAP OU-8 PM.

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7. REFERENCES

40 CFR 261, *Code of Federal Regulations*, Title 40, “Protection of the Environment,” Part 261 “Identification and Listing of Hazardous Wastes,” Office of the Federal Register.

40 CFR 300, 2000, *Code of Federal Regulations*, Title 40, “Protection of Environment,” Part 300, “National Oil and Hazardous Substances Pollution Contingency Plan,” Office of the Federal Register.

49 CFR 100 – 185, 2000, *Code of Federal Regulations*, Title 49, “Transportation,” Hazardous Materials Regulations, Office of the Federal Register.

49 CFR 172, 2000, *Code of Federal Regulations*, Title 49, “Transportation,” Part 172, “Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements,” Office of the Federal Register.

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42 USC § 9601 et seq., 1980, “Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund),” *United States Code*, December 11, 1980.

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USACE, 2013b. "Remedial Design/Remedial Action Field Sampling Plan, Iowa Army Ammunition Plant, Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation, Middletown, Iowa (FINAL)," Revision 0, U.S. Army Corps of Engineers, February 2013.

Utah Administrative Code Rule R313-25-8, Rule R313-25, "License Requirements for Land Disposal of Radioactive Waste," Part R313-25-8, "Technical Analyses," as in effect on August 1, 2012.

8. FIGURES

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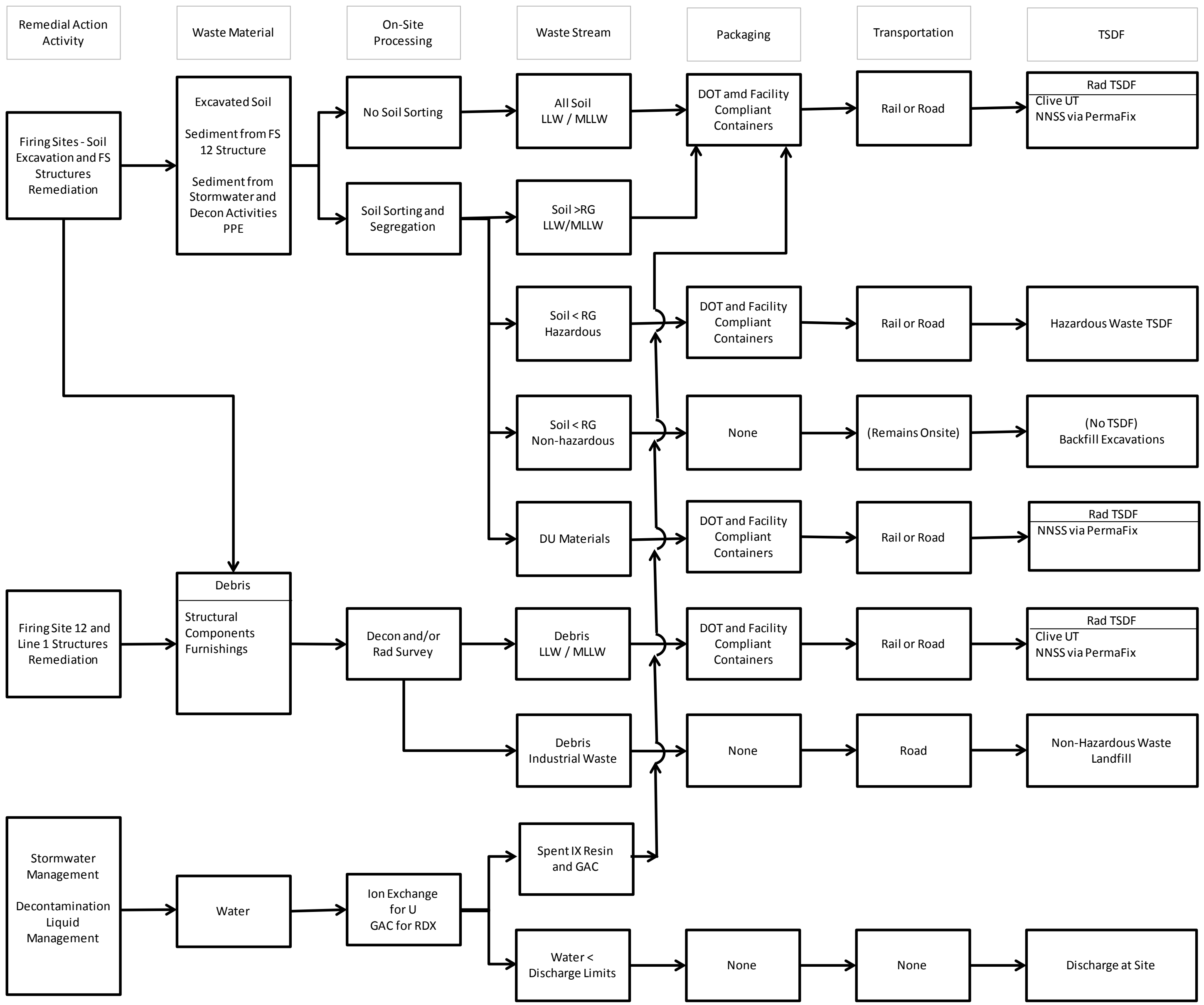

Figure 2-1. OU-8 waste management process flow.

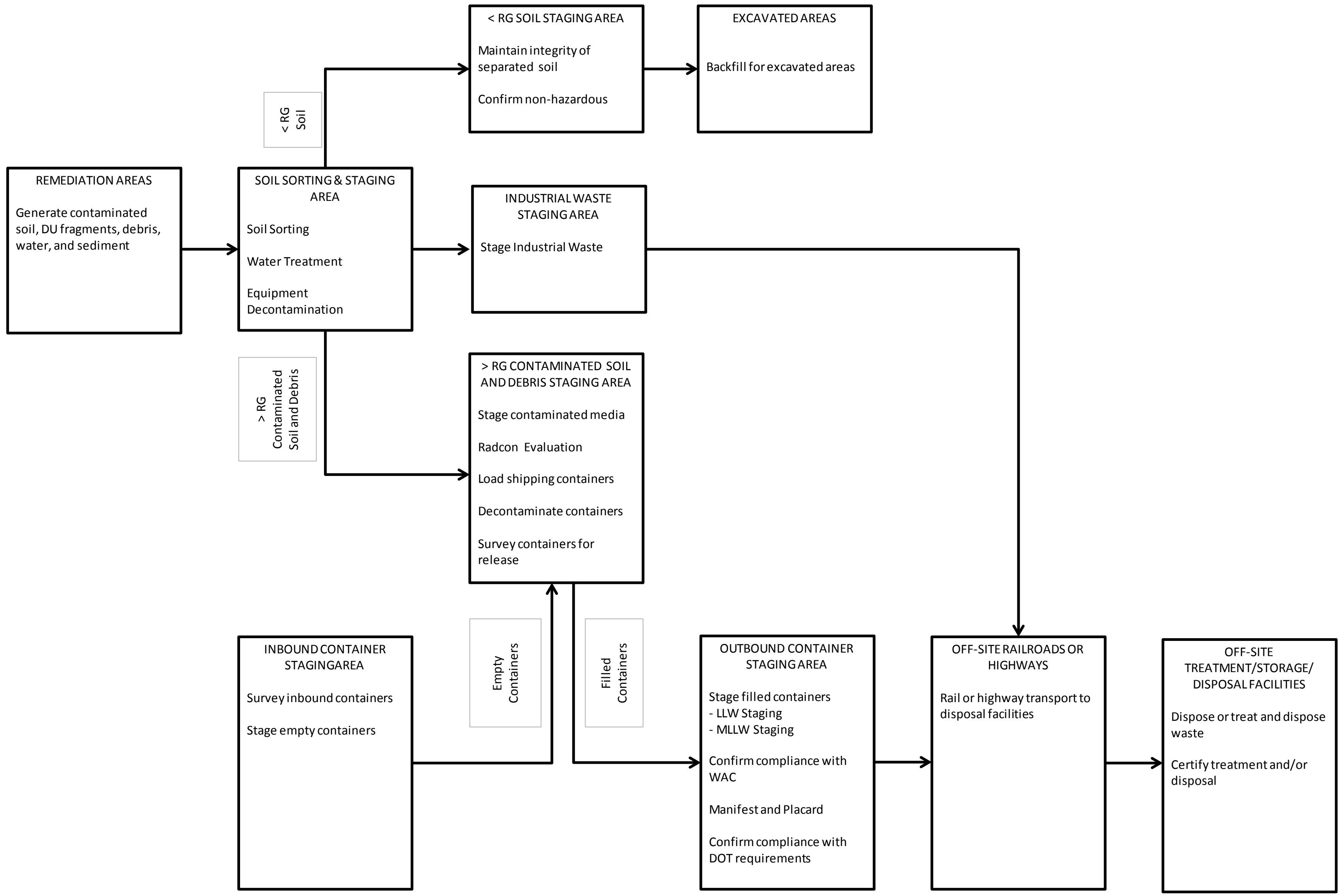

Figure 4-1. Staging Areas Process Diagram.

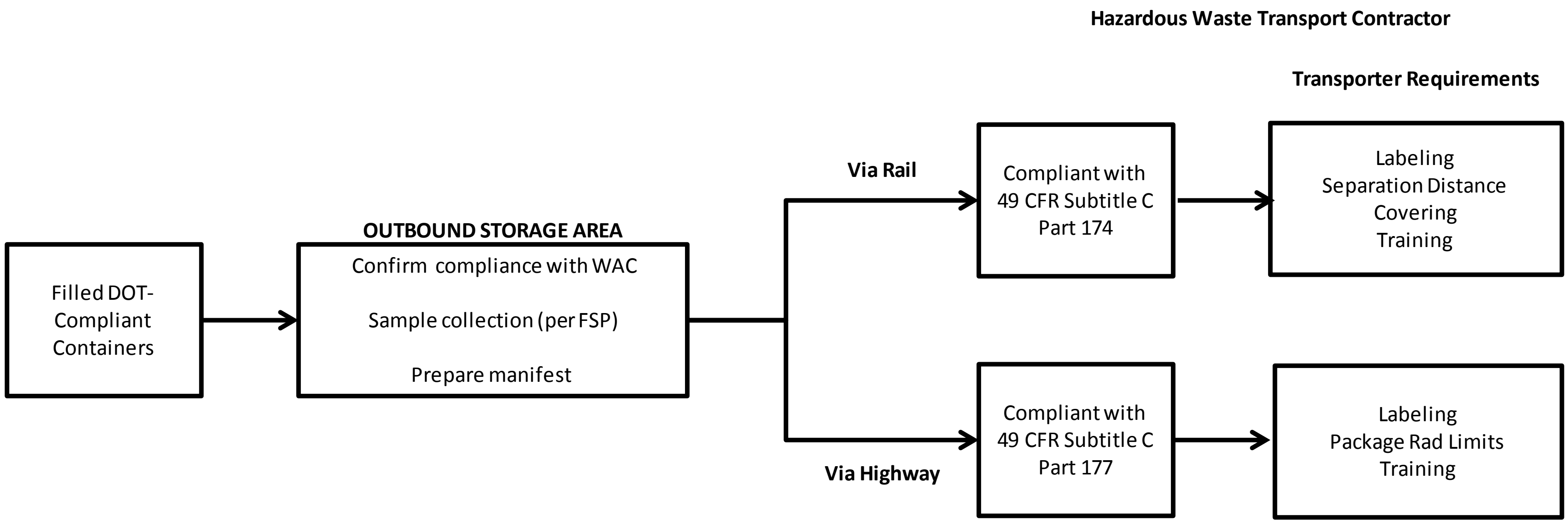

Figure 5-1. Waste flow.

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9. TABLES

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Table 4-1. Advantages and disadvantages of each packaging option.

Container	Size	Estimated No. Required	Time Sequence @ 100 Ton/Hour (Hr) @ 80% Reduction	Handling				Notes
				On-Site	Rail Yard	Transport	Disposal Facility	
Super Sack	~2 cubic yards (yd^3) (4,400 pounds [lb])	2,000	10/hr	Forklift, Small Crane	Forklift, Small Crane	Gondola Rail Car**	Custom Rail Car Unloading	Super Sacks Disposed With Waste
Roll-Off	20 yd^3	200*	1/hr	Roll-Off Truck	Large Crane	Flat Rail Car	Large Crane	

* Estimated number does not include possible re-use.

** Rail cars will be provided by disposal facility.

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Appendix A

LLW/MLLW Container Pre-Use Inspection Form

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*Complete this form prior to placing a container in service for LLW/MLLW.

LLW/MLLW Container Pre-Use Inspection Form

Project: ___________________________

Container Number: ___________________________

Container DOT Rating:
(e.g., IP-1, IP-2, Type A) ___________________________

Container Description:
(e.g., 20 cy roll off) ___________________________

Manufacturer: ___________________________

Provider: ___________________________

CRITERIA	REFERENCE	INITIALS / DATE
Container is clean and free of debris with nothing more than superficial scratches and dents that do not impair the ability of the container to contain its contents under normal conditions of transport	49 CFR 173.410	
All closure devices are present and functional	49 CFR 173.24 49 CFR 173.410	
Container has passed a procurement QA receipt inspection OR If Customer has shipper responsibilities, Customer has approved usage of container type and provider *(e.g., MPe roll-offs)*	49 CFR 173.410	
Certificate of Conformance to DOT design requirements is present OR If Customer has shipper responsibilities, Customer has approved usage of container type and provider	49 CFR 173.24	
Manufacture closure instructions have been provided or are available	49 CFR 173.24 49 CFR 178.2	
The container is physically and chemically compatible with the material to be packaged	49 CFR 173.24 49 CFR 173.410	
No features have been added to the container that may reduce the safety of the container *(e.g., inhibits decontamination of the container, create pockets or crevices for water collection, reduces the effectiveness of closure devices, reduces the integrity of the container, or reduces the safe handling, loading and transport of the container)*	49 CFR 173.410	
If container has been previously used (e.g., cargos, roll-offs) a pre-use radiological contamination and dose survey meeting "return to service" criteria has been completed *(conservatively, 220 disintegrations per minute (dpm) α/100 square centimeters (cm^2) and 2,200 dpm β-γ/100 cm^2 removable on internal and external surfaces; 0.5 millirems per hour (mrem/hr) on accessible surfaces)*	49 CFR 173.443(d)	

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Appendix B

Waste Management Area Inspection Form

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SELF-INSPECTION CHECKLIST

SITE ID	LOCATION/AREA	BLDG	ROOM	DATE	☐SAA ☐< 90 ☐UWA ☐UOA

☐No concerns ☐With concerns ☐Inactive/Removed ☐Active but not storing ☐Comments

GENERAL REQUIREMENTS	
1. The generator has initiated a hazardous waste determination.	☐YES ☐NO ☐NA
2. Containers are in good condition.	☐YES ☐NO ☐NA
3. Waste is compatible with containers.	☐YES ☐NO ☐NA
4. Containers are closed.	☐YES ☐NO ☐NA
5. Hazardous waste containers are marked with the words: "HAZARDOUS WASTE," "UNIVERSAL WASTE" or "USED OIL."	☐YES ☐NO ☐NA
Mixed low-level waste is additionally labeled "RADIOACTIVE."	☐YES ☐NO ☐NA
6. Constituents of waste are on container.	☐YES ☐NO ☐NA
7. A. All hazardous waste or oil spills/leaks have been cleaned up.	☐YES ☐NO ☐NA
B. The resultant clean-up materials have been handled as hazardous waste or used oil, as appropriate.	☐YES ☐NO ☐NA
8. Incompatible wastes are segregated properly.	☐YES ☐NO ☐NA
9. The waste/material has a known owner/generator.	☐YES ☐NO ☐NA
UNIVERSAL WASTE	
1. The universal waste area sign is prominently posted and visible.	☐YES ☐NO ☐NA
2. Batteries have an accumulation start date on containers.	☐YES ☐NO ☐NA
3. Batteries have been stored for less than 1 year.	☐YES ☐NO ☐NA
4. Lamps/bulbs have an accumulation start date on containers.	☐YES ☐NO ☐NA
5. Lamps/bulbs have been stored for less than 1 year.	☐YES ☐NO ☐NA
6. Lamps/bulbs containers are closed.	☐YES ☐NO ☐NA
7. Mercury thermostats/equipment has an accumulation start date on	☐YES ☐NO ☐NA
8. Mercury thermostats/equipment has been stored less than 1 year.	☐YES ☐NO ☐NA
9. Pesticides have an accumulation start date on containers.	☐YES ☐NO ☐NA
10. Pesticides have been stored less than 1 year.	☐YES ☐NO ☐NA
11. Pesticides containers are closed.	☐YES ☐NO ☐NA
SATELLITE ACCUMULATION AREA	
1. The waste is accumulated "at or near the point of generation".	☐YES ☐NO ☐NA
2. The waste is "under the control of the operator of the process generating the waste".	☐YES ☐NO ☐NA
3. The users of the Satellite Accumulation Area (SAA) have an inventory system or their names and waste profile/waste	☐YES ☐NO ☐NA
4. The SAA has administrative controls and authorized users.	☐YES ☐NO ☐NA
5. If outside, the SAA has physical controls.	☐YES ☐NO ☐NA
6. The waste volume is less than 55 gallons of hazardous waste or 1 quart of acutely hazardous waste.	☐YES ☐NO ☐NA
A. If the waste volume has been exceeded, the containers are marked with the date the excess began.	☐YES ☐NO ☐NA
B. The excess waste has been moved to a <90 or TSDF within 3 days.	☐YES ☐NO ☐NA
7. The satellite accumulation area sign is prominently posted and visible.	☐YES ☐NO ☐NA

SELF-INSPECTION CHECKLIST (Cont'd.)	
< 90 DAY	
1. There is an accumulation start date on every container.	☐YES ☐NO ☐NA
2. All wastes have been stored less than 90 days.	☐YES ☐NO ☐NA
3. The accumulation area is inspected at least weekly.	☐YES ☐NO ☐NA
4. Deficiencies that are noted are being corrected in a timely manner.	☐YES ☐NO ☐NA
5. The < 90 day accumulation area sign is prominently posted and visible.	☐YES ☐NO ☐NA
6. Required equipment is present and in working order:	
- Spill control equipment;	☐YES ☐NO ☐NA
- Emergency equipment;	☐YES ☐NO ☐NA
- Communication equipment; and	☐YES ☐NO ☐NA
- Decontamination equipment.	☐YES ☐NO ☐NA
7. There is adequate aisle space between containers.	☐YES ☐NO ☐NA
8. The operators/inspectors/owners have completed required training.	☐YES ☐NO ☐NA
9. A. Copy of the Contingency Plan is at the accumulation area.	☐YES ☐NO ☐NA
B. There is an Emergency Contact List/Site Specific Plan	☐YES ☐NO ☐NA
Signature:	Date:
Comments:	

FINAL

ACCIDENT PREVENTION PLAN
IOWA ARMY AMMUNITION PLANT
OPERABLE UNIT 8,
DEPLETED URANIUM CONTAMINATED SOIL
AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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FINAL

ACCIDENT PREVENTION PLAN IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPELTED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

Prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:

North Wind Services, LLC
Under Contract No. W912P9-12-D-0510

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ACCIDENT PREVENTION PLAN
IOWA ARMY AMMUNITION PLANT
OPERABLE UNIT 8,
DEPLETED URANIUM CONTAMINATED SOIL
AND STRUCTURE REMEDIATION

Plan Prepared by:

02/06/2013

Micah F. Nielsen — Date
Health and Safety Manager, NWS
208-557-0823

Plan Approved by:

02/06/2013

Joe Rothermel — Date
Project Manager, NWS
406-258-1123

Plan Concurrence from:

02/06/2013

John El Shaler — Date
President, NWS
303-741-4488

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APPENDICES

ADDENDUMS

ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienist
AEC	Atomic Energy Commission
AHA	activity hazard analysis
APP	Accident Prevention Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CO	Contracting Officer
COR	Contracting Officer Representative
CPR	cardiopulmonary resuscitation
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DU	depleted uranium
EMR	experience modification rate
EPA	Environmental Protection Agency
FS	Firing Site
FUSRAP	Formerly Used Sites Remedial Action Program
GDA	Government Designated Authority
HAZWOPER	hazardous waste operations and emergency response
HRD	Human Resources Director
HSO	Health and Safety Officer
IAAAP	Iowa Army Ammunition Plant
MEC	Munitions and Explosives of Concern
MSDS	material safety data sheet
NCP	National Contingency Plan
NIOSH	National Institute of Occupational Safety and Health
NRC	U.S. Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
OU	operable unit

PM	Project Manager
PPE	personal protective equipment
RA	remedial action
RD	remedial design
RG	remediation goal
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
USACE	United States Army Corps of Engineers
UXO	Unexploded Ordnance

Accident Prevention Plan
Iowa Army Ammunition Plant Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation Middletown, Iowa

1. INTRODUCTION

This Accident Prevention Plan (APP) describes protective measures to be instituted during implementation of the remedial design (RD)/remedial action (RA) for Operable Unit (OU)-8 at the Iowa Army Ammunition Plant (IAAAP) near Middletown, Iowa. The work will be conducted in accordance with the IAAAP Federal Facilities Agreement (EPA, 2006) by the United States Army Corps of Engineers (USACE), St. Louis District Formerly Utilized Sites Remedial Action Program (FUSRAP) Project Office. This Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RA will proceed in accordance with the signed OU-8 Record of Decision (ROD; USACE, 2011), which presents the selected remedy for remediation of soil and structures in designated areas. This APP is a supporting document to the RD/RA Work Plan (USACE, 2013). The activity hazard analysis (AHA) forms are included in Appendix A and a Site Safety and Health Plan (SSHP) is included in Appendix B of this APP.

The purpose of the APP is to ensure that health and safety issues anticipated during the selected RA are considered and addressed prior to starting work. The APP identifies applicable site-specific hazards and site-specific safety and health considerations encountered during the RA activities at IAAAP.

This APP was developed in accordance with Environmental Protection Agency (EPA) requirements, Occupational Safety and Health Act (OSHA) standards (29 Code of Federal Regulations [CFR] Parts 1910 and 1926), and the USACE EM 385-1-1, *Safety and Health Requirements Manual*.

This APP assigns responsibilities, establishes personnel protection standards and mandatory safety practices and procedures, and provides for contingencies during activities proposed for IAAAP. The contractor is required to employ safe work practices at all times and comply with all current federal, state, and local directives specific to health and safety requirements. A copy of the APP will be maintained onsite during work activities and made available for inspection and review by site or agency personnel. Field personnel will review applicable aspects of the APP before site work and sign an acknowledgment form indicating that they have reviewed the applicable aspects of the plan.

Contents of the APP may be revised and/or amended if additional information becomes available regarding hazards present at the site and/or if significant changes occur in the scope of work, operational procedures, site hazards, and/or hazard control measures. The APP may be modified by the Site Safety and Health Officer (SSHO) upon review and approval of the Project Manager (PM). Field personnel are informed of revisions or addendums to the APP during safety meetings.

All personnel involved in field work at the site will:

- Have completed the required 40 hours initial training in hazardous waste operations,
- Maintain qualification through annual refresher training,
- Be included in a program of medical monitoring, and
- Be qualified to wear respiratory protection, as specified in 29 CFR Part 1910.134.

Changes and modifications to the APP are permitted and will be made in writing with the knowledge and concurrence of the Health and Safety Officer (HSO) and accepted by the Government Designated Authority (GDA). It is recognized that conditions at a site may change or that more information may become available during the operation. If during the operation it is determined that the conditions are not as described, or the protection specified in the APP requires modifications, work will stop and the HSO will be contacted for guidance. Work would not resume until authorized by the PM and approved by the GDA.

2. SIGNATURE SHEET

A signature sheet included at the beginning of this report contains the required names, titles, phone numbers, and signatures for this APP.

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3. BACKGROUND INFORMATION

3.1 Contractor

To be determined.

3.2 Contractor Number

To be determined.

3.3 Project Name

IAAAP OU-8, Depleted Uranium (DU)-Contaminated Soil and Structure Remediation.

3.4 Site Background

The IAAAP is a government-owned, contractor-operated facility located approximately 10 miles west of Burlington, Iowa and the Mississippi River. The IAAAP consists of approximately 19,000 acres, of which approximately one-third is occupied by active or formerly active munitions production or storage facilities. The remaining property is either forested (7,766 acres) or leased for agricultural use (7,107 acres).

The primary activity at IAAAP since 1941 has been to load, assemble, and pack a variety of conventional ammunition and fusing systems for the U.S. Department of Defense (DOD). From 1947 to 1975, portions of the IAAAP facility were under the control of the U.S. Atomic Energy Commission (AEC) for weapons-assembly operations. The IAAAP was listed on the National Priorities List in 1990.

Historical AEC activities resulted in contamination of soil at outdoor firing sites where tests of DU surrogates for weapon components were performed. DU is present as metallic uranium and as chemical weathering products of metallic uranium in soil. Soil contaminated with metallic and/or weathered DU poses a risk to human health and the environment.

AEC performed manufacturing operations that resulted in DU contamination of structure components in two buildings in the Line 1 portion of IAAAP. Contaminated components are located in Building 1-11 and Building 1-63-6.

The FUSRAP ROD (USACE, 2011) presents the selected remedy for the remediation of soil and structures at specific (i.e., former AEC) areas at IAAAP. The specific areas for which this selected remedy applies include Line 1 Structures; the Firing Sites Area (consisting of five subareas); Yards C, G, and L; and Warehouse 3-01. The selected remedy addresses soil and structures that are radiologically contaminated as a result of AEC operations. USACE is authorized by Congress as the lead agency implementing the selected remedy under the authority of FUSRAP.

The selected remedy is the final remedy for the FUSRAP areas of IAAAP (OU 8). Six other OUs have been defined at IAAAP. They are being addressed by other U. S. Army programs.

3.5 Description of Selected Remedy

The selected remedy was chosen in accordance with CERCLA (42 USC § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 CFR §300.430(a)(1)(iii)(A)). This decision is based on the Administrative Record file located at the Burlington, Iowa Public Library and at the USACE, St. Louis District FUSRAP Project Office.

No principal threat wastes, as defined by the NCP, are present at the FUSRAP areas of IAAAP. The principal contaminant of concern for the FUSRAP areas is DU. The selected remedy for DU-contaminated soil is removal by excavation and physical treatment prior to off-site disposal. Additionally, DU will be removed from structures using decontamination and/or removal and off-site disposal.

The main components of the selected remedy for soil (ROD – Alternative 4) include:

- Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) at Firing Sites 1 and 2 (FS-1, FS-2); Firing Sites 3, 4, and 5 (FS-3, FS-4, FS-5); the Firing Site 6 Area (FS-6); and the Firing Site 12 Area (FS-12). Excavation will not be conducted at Yards C, G, and L or Firing Site 14 (FS-14).
- Physical treatment of DU and DU-contaminated soil excavated from FS-1 and FS-2; FS-3, FS-4, and FS-5; FS-6; and FS-12 via soil sorting.
- Materials exceeding the DU RG will be disposed of at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate.
- Site restoration, including backfilling, grading, and re-vegetation.
- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.
- Five-year reviews for FUSRAP areas where contaminants remain above levels acceptable for unlimited use and unrestricted exposure to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use will be verified during each 5-year review.

The main components of the selected remedy for structures (ROD – Alternative S3) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures.
- Disposal of DU-contaminated materials at a properly permitted off-site facility.
- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.
- Five-year reviews for structures if they exceed levels appropriate for unlimited use and unrestricted exposure to ensure continued protectiveness of human health under industrial land use. Industrial land use will be verified during each 5-year review.

4. SAFETY AND HEALTH

This APP was written to address the task activities that take place during the OU-8 RA. Specific project activities and their associated hazards are identified in the following subsections. An AHA has been prepared for each task and, in some cases, sub-tasks (see Appendix A).

4.1 Accident Experience

The contractor will submit information regarding their most recent health and safety experience and current experience modification rate (EMR). Table 4-1 is an example of the health and safety metrics.

4.2 Phases of Work and Activity Hazard Analysis

The objective of this hazard assessment section is to identify hazards present during each phase of work and provide guidance to eliminate or mitigate these hazards. The primary activities and the associated hazards are identified in multiple AHAs, as presented in Appendix A.

Personnel may be exposed to safety and health hazards identified for major work activities identified in Appendix A. The following sections provide hazard mitigation steps necessary to reduce or eliminate risk of personnel injury or exposure during the performance of site work activities. The mitigation steps identified are intended to provide the minimum protective actions to be taken during work activities. The Field Project Engineer and/or SSHO may implement additional or more stringent mitigation steps if determined necessary by field condition observations through the revision of current AHAs or the creation of a new AHA. No hazards will be left unmitigated. Identification of new hazards will be reported to the HSO, and this APP will be revised or supplemented with additional AHAs and mitigation information. Additional AHAs may be included in Appendix A of this APP after applicable workers have been briefed and trained to the AHA. All changes to AHAs and the creation of new AHAs must be reported to, and have concurrence from, the USACE Contracting Officer Representative (COR).

4.3 Statement of Safety and Health Policy

The contractor will provide their corporate health and safety policy before the start of field work.

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5. RESPONSIBILITIES AND LINES OF AUTHORITY

This section describes the organization and responsibilities of key personnel, including interfaces and lines of communication. A project organization chart is shown in Figure 5-1, and the responsibilities of personnel are stated in the following sections.

5.1 Statement of Ultimate Responsibility for Safety

The contractor senior management assigns PMs and has overall responsibility for the health and safety program. The Field Project Engineer and SSHO have the responsibility and authority for implementing project-specific health and safety programs, maintaining a safe work environment, stopping unsafe acts of workers, and are authorized to remove unsafe workers from the work site after consultation with, and agreement from, the PM.

The HSO is responsible for identifying the health and safety regulatory requirements, developing programs and procedures to meet these requirements, interpreting health and safety requirements (in concert with various technical and medical resources), and approving variances from corporate safety program requirements.

All personnel are responsible for their own safety and the safety of other individuals affected by their actions. These responsibilities include making a prompt report of any occupational injury, illness, spill/environmental release, or potential hazardous material exposure to the appropriate PM, Field Project Engineer, or SSHO. Management is responsible for ensuring that employees and subcontractors are not subject to discrimination or reprisal for taking responsible safety actions.

5.2 Identification and Accountability of Personnel Responsible for Safety at Corporate and Project Levels

5.2.1 Contractor Senior Management

Contractor senior management will be committed to perform the following actions and activities:

- Support the HSO, who has enforcement authority over safety, loss control, and claims;
- Establish, and make known to all employees, rules and programs designed to promote safety;
- Make available the necessary training for employees to perform jobs safely;
- Provide protective equipment, as applicable;
- Impress upon everyone the responsibility and accountability of each individual to maintain a safe work place;
- Record all instances of violations and investigate all accidents;
- Discipline any employee willfully disregarding this safety program; and
- Require all subcontractors to follow all safety policies and procedures.

5.2.2 Health and Safety Officer

The HSO will:

- Assume responsibility for overall company safety and health performance.
- Develop and administer policies and procedures for controlling the company's risks and exposures. This will include loss control principles concerning employee safety, property, equipment, fleet, environmental, and general liability exposures.
- Manage and monitor all claims following an accident (i.e., workers compensation, automobile, general liability, equipment, and property).
- Develop and monitor an accountability program for field supervisors to measure project-specific performance.
- Track the frequency and severity of injuries, illnesses, and workers compensation losses, and provide routine updates.
- Provide formal loss control training sessions for field supervisors.
- Ensure safety inspections are conducted at all job sites on a routine basis and follow up on all recommendations resulting from the inspection.
- Review and investigate all accidents with the appropriate personnel and take necessary measures to prevent future occurrences.
- Be familiar with all laws and regulations pertaining to safety, and ensure the company is in compliance.
- Monitor safety performance of subcontractors.
- Ensure a qualified safety representative is present for all inspections and consultations performed by federal, state, and local authorities, if possible.
- Ensure health and safety procedures are reviewed on a regular schedule and updated as needed.

5.2.3 Project Manager

The PM is the primary point of contact for all work performed and is responsible for the management and execution of this work in accordance with the contract, approved work plans, and all federal, state, and local laws and regulations. The PM will ensure that all site activities are performed in a safe manner by ensuring that all personnel meet the necessary requirements for site work, and will further ensure that equipment is safe and free from obvious hazards.

5.2.4 Field Project Engineer

The Field Project Engineer is responsible for complying with the following requirements:

- Carry out safety and loss control programs at the work level.

- Be aware of all safety requirements and safe working practices.
- Plan all work activities with safety in mind and with full authority to act on behalf of the contractor.
- Instruct new and existing employees performing new tasks in safe working practices and provide their crew with continuing instruction on safety requirements, including daily pre-job briefings or "toolbox" meetings.
- Make sure personal protective equipment (PPE) is available.
- Make sure all work is performed in a safe manner and no unsafe conditions or equipment are present.
- Act without delay to correct hazards, including unsafe acts and conditions.
- Notify the PM, the HSO, and the Human Resources Director (HRD) by phone of all incidents immediately upon incident occurrence. The PM will notify the GDA within 30 minutes of receiving notification of any incident involving an injury or illness.
- Monitor safety activities of subcontractors.
- Provide employees access to a copy of this APP and SSHP during their initial safety briefing, at which time the plans will be covered in detail.

5.2.5 Site Safety and Health Officer

The PM will designate a SSHO who is familiar with the type of work performed and potential hazards specific to the project. For smaller or less complex projects, the SSHO may also serve as the Field Project Engineer. The designated SSHO will:

- Maintain records of project-related injuries, illnesses, and equipment damaged due to accidents;
- Report injuries and illnesses to the HSO that are applicable to the contractor's OSHA 300 Log;
- Perform inspections, training, and investigations;
- Complete and revise AHAs, as needed;
- Maintain training records;
- Analyze accident data, trends, and lessons learned, and review these with employees;
- Be trained in first-aid, cardiopulmonary resuscitation (CPR), and blood borne pathogens;
- Ensure that a stocked first-aid kit is readily available at the project site;
- Secure prompt medical attention for any injured employee; and
- Notify the Field Project Engineer immediately of any accidents.

5.2.6 Supporting Field Personnel

The supporting field personnel are required to safely complete the onsite tasks required to fulfill the requirements of the Work Plan (USACE, 2013) and comply with the requirements of the APP and SSHP. Field personnel include all contractor and subcontractor personnel performing work onsite not identified elsewhere in this section. Field team personnel will immediately notify the Field Project Engineer or SSHO of unsafe conditions. Personnel are expected to work in a safe and compliant manner. In no case may personnel perform work in a manner that conflicts with the intent of, or the inherent safety and environmental cautions expressed in, this APP. Personnel who violate safety procedures will be dismissed from the site and may be terminated.

5.2.7 Radiation Safety Officer

The Radiation Safety Officer(s) will be a person technically qualified, trained, and educated to the following requirements:

- Formally trained in radiation protection topics, including: physics of radiation; radiation's interaction with matter; mathematics necessary for the subject matter; biological effects of radiation; type and use of instruments for detection, monitoring, and surveying radiation; radiation safety techniques and procedures; and use of time, distance, shielding, engineering controls, and PPE to reduce radiation exposure;

- Hands-on training in the uses of equipment, instrumentation, procedures, and theory used in their unit;

- Has knowledge of applicable regulations, including those of the U.S. Nuclear Regulatory Commission (NRC), EPA, Department of Energy (DOE), Department of Transportation (DOT), and DOD, to include all applicable DOD components pertaining to radioactive materials, radiation generating devices, and radioactive and mixed waste; and

- Has knowledge of the USACE Radiation Safety Program and recordkeeping requirements for working with radioactive materials and radiation generating devices.

5.2.8 Employee Responsibility

All employees and subcontractors must comply with the following requirements:

- Work in such a manner that ensures their own safety, as well as the safety of others, in strict compliance with OSHA regulations and corporate policies and procedures;

- Request help when uncertain how to perform work safely;

- Correct unsafe acts or conditions within the scope of immediate work;

- Report for work in appropriate mental and physical condition to safely carry out assigned duties;

- Report all unsafe acts or conditions to the Field Project Engineer or SSHO;

- Use and maintain all provided safety devices;

- Maintain and operate tools per manufacturer recommendations;

- Follow all safety rules; and
- Ask immediate supervisor if there are any questions concerning procedures or hazardous materials.

5.2.9 Visitors

If no potential for exposure to safety or occupational health hazards exists, a visitor may be escorted to the project site after receiving a site orientation consisting of:

- An overview of the work areas at the site and access restrictions;
- Review of inherent site hazards (e.g., terrain and equipment) and mitigating actions or avoidance;
- Receipt of required PPE for entry to the site (must be trained to wear required PPE); and
- Instruction in emergency actions to take in the event of a site emergency.

Where access is allowed, a fully-trained site representative (e.g., PM, Field Project Engineer, or SSHO) will escort visitors entering the project site. A casual visitor to the task site is a person who does not have a specific task or official business at the project site. Casual visitors are not permitted in controlled project work areas.

5.3 Names of Competent and/or Qualified Person(s)

OSHA defines a competent person in 29 CFR 1926.32(f) as "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them." The contactor (or its subcontractors) will assign competent persons in writing, as required by the 29 CFR 1926, Construction Standard, before a person assumes any competent person duties.

Competent persons for this project are as follows:

- SSHO Competent Person – will be identified before the start of any field work and made known to all field personnel. The SSHO will be identified in the Pre-Construction Planning and Procurement Phase.
- Excavation/Trenching Competent Person – will be identified before the start of any excavation/trenching work and made known to all field personnel. The Competent Person will be identified in the Pre-Construction Planning and Procurement Phase.

5.3.1 Requirement That No Work will be Performed Unless a Competent Person is Present On Site

No work for which a competent person is required will be performed unless a qualified competent person is present at the project site and overseeing that operation. The following activities require the presence of a competent person:

- A qualified and approved SSHO must be on site during all field activities; and
- Excavations greater than 5 feet (1.5 meters) below grade where worker entry is required and during excavation.

5.4 Requirements for Pre-Task Safety and Health Analysis

An AHA has been completed for each specific task activity to be conducted associated with the alternative activities. This information is summarized in Appendix A. A tailgate safety meeting will be conducted at the beginning of every day and prior to initiating any task to address the hazards associated with the planned daily activities and any changes to the approved work control documents.

5.5 Lines of Authority

At all times, a qualified SSHO will be present at the project site overseeing daily operations. The names and cell phone numbers for the Field Project Engineer and SSHO on duty will be distributed to all site personnel at the beginning of the project, and site personnel will be instructed to program these numbers in their cell phones. In the event that more than one person rotates through the position of Field Project Engineer or SSHO, the name of the current Field Project Engineer and SSHO will be reviewed each morning during the tailgate briefing. The Field Project Engineer is responsible for ensuring work activities are completed in accordance with the Work Plan (USACE, 2013) and applicable regulatory requirements. The SSHO is responsible for ensuring the requirements of this APP are followed when performing the work. The PM has overall responsibility for completion of the project. The Field Project Engineer and SSHO have the authority to immediately stop any operations they believe are unsafe in accordance with the Stop Work Authority described in Section 5.6 below. The PM has the authority to make decisions pertaining to the USACE Contract and the Work Plan for this project. Figure 5-1 depicts the organizational structure for the project.

5.6 Stop Work Authority

All persons on the job site, including contractor employees, subcontractors, and client representatives, have the right and responsibility to pause, stop work, or to decline to perform an assigned task whenever they discover an unsafe condition that endangers workers, the public, the environment, facilities, equipment, or the quality of work or products being produced. *Stop Work is the ability of all workers to halt work in order to resolve safety issues or concerns that are not readily fixable by the performing employees and their first line supervisors*.

Stop work authority is typically used when an unsafe condition exists that it is reasonable to believe would result in imminent risk of death, serious physical harm, or other serious hazard to the workers or the public. If continued, the condition could cause an adverse effect to the safe operation of, or damage to, the facility; or, if allowed to continue, could result in release of radiological or chemical effluents that exceed regulatory limits.

Contractor employees and subcontractors also have the right and responsibility to step back when they identify a potentially unsafe condition that could be corrected by the performing employee and/or the project management with minimal effort and time. *A step back can be as simple as an employee pausing to refocus on the task at hand after a break, or by asking for clarification about a task from an immediate supervisor.* A potentially unsafe condition can also exist when an employee encounters any situation, condition, or potential hazard not discussed in pre-job briefings, or if an employee has a concern about whether the job can be performed safely.

5.6.1 Policy Regarding Noncompliance with Safety Requirements

Disciplinary actions will be taken if any manager, supervisor, employee, or subcontractor fails to follow the APP and SSHP (Appendix B) requirements. Actions range from a written reprimand to termination.

Subcontractors who fail to follow contractor requirements are subject to contract termination. ***Unsafe acts or environmental negligence will not be tolerated***. The PM and field manager have direct responsibility for safety on this project. Unsafe acts by subcontractors will be handled through punitive contractual actions, which may include contract termination as warranted.

5.6.2 Written Procedure for Holding Managers and Supervisors Accountable for Safety

The PM and Field Project Engineer are charged with the overall responsibility of preventing incidents and eliminating conditions that can lead to occupational injuries and illnesses. Contractor employees and subcontractors are responsible to manage their safety and the safety of others affected by their actions. These responsibilities include making a prompt report of any occupational injury, illness, spill/environmental release, or potential hazardous material exposure to the appropriate PM, Field Project Engineer, or SSHO. Contractor management is responsible for ensuring that employees or subcontractors are not subject to discrimination or reprisal for taking responsible safety actions.

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6. SUBCONTRACTORS AND SUPPLIERS

Subcontractors performing on-site work activities will adhere to the requirements of the APP and SSHP (Appendix B).

6.1 Identification of Subcontractors and Suppliers

Table 6-1 identifies subcontractors and/or suppliers applicable to this project.

6.2 Safety Responsibilities of Subcontractors and Suppliers

No work will be conducted without evidence of insurance and a signed subcontract agreement. Prior to the start of the project, the PM will verify that the Work Plan (USACE, 2013) and APP have been read, signed, and will be followed by the subcontractor throughout the duration of the project. Any deviations from the site plans could be used as the basis for termination of the subcontract agreement.

6.2.1 Subcontractor Field Leaders

The subcontractor field leaders are responsible for overseeing the field activities of his/her employees and enforcing the field requirements of this APP and applicable AHAs. Specific responsibilities include:

- Ensuring that onsite subcontractor personnel follow the requirements of the APP and any other applicable health and safety requirements;
- Verifying that the APP adequately addresses the hazards and controls of the subcontracted work, and supplementing the information to the APP, if necessary;
- Ensuring the safe operation of any subcontractor equipment;
- Coordinating onsite operations of personnel; and
- Maintaining any required documentation specific to operations.

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7. TRAINING

Project specific training requirements are listed in Table 7-1.

7.1 New Hire Orientation

Indoctrination and training will comply with general safety and health policies and procedures. All training, meetings, and indoctrinations will be documented in writing by date, name, content, and trainer. Training will be based on existing safety and health programs and cover requirements and responsibilities for accident prevention and how to facilitate a safe and healthy work environment. Employees and supervision responsibilities for reporting all accidents will be discussed. Other topics to be discussed include directions to the nearest hospital, emergency response procedures and how to obtain emergency assistance, procedures for reporting and correcting unsafe conditions or practices, job hazards and associated AHAs, and specific training (as required by this project).

7.2 Mandatory Training and Certification Requirements for Project

The SSHO will meet the qualifications as addressed in the Work Plan (USACE, 2013). The SSHO must have completed an OSHA 30-hour construction course with 5 years' experience or be a Certified Industrial Hygienist (CIH) or Certified Safety Professional, or have a safety and health degree with 3 years' experience. Modification to this requirement will only be made and approved by the USACE Contracting Officer (CO) and Safety Office based upon the complexity of hazards associated with the project.

Radiological Safety Officers will have proficiency by either experience or by demonstration.

7.3 Procedures for Periodic Safety and Health Training for Supervisors and Employees

The Field Project Engineer, SSHO, or designee will conduct a daily tailgate safety meeting (or equivalent). During this meeting, daily task activities will be discussed; hazards identified; hazard controls, mitigation, and work zones established; PPE requirements discussed; and feedback from personnel solicited. At the end of this meeting, any new work-control documents will be reviewed and signed.

Particular emphasis will be placed on lessons learned from the previous workday's activities and how tasks can be completed in the safest, most efficient manner. All personnel are encouraged to contribute ideas to enhance worker safety and mitigate exposures to hazards at the project sites. This training will be documented daily on a training acknowledgement form.

7.4 Other Safety Training

All training requirements addressed in an AHA will be completed by applicable employees and subcontractors prior to commencing the task(s) addressed in the AHA. Completion of the training will be verified by the PM.

Health and safety topic-specific training or safety meetings may be given during the course of the project to reinforce key safety topics. These meetings can be conducted by assigned project health and safety professionals or any field team member and should be held in conjunction with the safety meeting.

Training requirements are also addressed in the AHAs (Appendix A), the SSHP (Appendix B), and Table 7-1.

7.4.1 Requirements for Emergency Response Training

The SSHO and the Field Project Engineer will be trained to respond to medical or other emergencies, as addressed in the APP. A minimum of two people trained in first-aid and CPR will be present on site while hazardous activities are being performed.

Prior to commencement of the project, all site personnel and subcontractors will review and discuss the posted emergency telephone numbers, location of spill kit materials, directions to hospital, the location and use of all site fire extinguishers, location of first-aid kits, spill cleanup procedures, and onsite personnel trained in first-aid and CPR. When establishing work zones, the SSHO will identify the evacuation route, what conditions would require site evacuation, and a designated safe meeting location in the event of an emergency. Personnel will be designated to direct emergency response personnel to the area and to block entrance to the site of all unauthorized personnel until help arrives at the scene.

8. SAFETY AND HEALTH INSPECTIONS

8.1 Specific Responsibilities for Minimum Daily Job Site Inspections

Daily job site inspections will be conducted by the Field Project Engineer or SSHO during periods of work activity and at a level commensurate with the tasks being conducted. Persons conducting site or equipment inspections will do so to the level of technical proficiency needed to perform said inspections. A designated competent person will perform inspections requiring a competent person (i.e., fall protection, excavation, etc.). Inspections addressed in each AHA will be conducted.

Deficiencies in training/qualifications (e.g., qualified operator, competent person, etc.) must be addressed and corrected prior to any work commencing for each applicable worker.

All PPE and emergency supplies will be inventoried and inspected by the Field Project Engineer or SSHO and the employee who will be wearing the PPE prior to mobilizing to the project sites. All PPE must also be inspected by the worker prior to initial use. PPE that fails integrity inspections will be appropriately disposed.

8.2 External Inspection and Certifications

Inspections by the contractor, subcontractors, the USACE COR, and other applicable agencies may be conducted at any time. Onsite walk-downs may not occur without the presence of a qualified SSHO and permission from the Field Project Engineer.

Any industrial hygiene sampling will occur under the direction of a CIH currently certified by the American Board of Industrial Hygiene.

8.3 Safety and Health Expectations, Incentive Programs, and Compliance

The safety goal for this project is **ZERO recordable accidents** or environmental violations.

It is policy to expect a high degree of professionalism from employees and subcontractors during the course of each project. The contractor will interview prospective employees and subcontractors to assess whether their safety awareness and attitude is acceptable. This includes review of subcontractor recordable injury and illness/lost workday incidence rates and EMRs. Safety awards are occasionally presented to highlight exceptional safety awareness or actions.

8.3.1 Safety Incentive Program

The contractor and subcontractors may have an established safety program to reward employees and subcontractors for safety compliance.

8.3.2 Policies and Procedures for Noncompliance

Minor infractions of noncompliance will be corrected immediately, as designated by onsite supervisory personnel, and documented in the project logbook. The Field Project Engineer or SSHO will report serious, noncompliant personnel to the immediate supervisor, who will then counsel the employee. Repeated non-compliance will lead to a written reprimand for the employee’s personnel file. Serious, willful, or repeat noncompliance will lead to more serious disciplinary actions.

Disciplinary actions will be given to a manager, supervisor, employee, or subcontractor who fails to follow environmental, safety, and health program requirements and/or the health and safety requirements of this APP. Actions will range from a written reprimand to termination. ***Unsafe acts or environmental negligence will not be tolerated.*** The PM and field manager have direct responsibility for safety on this project.

9. ACCIDENT REPORTING

This section provides the requirements for the accident reporting provisions of EM 385-1-1. This requirement applies to all work performed for the project. The PM, HSO, and Field Project Engineer will be notified immediately of any accidents, near misses, or incidents. The USACE PM will be notified by telephone within 24 hours. All lost time injuries and property damage accidents (excluding on-the-road vehicle accidents) in which the property damage exceeds $2,000 will be reported to the GDA within 48 hours of the accident/incident using ENG Form 3394.

Daily logbook entries will be maintained by the Field Project Engineer. The logbook will include exposure data entries, safety program management details on site assessments, investigations, corrective actions, and other safety related inspections/findings.

9.1 Exposure Data

The Field Project Engineer will be responsible for reporting exposure data (person-hours worked) to the PM. Personnel man-hours will be defined as hours worked by all persons assigned to a project, including subcontractor employees at the work site. These man-hours should be listed on the project man-hours section of the reporting form. Hours will be reported on a calendar month basis from the first day of each month to the last day of each month. The Field Project Engineer will submit to the PM (by the fifth working day of each month) the contractor man-hours worked for the prior month. All recordable hours will be submitted to the PM, who will forward them to the USACE PM for statistical purposes.

9.2 Accident Investigations, Reports, and Logs

The SSHO will immediately report any incident or injury to the PM, who will report the incident to the HRD and the USACE COR as soon as reasonably possible but no later than 24 hours after the incident. The PM will gather the resources needed to investigate the circumstances surrounding the injury or exposure and file an exposure/injury incident report. This report will include recommendations on how to prevent similar events from recurring. Within 2 working days of any reportable accident, **the contractor will complete and submit required accident reports (USACE Form ENG 3394) using the following accident classifications:**

- Class A Accident—An accident in which the resulting total cost of property damage and personal injuries is $1 million or greater, or an injury or occupational illness resulting in a fatality or permanent total disability.

- Class B Accident—An accident in which the resulting total cost of property damage and personal injuries is $200,000 or more but less than $1 million; or an injury or occupational illness resulting in permanent partial disability; or when three or more personnel are hospitalized as inpatients as the result of a single occurrence.

- Class C Accident—An accident in which the resulting total cost of property damage and personal injuries is $20,000 or more but less than $200,000; a nonfatal injury that causes any loss of time from work beyond the day or shift on which it occurred; or a nonfatal occupational illness that causes loss of time from work or disability at any time.

- Class D Accident—An accident in which the resulting total cost of property damage is $2,000 or more but less than $20,000.

The accident investigation may exceed the 2-day notification period required to submit the USACE Form ENG 3394. Accident investigation information collected and documented after submittal of Form ENG

3394 will be communicated to the appropriate USACE personnel following completion of the investigation. If additional information is obtained, a revised Form ENG 3394 will be submitted.

The governing USACE district may have additional reporting requirements; therefore, the Field Project Engineer should ask the COR if other reporting requirements are wanted or needed.

First-aid treatment(s) provided by a trained first-aid/CPR worker to another worker that requires a hospital visit, that is associated with a recordable injury, or inhibits a worker's ability to perform his or her tasks will be reported to the USACE COR or PM as a Form ENG 3394 communication. Minor first-aid treatments (i.e., self-treat or those not meeting the above criteria) may be reported to the USACE COR/PM via verbal or email communication within 2 working days of the incident.

The PM will implement corrective actions as soon as reasonably possible following the investigation prior to continuing site activities. Drug and alcohol testing will be conducted following all accidents. All injuries or illnesses will be evaluated to determine if the incident is an OSHA recordable injury or illness and should be entered on the OSHA 300 Log (as required under 29 CFR 1904, "Recording and Reporting Occupational Injuries and Illnesses").

9.3 Accident Notification

The HRD will be contacted immediately following any accident, injury, or environmental release. An investigation will be performed as discussed in Section 9.2 above.

The PM will report all accidents as soon as possible (but not more than 24 hours afterwards) directly to the GDA and the CO/COR. Findings from the investigation, along with appropriate corrective actions, will be submitted to the CO/COR within 2 working days following the accident.

The following require immediate accident notification to the GDA and USACE CO/COR:

1. A fatal injury,
2. A permanent total disability,
3. A permanent partial disability,
4. Hospitalization of three or more people resulting from a single occurrence, and
5. Property damage in excess of $200,000.

Minor first-aid treatments (i.e., self-treat or those not meeting the above criteria) may be reported to the USACE COR/PM via verbal or email communication within 2 working days of the incident.

9.3.1 Medical Support

At least two personnel with first-aid/CPR training will be on-site at all times during hazardous operations if a medical facility or physician is not accessible within 5 minutes of an injury to a group of two or more employees. Procedures to be followed in the event that medical emergency response is required are discussed in Section 10.2.

9.3.2 Condition Follow-up

The contractor will ensure that the employee is fit for duty prior to their return to work. If applicable, a release from a medical professional will be provided prior to the employee returning to work. Lost time will be documented on contractor man-hour reports.

10. PLAN PROGRAMS AND PROCEDURES REQUIRED BY THE SAFETY MANUAL

Based upon anticipated or potential risks of contracted activities, the plans discussed in the following subsections are applicable to this project.

NOTE: *No changes may occur to plans addressed in the APP without plan(s) being reviewed and accepted by the COR or GDA.*

10.1 Layout Plans

Layout plans are included in the OU-8 DU Contaminated Soil and Structures Remedial Design Drawings Package.

10.2 Emergency Response Plans

The following plans will be implemented as necessary in the event of an emergency.

10.2.1 Emergency Response Procedures and Tests

All emergency response plans and procedures will be reviewed at the initial site meeting prior to starting the project. At that time, the site evacuation route, directions on what to do in the case of an emergency, and roles and responsibilities for completing each emergency task (i.e., placing emergency telephone calls or performing CPR, first-aid, or firefighting) will be established. These procedures will be reviewed at the beginning of each work week and reviewed in detail at the beginning of each change in Field Project Engineer or SSHO.

The response sequence will be to remove all personnel from the source of the chemical or physical hazard, assess the severity of the incident, contact appropriate emergency assistance, and swiftly move injured or exposed personnel to a rendezvous point for aid.

The following planning measures will be instituted to facilitate responses to emergency situations:

- The PM, Field Project Engineer, or SSHO will conduct a tailgate safety meeting prior to the start of field work. The APP and SSHP will be made available to all project personnel for review, including applicable subcontractor personnel.

- All project personnel, including applicable subcontractor personnel, will be instructed in the use of all field safety equipment before any field work or field sampling takes place.

- All project personnel, including applicable subcontractor personnel, will be instructed in emergency communication protocols appropriate to the site investigation.

- The PM or Field Project Engineer will verify that all field personnel have fulfilled the project training and medical monitoring requirements, as required.

- The SSHO will check to see that all required safety equipment is at the job site prior to the start of each day’s field activities.

- Emergency contacts and the available local/site resources are described below. The PM or Field Project Engineer will be responsible for verifying availability of these resources prior to start of the field work at the work site and for providing any requested or necessary information related to the field work to these emergency contacts and resources.

The project will implement applicable emergency planning tasks before starting field activities. This includes contacting on-site parties, the facility, and local emergency service providers, as appropriate. To implement emergency planning, the SSHO will:

- Review the facility or area emergency and contingency plans, where applicable.

- Verify that on-site communication equipment (i.e., radios or public address system) is available and functional. If applicable, ensure the required off-site communication equipment (telephone or cell phone) is available and functional.

- Provide an effective means of emergency communication to employees working alone in a remote location or away from other workers. This means of communication will include a cellular phone, two-way radio, or other similar device. The cell phone or two-way radio will be readily available and easily within the immediate reach of employee and will be tested prior to the start of work to verify that it effectively operates in the area/environment. All employees, visitors, and other personnel entering the work site must check in with the Field Project Engineer or SSHO and receive a safety briefing appropriate to the areas of the site they will be entering and the work they will be performing. Personnel leaving the site will check out with the Field Project Engineer or SSHO.

- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital in or near the support zone or inside site vehicles where an exclusion zone is not established. This information and its location will be communicated to on-site personnel.

- Designate one vehicle as the emergency vehicle, place hospital map inside, and keep the keys in the ignition during field activities. Rehearse the emergency response plan before site activities begin, including driving the route to the hospital.

10.2.2 Emergency Notifications

The Field Project Engineer or SSHO is responsible for notifying the PM of any emergency events. The SSHO will ensure personnel are accounted for and response actions are implemented during any local or site-wide emergency. The PM will notify the USACE representative of any emergency event at the project site.

10.2.3 Onsite Incident Response

In case of fires, explosions, or chemical releases, actions to be taken include:

- All personnel will shut down work operations and evacuate the immediate work area;

- The Field Project Engineer will immediately notify appropriate emergency response personnel (phone number can be found in Table 10-1); and

- The Field Project Engineer or SSHO will account for personnel at the designated assembly area(s).

10.2.4 Evacuation

The PM or SSHO will designate evacuation route(s) and assembly area(s) before work begins. Evacuation routes will be reviewed with site personnel during each pre-job briefing.

10.2.5 Notification and Follow Up

The PM will provide a written summary of the incident within 24 hours to the HRD. The written report will detail the event, cause(s), contributing factors, end result, and mitigation in place to prevent recurrence.

10.2.6 Spill Plans

A limited number of chemicals will be brought onsite for use during the RA activities. These materials are expected to include diesel fuel and lubricants for excavation equipment. Material safety data sheets (MSDSs) for these materials will be compiled in a binder and kept onsite at all times.

These chemicals will be brought onsite in small quantities as needed for the project. In the event of a spill, absorbent material will be used to absorb the spilled chemical. The absorbent will be swept up and placed in an appropriate container for disposal. Any contaminated soil will also be placed in the container. The MSDSs will be consulted for disposal requirements. The Field Project Engineer will contact the PM by telephone and verify the disposal requirements prior to disposal.

10.2.7 Firefighting Plans

In the event of a fire, explosion, or chemical release, actions to be taken include:

- All personnel will shut down work operations and evacuate the immediate work area;
- Emergency response personnel will be notified immediately (phone numbers can be found in Table 10-1); and
- The Field Project Engineer and/or SSHO will account for personnel at the designated assembly area(s).

The Field Project Engineer or SSHO will have a fire extinguisher onsite in his vehicle. In addition, the subcontractors will have fire extinguishers onsite in their vehicles and present during equipment fueling activities.

10.2.8 Posting of Emergency Telephone Numbers

The main emergency number is **911.** The Field Project Engineer and SSHO will be instructed to pre-program this number into their cell phones. This emergency number will be included in the daily tailgate safety briefings at least on a weekly basis. Project personnel will also be informed in the event that they accidentally dial 911. Table 10-1 lists emergency contact information. This information will also be posted on the project bulletin board.

10.2.9 Man Overboard/Abandon Ship

This project does not involve floating plan and marine activities; therefore, this plan is not applicable.

10.2.10 Medical Support

10.2.10.1 On-Site

The Field Project Engineer and SSHO will have current CPR and first-aid certifications. The names and cell phone numbers for these personnel will be posted on the project bulletin board. The Field Project Engineer and SSHO may voluntarily provide CPR and/or first-aid, or they may use their professional judgment to determine that the medical situation exceeds their training and ability and immediately call for professional assistance.

10.2.10.2 Off-Site Medical Arrangements

NOTE: ***Call 911 for all medical emergencies requiring immediate attention!***

For emergency and non-emergency medical needs, the nearest hospital is Great River Medical Center. The address and contact information are listed below:

Great River Medical Center
1221 S. Gear Ave.
West Burlington, IA 52655
(319) 768-1000

Directions from IAAAP to the Great River Medical Center are included in Table 10-2. The route to the Great River Medical Center is shown in Figure 10-1.

10.3 Plan for Prevention of Alcohol and Drug Abuse

Persons known or suspected to be under the influence of drugs or alcohol will not be allowed to perform work activities by the PM or Field Project Engineer. The HSO and HRD will immediately be informed. Persons suspect will undergo a drug test, as directed by the HSO or HRD. Persons involved in injuries, near-miss injuries, or damage to equipment may be subject to drug testing at the discretion of the HSO. Failure to comply with a drug test will be cause for immediate termination from the project.

Personnel who appear to be under the influence of over-the-counter drugs or medications (e.g., antihistamines, allergy medication, etc.) that may impair their ability to function while operating equipment or vehicles will be prevented from performing these activities. The Field Project Engineer and/or SSHO will contact the HRD for guidance.

10.4 Site Sanitation Plan

Portable toilets will be provided at the project site. Hand washing facilities will also be made available. This will consist of a hand washing station or wet wipes, hand sanitizer, and paper towels. Prior to breaking for lunch and at the end of the workday, all employees who have handled or been exposed to contaminated soil will be directed to wash with soap and water.

10.4.1 Drinking/Potable Water

A location for drinking clean and cool drinking water will exist at the site. Drinking water may be provided by purchasing water bottles or providing coolers refilled each day with fresh drinking water with disposable cups.

10.4.2 Personal Sanitation

A hand and face washing station will be established with soap, potable water, paper towels or wet wipes, hand sanitizer, and paper towels. Hand sanitizer will be made available near the portable toilets.

10.4.3 Non-Potable Water

Any non-potable water sources on site will be identified with a posted sign that reads "Caution – water unsafe for drinking, washing, or cooking."

10.4.4 Toilets

Chemical toilets will be present at the work site unless employees have a nearby toilet facility that can be easily reached. The toilet will be equipped with toilet paper, light, and adequate ventilation.

10.4.5 Waste Disposal

A trash receptacle will be present outside the work zone for the disposal of hand drying materials, disposable PPE, and other miscellaneous trash where exposure to radiation is not expected.

10.5 Access and Haul Road Plan

All commercial vehicles will travel the main roads while at IAAAP. Haul trucks leaving the project area will be covered and free from debris (i.e., mud or rubble in tires) before traveling to other locations at or near IAAAP. Vehicles and persons driving haul trucks will meet all federal and state DOT requirements, and drivers will possess a Commercial Driver's License before operating such equipment.

10.6 Respiratory Protection Plan

Where airborne radiological contamination is a concern, respiratory protection PPE may be required. This plan includes the following elements:

1. Personnel will review and follow a corporate respiratory protection program.
2. All respirator users must have completed the following duties, which are to be performed within the past 12 months:
   a. Obtained medical clearance to perform duties and don the respirator they will use;
   b. Passed a respirator fit test for the specific make and model of respirator in use (not applicable for hooded power-air purifying respirators); and
   c. Received training for the use, storage, limitations, and care of the specific make and model of respirator in use.

10.6.1 Respiratory Selection

Full-face air purifying respirators with P100 cartridges may be used by site personnel involved in soil sampling activities, as dictated by air monitoring results. At no time will respirators or their components be altered or combined in a manner that is not National Institute of Occupational Safety and Health (NIOSH) approved because this may void the NIOSH respirator approval and significantly affect the performance of the respirator.

10.6.2 Written Respiratory Protection Program

A respiratory protection program for all personnel that use respirators will be established by the contractor and will be in accordance with OSHA's respiratory protection standard (29 CFR 1910.134). The CIH will update the program as regulations change and ensure that respirator users comply with the requirements of the program.

10.6.3 Medical Evaluation

All employees will be medically evaluated during their initial or annual physical exam to ensure they are fit enough to wear the selected respirators. Personnel must obtain a written letter of medical clearance from the examining physician stating that they are fit to wear a respirator or state respirator limitations. The medical evaluation will be supervised and signed by a Board-Certified Occupational Medicine Physician. Personnel will be evaluated annually.

10.7 Health Hazard Control Programs

All operations, materials, and equipment will be evaluated to determine the presence of hazardous environments or if hazardous or toxic agents could be released into the work environment. An AHA has been prepared for each task of field operations. The AHA identifies all substances, agents, and environments that present a hazard and recommended control measures.

Field personnel will receive adequate training specifically related to safe work practices, administrative and engineering controls and PPE to be used, the use and care of PPE, and storage and disposal. The AHAs for this project are presented in Appendix A. Chemical hazard information and PPE are detailed in the SSHP (Appendix B).

The AHAs identify the following:

- Certification of the hazard assessment,
- The workplace and activity evaluated,
- The name of the person certifying that the evaluation has been performed, and
- The date of the evaluation.

The following methods will be used to control hazards that are identified in the work place:

- Substitution, if the substitute process or product is determined to provide the same outcome and to present less of a hazard;
- Engineering controls (i.e., local/general ventilation) to limit exposure to hazardous or toxic agents and environments within acceptable limits;
- Work practice controls, when engineering controls are not feasible or are not sufficient to limit exposure to hazardous or toxic agents and environments within acceptable limits; and
- Appropriate PPE (i.e., respirators, gloves, etc.) and associated programs will be used when engineering, work practice controls, or material substitution are not feasible or are not sufficient to limit exposure to hazardous or toxic agents.

Operations, materials, and equipment involving potential exposure to hazardous or toxic agents or environments will be evaluated by a qualified industrial hygienist, or other competent person, to formulate a hazard control program. This program will be submitted to the GDA for review and approval before the start of operations.

10.8 Hazard Communication Plan

The OSHA hazard communication standard is composed of the following five key elements:

1. Written Hazard Communication Plan,
2. Inventory of hazardous materials,
3. MSDSs,
4. Container labeling and other forms of warning, and
5. Employee training.

This section summarizes a Hazard Communication Plan.

10.8.1 Written Hazard Communication Plan

A Hazard Communication Plan is written to ensure that personnel working onsite are aware of the hazards associated with chemicals and other substances used in the work place or on a project site. The Hazard Communication Plan will apply to all full-time, part-time, and temporary duty employees, and the employment agency hired and supervised at the project site. The Hazard Communication Plan also applies to subcontractors and associates on projects.

The SSHO is responsible for ensuring that all personnel receive training in the written Hazard Communication Plan and are provided access to required information on materials covered by the program. Employees will be made aware of the hazardous materials on the project site and how to handle and dispose of these materials.

The SSHO will be responsible for maintaining a copy of the written Hazard Communication Plan and all the required elements (e.g., hazardous material inventory and MSDS copies) in the project field office.

10.8.2 Hazardous Materials Inventory

Hazardous chemicals that will be included in the inventory and for which MSDSs will be maintained are those materials included in any of the following:

- Toxic and hazardous substances identified in 29 CFR 1910, Subpart Z;
- Threshold limit values and biological exposure indices, as identified in the American Conference of Governmental Industrial Hygienist (ACGIH), current edition; and
- Carcinogens identified by the National Toxicology Program, International Agency for Research on Cancer, National Institute for Occupational Safety and Health, or 29 CFR 1910, Subpart Z.

Only hazardous chemicals used by employees or subcontractors are included in the program. Other hazardous materials that might be present at the site include materials brought to the site by other contractors or subcontractors. These hazardous materials may include solids, liquids, compressed gases, raw materials to be welded, or other materials listed or identified as a hazardous materials under the definition above. Contractor employees working in areas where subcontractors are using or storing hazardous materials need to be informed of hazards and protective measures, as outlined in the training section (Section 7) of this APP.

Materials that are not subject to this program include:

- Hazardous waste;
- Tobacco/tobacco products;
- Wood/wood products;
- Articles;
- Retail food, drugs, cosmetics, alcoholic beverages packaged for sale to consumers; and
- Foods, drugs, or cosmetics intended for personal use by employees at work.

10.8.3 Operations

The SSHO is responsible for maintaining an inventory of all hazardous chemicals for the project site. This list will be maintained at the site and will include all hazardous chemicals to which personnel are potentially exposed. The inventory will be developed based on chemicals known to be present at the project site and hazardous chemicals introduced by the contractor or subcontractors. The inventory will be updated to include new hazardous materials that are brought to the site and additional hazardous chemicals that are identified as site activities change. The SSHO will maintain a copy of the hazardous material inventory in the project field office and make it available to project employees, customer representatives, and agency personnel during normal working hours.

10.8.4 Subcontractors

Each contractor will provide to the Field Project Engineer a copy of their hazardous chemical inventory and a complete set of MSDSs for all chemicals designated as a hazardous chemical prior to bringing hazardous chemicals to the project site. The Field Project Engineer will maintain copies of the subcontractor hazardous material inventories and MSDSs for materials in use at the project site in the project field office and make these available to project employees, customer representatives, and agency personnel during normal working hours.

10.8.5 Material Safety Data Sheets

The SSHO will ensure that a current, complete MSDS is maintained at the project field office for each hazardous chemical on the hazardous materials inventory.

Subcontractors will review the MSDS for each hazardous chemical on their inventory to ensure all are current and complete. Copies of subcontractor MSDSs for materials in use at the project site will be provided to the Field Project Engineer and maintained in the project field office.

10.8.6 Container Labeling and Other Forms of Warning

All hazardous materials in use at project sites will be labeled with the following information:

- Name of the material (must match that on the MSDS);
- Name and address of the material manufacturer, supplier, or distributor; and
- Appropriate hazard warnings, including target-organ information.

Any specialized labeling systems used by subcontractors will be explained in writing to the SSHO. A copy of the explanation will also be forwarded to all other subcontractors at the site and included in site-specific training that is provided to employees.

10.8.7 Secondary Containers

Should it be necessary to dispense hazardous chemicals from a labeled bulk container into a smaller secondary container, the secondary container will be labeled with the same information as is required above. Corrosives or other liquids that will degrade the labels and make them unreadable will be labeled with a tag, placard, label in a sheet protector, or other method that will protect the label from the effects of the material.

10.8.8 Site-Specific Hazard Communication Training and Orientation

All personnel whose work involves use of hazardous materials included in this program will receive training prior to working with hazardous materials and at intervals necessary to ensure employees have received the required training prior to working with any new materials. Training will be provided and consist of the following:

- Explanation of the regulatory requirements for this procedure and where to obtain and review these regulations.
- Review of the contents of this procedure, its location(s), and availability.
- Review of the hazardous chemical inventory for the work area, including where specific chemicals are used and why they are hazardous. This will include a review of the MSDS for each chemical and training on the health hazards and properties for each category (e.g., acids, flammable liquids, irritants, etc.) of chemicals that employees may be exposed to.
- Explanation of how to use an MSDS and where the MSDSs for chemicals in their work area can be found.
- Explanation of any special labeling systems in use for identifying hazardous materials and communicating hazard information.
- Information about hazardous chemicals in use or being stored at the project site by other contractors, as appropriate.
- General emergency procedures to be followed in the event of a fire, spill, or other incident resulting in release of a hazardous chemical.

Personnel assigned to work at the project site will receive site-specific hazard communication training consisting of a review of this procedure to ensure that employees are aware of the hazards posed by possible contaminants at the project site and the mechanisms that will be used for information exchange between contractors. Additional job-specific training consisting of a review of the Hazard Communication Program may be provided by subcontractors to supplement this training.

10.9 Process Safety Management Plan

The activities to be performed under this project are not subject to regulation under the OSHA process safety management regulations; therefore, this plan is not applicable.

10.10 Lead Compliance Plan

The project does not include lead abatement; therefore, this plan is not applicable.

10.11 Asbestos Abatement Plan

This project does not include asbestos abatement; therefore, this plan is not applicable.

10.12 Radiation Safety Program

Low levels of radiation are expected at the site. A Radiation Safety Plan will be provided by the radiation contractor (to be determined). The Plan will adhere to EPA Regional Radiation Protection Programs for Region 7, *The Army Radiation Safety Program* (Department of the Army, 2011), and EM-385-1-80, *USACE Radiation Protection Manual* (USACE, 1997). The Plan will include information regarding dose limits and individual monitoring, site monitoring, instrumentation, entry control, posting and labeling, radiation safety training, “as low as reasonably achievable” design and work control, contamination control, radioactive sources (for instrument calibration), and emergency exposure situations or abnormal events. The plan is included as Addendum 1 to this APP.

10.13 Abrasive Blasting Plan

The toxicity of the blasting media and material being removed must be determined prior to abrasive blasting. Silica sand may not be used as a blasting media. Employees associated with performing the abrasive blasting must be medically cleared.

Outdoor blasters will be protected in a manner equivalent to the ventilation requirements of 29 CFR 1910.94 (a)(5) or per the requirements of Section 5 of USACE EM 385-1-1.

Outdoor blasting may not occur without an applicable AHA included in Appendix A. Prudent care will be taken to prevent the dust cloud from spreading to other work areas. Local and state requirements should be checked and listed in the AHA.

Hearing and respiratory protection will be available to all other employees in the area if their presence is required.

10.14 Heat/Cold Stress Plan

The field season is set to begin in the spring and continue into the fall. A heat and cold stress plan are contained in the SSHP (Appendix B).

10.15 Crystalline Silica Monitoring Plan

The project does not include activities that are subject to crystalline silica exposure or required monitoring; therefore, this plan is not applicable.

10.16 Night Operations Lighting Plan

The project does not include night operations; therefore, this plan is not applicable.

10.17 Fire Prevention Plan

Potential fire hazards or ignition sources for this project include:

- Electrical storms,
- Smoking,
- Hot vehicle engines and exhausts igniting dried grasses, and
- Sparks from cutting or welding operations.

It is the responsibility of each person at IAAAP to report all fires immediately regardless of size or extent of damage. All fires must be investigated to prevent recurrence.

In the case of a fire, remain calm and respect the established lines of authority. Report all site fires to the SSHO, who will then determine the need to evacuate a portion of the site. Site personnel in the impacted area will be directed through the use of signals or verbal instructions to leave the area and reassemble at the designated safe refuge location. The SSHO will account for all personnel at the work site and notify the Field Project Engineer.

Prior to the start of the project, all personnel will review the points of contact list (which will be posted within the project area), the location of the designated assembly areas, and the location of and directions to the nearest hospital.

All personnel will review the locations of the fire extinguishers and will be competent in fire extinguisher use. Fire extinguishers rated 20-A:B:C will be located in all on-site vehicles and on-site work trailers.

Emergency phone numbers and the directions to the hospital will be maintained in the Field Project Engineer vehicle.

Potential fire hazards will be identified and handling of combustible materials will be addressed during the initial site training and reviewed during tailgate training meetings on a routine basis. In the event of a fire, the Field Project Engineer will notify Emergency Services and the PM. The Field Project Engineer will meet the emergency vehicles at the project gate and escort the response personnel to the location of the fire/explosion.

The SSHO will evaluate the extent of the fire, coordinate and manage fire suppression efforts until the fire department arrives, use available on-site fire extinguishers for incipient stage fires only, and provide emergency first aid as needed. The following guidelines will be followed by the Field Project Engineer and SSHO when attempting to control an incipient stage fire:

- Attack the fires using available fire extinguishers (only if this can be performed safely),
- Try to extinguish the fire only after calling for help from IAAAP Emergency Services or 911,
- Never try to extinguish a fire if hazardous materials are stored in the area,
- Ensure all site personnel evacuate the site and meet at a designated, safe location,
- Never endanger your own life,
- Remove any combustible material whenever possible from the vicinity of the fire, and
- Remove any equipment that can be safely moved.

Fire extinguisher types (classes) include:

- Class A - Used on materials such as wood, paper, rubber, or cloth;
- Class B - For use on flammable liquids, gases, and grease;
- Class C - For use on energized electrical fires; and
- Class D - For use on combustible metals.

The fire chief or senior fire protection representative at the scene of the fire is in complete charge of all firefighting and rescue operations. No one outside the fire protection organization will give orders concerning firefighting activities or interfere with the fire chief or firefighters.

To minimize the potential for fires, there will be no smoking around potential fire sources or when there is a fire alert posted. Smoking onsite will be limited to designated and posted smoking areas at a distance of at least 50 feet (15.2 meters) from the work area where extinguished cigarettes will be placed in a contained ashtray. No smoking materials will be thrown on the ground. Vehicles must park on the road, on a gravel/dirt surface lot surface, or a designated parking area. No vehicles will be parked over high grass or weeds.

10.18 Wild Land Fire Management Plan

The requirements for a Wild Land Fire Management Plan are contained in Section 09.K of EM 385-1-1. These requirements apply to activities in areas with potential exposure to wild land fire, whether prescribed or planned.

No fires will be intentionally started for the clearing of debris, land, or for another purpose as part of this project. In the event that fires are accidentally set by equipment, personnel, or acts of nature, project personnel will respond to incipient stage fires that can be controlled through the use of a fire extinguisher. The IAAAP Fire Department will be notified immediately of all fires regardless of size or extent of damage.

10.19 Hazardous Energy Control Plan

Electrical equipment, tools, and frayed/damaged extension cords may pose a shock or electrocution hazard to personnel. Only authorized qualified electricians will be allowed to install, modify, or work on electrical systems. This includes installation of a temporary electrical supply or modification of permanent electrical supply equipment. Working under or near power lines is not expected to occur during this project.

The following precautions will be observed:

- Prior to use, all electrical equipment, power tools, and extension cords will be inspected for damage. Damaged or defective electrical equipment will be removed from service immediately.
- All power tools must be double insulated, Underwriters Laboratory approved, or use a ground fault circuit interrupter.
- All electrical wiring or systems will be considered energized unless under the protection of lockout/tagout, as performed by the owner.

Extension cords must have a third wire ground and be protected from damage when passing through work areas.

During mobilization and prior to any activities that involve ground penetration, the contractor will coordinate with the local utilities protection agency to obtain utility clearances. The utilities protection agency will locate lines based on Directorate of Public Works information. It is assumed that the Directorate of Public Works, or a designated Army Ordnance representative, will accept responsibility for the accuracy of information provided regarding utility locations.

10.20 Critical Lift Plan

A crane or lift truck capable of lifting 35 tons may be used to move waste containers filled with soil from trucks to rail cars. However, these lifts do not fall within the criteria of a critical lift (as defined by Section 16.H of EM 385-1-1); therefore, no critical lift plan is required. All other Section 16.H or EM 385-1-1 requirements, as well as 29 CFR 1926 requirements applicable to cranes, hoists, and operator qualifications, will be complied with.

10.21 Contingency Plan for Severe Weather

A contingency plan for severe weather is contained in the SSHP (Appendix B).

10.22 Float Plan

This project does not include any floating plant and marine activities; therefore, this plan is not applicable.

10.23 Site-Specific Fall Protection and Prevention Plan

The Work Plan (USACE, 2013) does not include work performed at heights above 6 feet (1.8 meters) or in areas where workers are exposed to fall hazards; therefore, this plan is not applicable. If project activities require fall protection, all activities will be conducted in accordance with the contractor's fall protection procedures.

10.24 Demolition Plan

No demolition is scheduled for this project.

10.25 Excavation/Trenching Plan

The requirements for an Excavation/Trenching Plan are contained in Section 25.A.01 of EM 385-1-1. These requirements apply to excavations and trenches more than 5 feet (1.5 meters) in depth. The following information is included in the event that a contract modification is issued calling for deeper excavations:

- When depths reach 5 feet (1.5 meters) or more below ground surface, an excavation AHA will be developed, approved, and reviewed with affected workers before proceeding any further. An excavation competent person will be on site to inspect the excavation, the adjacent areas, and protective systems daily, as needed throughout the work shifts and after every rainstorm or other hazard-increasing occurrence.

- Excavations less than 5 feet (1.5 meters) in depth, and which a competent person examines and determines there to be no potential for cave-in, do not require protective systems unless a recognized potential hazard warrants them.

- Utility companies and other responsible authorities will be contacted to locate and mark utility locations prior to excavation activities. If utilities are located in the area of excavation, then the utility shut-off locations will be identified and used to de-energize utilities that may be damaged during excavation.

- No overhead utility lines, nearby trees, or man-made facilities will be affected by excavation activities.

- Traffic will be controlled into and out of the work area by the Field Project Engineer or SSHO. Only authorized personnel, vehicles, and heavy equipment may enter the area.

- A utility clearance and a digging permit will be obtained from Army Ordnance personnel or other authority having jurisdiction over excavations.

- If an unexploded munition or ordnance is discovered, then personnel will not disturb it. Stop work and contact the base to send qualified explosive ordnance disposal personnel to remove it.

- The need for cofferdams is not anticipated for this project.

10.26 Emergency Rescue (Tunneling)

This project does not include any underground construction work; therefore, this plan is not applicable.

10.27 Underground Construction Fire Prevention and Protection Plan

This project does not include any underground construction work; therefore, this plan is not applicable.

10.28 Compressed Air Plan

This project does not include any underground construction work; therefore, this plan is not applicable.

10.29 Formwork and Shoring Erection and Removal Plans

This project does not include any formwork or shoring operations; therefore, this plan is not applicable.

10.30 Pre-Cast Concrete Plan

This project does not include any lifting of pre-cast concrete members; therefore, this plan is not applicable.

10.31 Lift Slab Plans

This project does not include any jacking operations; therefore, this plan is not applicable.

10.32 Steel Erection Plan

The requirements for a Steel Erection Plan are contained in Section 27.F.01 of EM 385-1-1. These requirements apply to the erection of any structural steel. If it is determined that a steel weather enclosure be erected, a Steel Erection Plan will be developed during the Pre-Construction Planning and Procurement Phase.

10.33 Site Safety and Health Plan for Hazardous, Toxic and Radioactive Work

The requirements for an SSHP are contained in Section 30.A.13 of EM 385-1-1. The SSHP for this project is contained as Appendix B.

10.34 Munitions and Explosives of Concern (MEC) Encountered During Site Activities

If munitions and explosives of concern (MEC), including unexploded ordnances (UXO), are encountered on the project site, the site will be upgraded to a potential munitions response site as per EM 385-1-1 and work shall proceed in accordance with the requirements of EM-385-1-97. Addendum 2 contains an MEC Construction Support Safety Plan.

10.35 Blasting Safety Plan

This project does not include any blasting activities; therefore, this plan is not applicable.

10.36 Diving Plan

This project does not include any diving operations; therefore, this plan is not applicable.

10.37 Confined Space Program

A confined space is defined as a space that has **all** of the following characteristics:

- Large enough to allow personnel to enter the space with their entire body,
- Limited openings for entry and exit, and

- Not designed for continuous human occupancy.

This project does not include confined space entry; therefore, this plan is not applicable.

10.38 Risk Management Processes

The objective of the hazard assessment section is to identify hazards present during each phase of work and provide guidance to eliminate or mitigate these hazards. The primary activities and the associated hazards are identified in applicable AHAs (Appendix A) and the SSHP (Appendix B). Where hazards are identified that are not addressed in the APP, SSHP, or a current AHA, a revision to a current AHA or creation of new AHA may occur. The revised or newly created AHA must be briefed to affected workers prior to commencing work on that task.

11. REFERENCES

29 CFR 1904, *Code of Federal Regulations*, Title 29, "Labor," Part 1904, "Recording and Reporting Occupational Injuries and Illnesses," Office of the Federal Register.

29 CFR 1910, *Code of Federal Regulations*, Title 29, "Labor," Part 1910, "Occupational Safety and Health Standards," Office of the Federal Register.

29 CFR 1926, *Code of Federal Regulations*, Title 29, Part 1926, "Occupational Safety and Health Standards for the Construction Industry," Office of the Federal Register.

40 CFR 300, 2000, *Code of Federal Regulations*, Title 40, "Protection of Environment," Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Office of the Federal Register.

42 USC § 9601 et seq., December 11, 1980, *United States Code*, "Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA/Superfund)."

Department of the Army, 2011. *The Army Radiation Safety Program.* Pamphlet 385-24. September 2011.

EM 385-1-1, "Safety and Health Requirements Manual," United States Army Corps of Engineers, Engineering Manual, September 15, 2008.

EM-385-1-80, "Radiation Protection Manual, "United States Army Corps of Engineers, Engineering Manual, May 30, 1997.

EPA, 2006. *Federal Facility Agreement under CERCLA Section 120 in the Matter of the U.S. Army Corps of Engineers Iowa Army Ammunition Plant*, Administrative Docket Number: CERCLA-07-2005-0378, U.S. Environmental Protection Agency Region VII and the State of Iowa and United States Army Corps of Engineers, 2006.

USACE, 2011. *FUSRAP Record of Decision for the Iowa Army Ammunition Plant, Middletown, Iowa, Final*, September 2011.

USACE, 2013. "Remedial Design/Remedial Action Work Plan, Iowa Army Ammunition Plant, Operable Unit 8, Depleted Uranium Contaminated Soil and Structure Remediation, Middletown, Iowa (DRAFT FINAL)," Revision 0, February 2013.

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12. FIGURES

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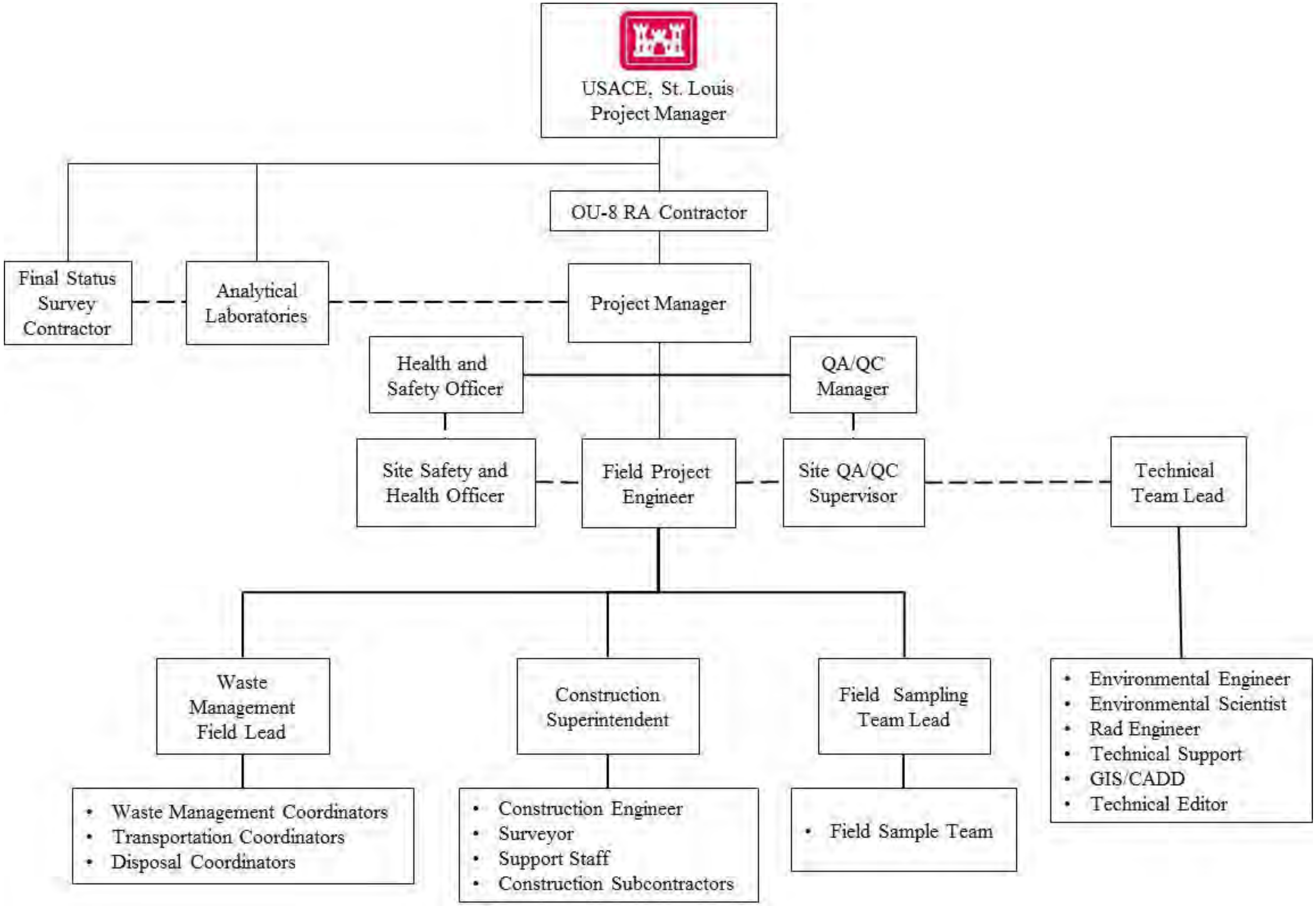

Figure 5-1. Project organization chart.

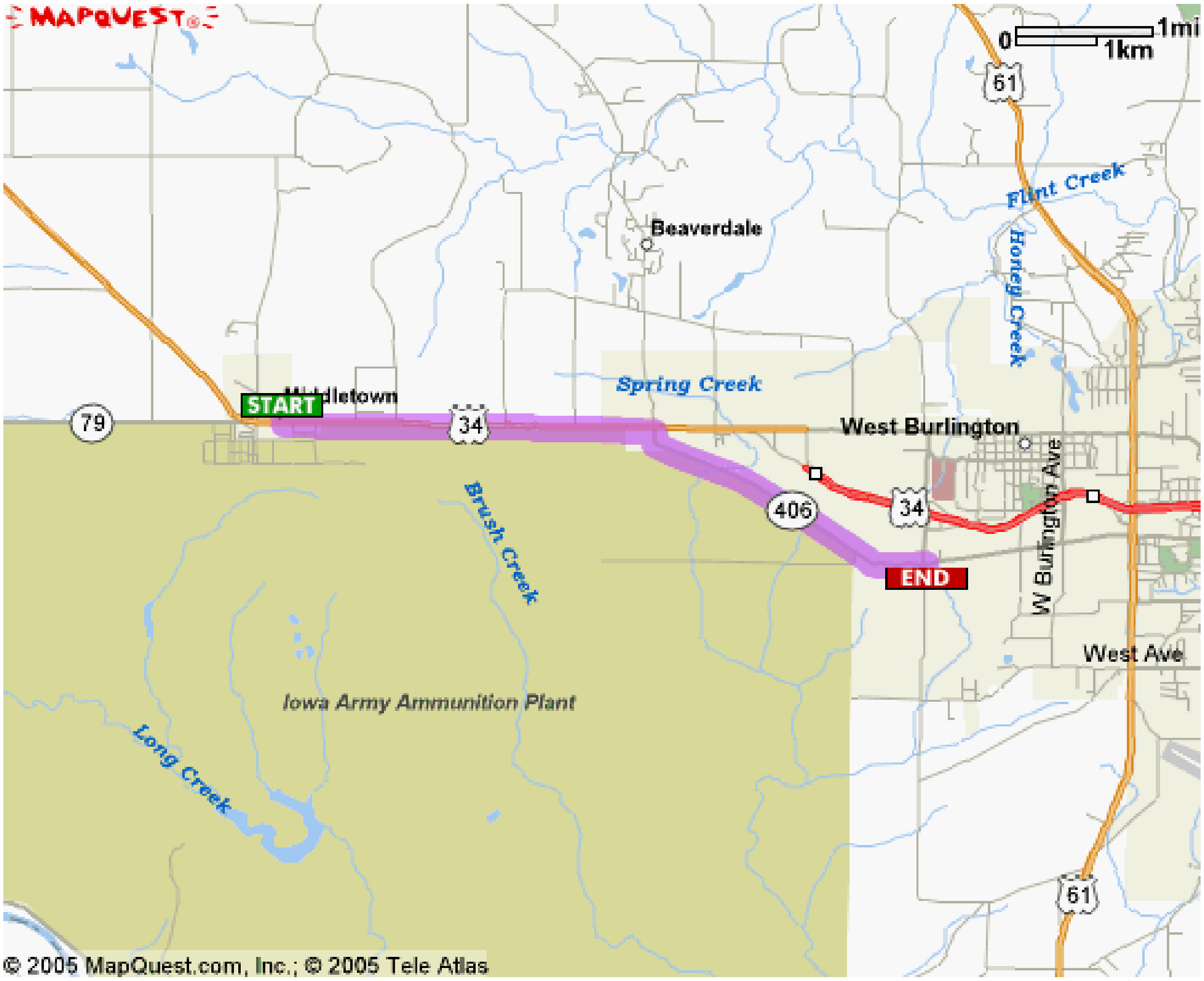

Figure 10-1. Route from IAAAP to Great River Medical Center.

Directions to Great River Medical Center from IAAAP:

1. Start out going North on Texas Ave. toward US_34.
2. Turn right onto US-34 E.
3. Turn right onto IA-406.
4. Turn right onto S. Gear Ave.
5. End at 1221 S. Gear Ave., West Burlington, IA 52655.

13. TABLES

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Table 4-1 Health and safety metrics (example).

Hours Worked	Total Recordable Injuries	Total Recordable Illnesses	Recordable Injury Incidence Rate	Total Lost Time Injuries	Lost Time Injuries Incidence Rate	Days Away, Restricted or Transferred	Current EMR
			EXAMPLE				

Table 6-1. List of subcontractors.

Subcontractor	Contact Information
Radiological Services	To be determined
Soil Sorting System	To be determined
Excavation Services	To be determined
Shipping and Disposal	To be determined
Transportation	To be determined
Site Restoration	To be determined

Table 7-1. Required site-specific training for project personnel.

Training	Field Project Engineer and SSHO	Field Personnel	Radiation Safety Officer	Visitors
40-hr hazardous waste operations and emergency response (HAZWOPER) with 8-hr current refresher training	X	X	X	
24-hr HAZWOPER with 8-hr current refresher training[1]				
APP/SSHP Training, to include review of: • Review of AHAs • Site Safety and Health Plan • Radiation Hazards • Emergency Response and Accident Reporting • Medical Surveillance Requirements for basic HAZWOPER worker • Decontamination procedures • Spill response and containment	X	X	X	Briefing on site hazards, controls, and emergency actions
Hazard Communications	X	X	X	
CPR/First-Aid[2]	X	R	R	
PPE Training	X	X	X	
Respirator Training (with fit test and medical evaluation), if applicable	A	A	X (on site)	

X = Training required.
A = Required only if action levels are exceeded. Includes training, medical exam, and fit test for air purifying respirator as needed based on hazards (29 CFR 1910.134).
R = Recommended

1 = Applies only to brief and infrequent site work. If a person spends more than 2 hours per week at work site, then 40-hour HAZWOPER is required.
2 = A minimum of two people in the field will be first-aid/CPR certified.

Table 10-1. Emergency contact information.

Contact	Phone Number
Emergency – Ambulance and Fire	911
Great River Medical Center	Great River Medical Center 1221 S Gear Ave. West Burlington, IA 52655-1679 (319) 768-1000 Call 911 for an ambulatory emergency
Poison Control Center	800-222-1222
EPA Superfund Hotline	800-424-9346
EPA National Response Center (to report releases to the environment in excess of a reportable quantity)	800-424-8802

Table 10-2. Directions from IAAAP to Great River Medical Center.

START	**1:**	Start out going NORTH on TEXAS AVE toward US-34.	<0.1 miles
EAST 34	**2:**	Turn RIGHT onto US-34 E.	2.6 miles
	3:	Turn RIGHT onto IA-406.	2.2 miles
	4:	Turn RIGHT onto S GEAR AVE.	<0.1 miles
END	**5:**	End at 1221 S Gear Ave West Burlington, IA 52655-1679, US	
		Total Est. Time: 8 minutes; **Total Est. Distance:** 5.09 miles	

Note: These directions came from MapQuest.

Appendix A

Activity Hazard Analysis (AHA) Forms

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<table>
<tr><td>Activity/Work Task:
Mobilization and Demobilization</td><td colspan="6" align="right">Highest Risk Assessment Code (RAC) from AHA:</td><td>M</td></tr>
<tr><td>Project Location: IAAAP, OU-8</td><td colspan="7" align="center">Risk Assessment Code (RAC) Matrix</td></tr>
<tr><td>Contract Number: W912P9-12-D-0510</td><td rowspan="2">Severity</td><td colspan="6" align="center">Probability</td></tr>
<tr><td>Date Prepared: August 2012</td><td>Frequent</td><td>Likely</td><td colspan="2">Occasional</td><td>Seldom</td><td>Unlikely</td></tr>
<tr><td>Prepared by:</td><td>Catastrophic</td><td>E</td><td>E</td><td colspan="2">H</td><td>H</td><td>M</td></tr>
<tr><td>Reviewed by:</td><td>Critical</td><td>E</td><td>H</td><td colspan="2">H</td><td>M</td><td>L</td></tr>
<tr><td rowspan="6">Notes: (Field notes, Review Comments, etc.)

Personal Protective Equipment (PPE) will be level D and consist of:
Hard hats (ANSI Z89.1)
Safety Glasses (ANSI Z87.1)
High visibility vests
Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
Gloves: Leather for general use or as appropriate to exposed hazards
Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions</td><td>Marginal</td><td>H</td><td>M</td><td colspan="2">M</td><td>L</td><td>L</td></tr>
<tr><td>Negligible</td><td>M</td><td>L</td><td colspan="2">L</td><td>L</td><td>L</td></tr>
<tr><td colspan="7"><u>Step 1</u>: Review each “hazard” with identify safety “controls” and determine RAC value as shone above</td></tr>
<tr><td colspan="4">“Probability” is the likelihood to cause an incident, near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.</td><td colspan="3" align="center">RAC Chart</td></tr>
<tr><td colspan="4" rowspan="2">“Severity” is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.</td><td colspan="3">E = Extremely High Risk</td></tr>
<tr><td colspan="3">H = High Risk</td></tr>
</table>

<table>
<tr><td></td><td colspan="4" rowspan="2"><u>Step 2</u>: Identify the RAC as E, H, M, or L for each “Hazard” on the AHA. Annotate the overall highest RAC at the top of this AHA.</td><td>M = Moderate Risk</td></tr>
<tr><td></td><td>L = Low Risk</td></tr>
</table>

Job Steps	Hazards	Controls	RAC
1) General Site Conditions *(applicable to site preparation, general site conditions, and site cleanup activities)*	1A) Struck by Objects or Equipment	1A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots.	1A = M
	1B) Back strain	1B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person’s body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1B = L
	1C) Cuts, abrasions, lacerations	1C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1C = L
	1D) Slips trips falls	1D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1D = M
	1E) Contact with insects and animals	1E) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist.	1E = L

	1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the Contractor PM, who will contact the USACE PM for guidance.	1F = M 1G = M 1H = L
2) Staging Areas and Clearing Vegetation	2A) Struck by Objects or Equipment 2B) Back strain 2C) Cuts, abrasions, lacerations 2D) Slips trips falls 2E) Heat or Cold Stress 2F) Dust 2G) Noise	2A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots. 2B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person's body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs. 2C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use. 2D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread. 2E) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS or SSHO where concerns exist. Have fluids available for drinking. 2F) Heavy equipment operators will work inside enclosed cabs where possible and nearby workers should avoid working directly in any visible dust created by the activity. Dust suppression by wetting from water hoses or water truck may be directed by the SSHO. Contact the SS and SSHO where concerns exist. 2G) Workers will don directed level of hearing protection warranted for noisy conditions. Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. The SS and/or SSHO will post areas where high noise conditions exist requiring the use of plugs or muffs. Double hearing protection will be required by workers where noise levels exceed 103 dBA.	2A = M 2B = L 2C = M 2D = L 2E = M 2F = M 2G = M

Equipment to be Used	**Training Requirements and Competent or Qualified Personnel Names**	**Inspection Requirements**
Hand and power tools, cars/trucks heavy equipment	Heavy equipment operator	User to inspect equipment prior to use. Operator shall daily inspect equipment prior to use during periods of work.

Activity/Work Task: **Clearing Vegetation**	***Highest Risk Assessment Code (RAC) from AHA:*** **M**
Project Location: **IAAAP, OU-8**	**Risk Assessment Code (RAC) Matrix**
Contract Number: **W912P9-12-D-0510**	
Date Prepared: **August 2012**	
Prepared by:	
Reviewed by:	

Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "hazard" with identify safety "controls" and determine RAC value as shone above

"**Probability**" is the likelihood to cause an incident, near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.

"**Severity**" is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.

Step 2: Identify the RAC as E, H, M, or L for each "Hazard" on the AHA. Annotate the overall highest RAC at the top of this AHA.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Notes: (Field notes, Review Comments, etc.)

Personal Protective Equipment (PPE) will be **level D** and consist of:

- Hard hats (ANSI Z89.1)
- Safety Glasses (ANSI Z87.1)
- Face shield with safety glasses for trimmer operations
- High visibility vests
- Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
- Gloves: *Leather for general use or as appropriate to exposed hazards*
- Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions

Job Steps	Hazards	Controls	RAC
1) General Site Conditions *(applicable to site preparation, general site conditions, and site cleanup activities)*	1A) Struck by Objects or Equipment	1A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots.	1A = M
	1B) Back strain	1B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person's body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1B = L
	1C) Cuts, abrasions, lacerations	1C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1C = L
	1D) Slips trips falls	1D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1D = M
	1E) Contact with insects and animals	1E) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist.	1E = L

	1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the Contractor PM, who will contact the USACE PM for guidance.	1F = M 1G = M 1H = L
2) Clearing Vegetation	*See General Site Conditions hazard section* 2A) Tree felling – falling on to nearby • Potential problems that may occur when the tree falls (such as splintering or spring back of trees); • The shape of the tree, the lean of the tree, and the decayed or weak spots; • Wind force and direction; • Potential electrical hazards (e.g., overhead power lines); and • Other obstructions such as curb stops, meter pits, sewer clean outs, and gas lines. 2B) Clearing brush with weed trimmer or mower. • Eye hazards from flying debris • Cuts/lacerations to skin 2C) Noise – Hearing loss; distractions	*See General Site Conditions controls section* 2A) Heavy equipment will be used to push trees over wherever possible. All on site workers will be instructed where to stand at safe distances during pushing of trees. A safe tree fall radius is at least twice the height of the tree unless unique circumstances determine otherwise. 2B) Be familiar with proper operation instructions; Inspect trimmer or mower prior to use • Trimmer: Level D PPE plus safety glasses with either safety glasses and face shield 2C) Workers will don directed level of hearing protection warranted for noisy conditions. Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. Double hearing protection will be required by workers where noise levels exceed 103 dBA.	 2A = M 2B = M 2C = M

Equipment to be Used	**Training Requirements and Competent or Qualified Personnel Names**	**Inspection Requirements**
Hand and power tools heavy equipment	Heavy equipment operator and laborers	User to inspect equipment prior to use. Operator shall daily inspect equipment prior to use during periods of work.

Activity/Work Task:
Radiological Surveying

Project Location: **IAAAP, OU-8**

Contract Number: **W912P9-12-D-0510**

Date Prepared: **August 2012**

Prepared by:

Reviewed by:

Notes: (Field notes, Review Comments, etc.)

Personal Protective Equipment (PPE) will be **level D** and consist of:

- Hard hats (ANSI Z89.1)
- Safety Glasses (ANSI Z87.1)
- High visibility vests
- Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
- Gloves: *Leather for general use or as appropriate to exposed hazards*
- Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions

Highest Risk Assessment Code (RAC) from AHA: **M**

Risk Assessment Code (RAC) Matrix

Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

<u>*Step 1*</u>: Review each “hazard” with identify safety “controls” and determine RAC value as shone above

“**Probability**” is the likelihood to cause an incident, near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.

“**Severity**” is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.

<u>*Step 2*</u>: Identify the RAC as E, H, M, or L for each “Hazard” on the AHA. Annotate the overall highest RAC at the top of this AHA.

RAC Chart
E = Extremely High Risk
H = High Risk
M = Moderate Risk
L = Low Risk

Job Steps	**Hazards**	**Controls**	**RAC**
1) General Site Conditions *(applicable to site preparation, general site conditions, and site cleanup activities)*	1A) Struck by Objects or Equipment	1A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots.	1A = M
	1B) Back strain	1B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person’s body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1B = L
	1C) Cuts, abrasions, lacerations	1C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1C = L
	1D) Slips trips falls	1D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1D = M
	1E) Contact with insects and animals	1E) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist.	1E = L

	1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the Contractor PM, who will contact the USACE PM for guidance.	1F = M 1G = M 1H = L
2) Soil surveying for depleted uranium (DU) contamination with handheld detectors	*See General Site Conditions hazard section* 2A) Inhalation or ingestion of DU contaminated soils 2B) Improperly calibrated detector can lead to a false negative or positive reading	*See General Site Conditions controls section* 2A) Avoid dust dispersion activities; avoid skin contact and ingestion; Survey hands, feet, and equipment within and prior to entering and exiting controlled work areas; adhere to instruction of radiological engineer/technician 2B) Ensure handheld detector is properly calibrated by radiological engineer or technician	2A = L 2B = L
3) Manual collection of soil samples to compare with radiological detector results	*See General Site Conditions hazard section* 3A) Inhalation or ingestion of DU contaminated soils	*See General Site Conditions controls section* 3A) Avoid dust dispersion activities; avoid skin contact and ingestion; Survey hands, feet, and equipment within and prior to entering and exiting controlled work areas; adhere to instruction of radiological engineer/technician	3A = L
4) Survey contaminated structures for contamination • Surface wipes • Handheld radiological detectors	*See General Site Conditions hazard section* 4A) Inhalation or ingestion of DU contaminated soils 4B) Improperly calibrated detector can lead to a false negative or positive reading	*See General Site Conditions controls section* 4A) Avoid dust dispersion activities; avoid skin contact and ingestion; Survey hands, feet, and equipment within and prior to entering and exiting controlled work areas; adhere to instruction of radiological engineer/technician 4B) Ensure handheld detector is properly calibrated by radiological engineer or technician	4A = L 4B = L
5) Post-remedial surveys	*See General Site Conditions hazard section* 5A) Inhalation or ingestion of DU contaminated soils 5B) Improperly calibrated detector can lead to a false negative or positive reading	*See General Site Conditions controls section* 5A) Avoid dust dispersion activities; avoid skin contact and ingestion; Survey hands, feet, and equipment within and prior to entering and exiting controlled work areas; adhere to instruction of radiological engineer/technician 5B) Ensure handheld detector is properly calibrated by radiological engineer or technician	5A = L 5B = L

Equipment to be Used	**Training Requirements and Competent or Qualified Personnel Names**	**Inspection Requirements**
Radiological Survey Equipment	Qualified Radiation Engineer or Technician Understanding of Radiological Procedures	Source Check Radiological Equipment

Activity/Work Task: **Soil Removal and Segregation**	***Highest Risk Assessment Code (RAC) from AHA:***					**M**
Project Location: **IAAAP, OU-8**	**Risk Assessment Code (RAC) Matrix**					
Contract Number: **W912P9-12-D-0510**	**Severity**	**Probability**				
Date Prepared: **August 2012**		Frequent	Likely	Occasional	Seldom	Unlikely
Prepared by:	Catastrophic	E	E	H	H	M
Reviewed by:	Critical	E	H	H	M	L
Notes: (Field notes, Review Comments, etc.)	Marginal	H	M	M	L	L
	Negligible	M	L	L	L	L

Step 1: Review each "hazard" with identify safety "controls" and determine RAC value as shone above

"**Probability**" is the likelihood to cause an incident, near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.	**RAC Chart**
"**Severity**" is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.	E = Extremely High Risk H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each "Hazard" on the AHA. Annotate the overall highest RAC at the top of this AHA.	M = Moderate Risk L = Low Risk

Personal Protective Equipment (PPE) will be **level D** and consist of:

- Hard hats (ANSI Z89.1)
- Safety Glasses (ANSI Z87.1)
- High visibility vests
- Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
- Gloves: *Leather for general use or as appropriate to exposed hazards*
- Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions

Job Steps	Hazards	Controls	RAC
1) General Site Conditions *(applicable to site preparation, general site conditions, and site cleanup activities)*	1A) Struck by Objects or Equipment	1A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots.	1A = M
	1B) Back strain	1B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person's body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1B = L
	1C) Cuts, abrasions, lacerations	1C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1C = L
	1D) Slips trips falls	1D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1D = M
	1E) Contact with insects and animals	1E) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist.	1E = L

	1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the Contractor PM, who will contact the USACE PM for guidance.	1F = M 1G = M 1H = L
2) Mechanical Excavation (< 5 ft) and Soil Stockpiling	*See General Site Conditions hazard section* 2A) Skin or eye injury 2B) Dust exposure from soil excavation 2C) Noise	*See General Site Conditions controls section* 2A) Don Level D PPE 2B) Use watering methods to control visible dust 2C) Workers will don directed level of hearing protection warranted for noisy conditions. Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. Double hearing protection will be required by workers where noise levels exceed 103 dBA	2A = L/M 2B = L/M 2C = L/M
3) Hand Excavation (< 2 ft) with Shovels	*See General Site Conditions hazard section* 3A) Skin or eye injury	*See General Site Conditions controls section* 3A) Don Level D PPE	3A = L
4) Vacuum Extraction of Soil	*See General Site Conditions hazard section* 4A) Skin or eye injury 4B) Dust exposure from soil excavation 4C) Noise	*See General Site Conditions controls section* 4A) Don Level D PPE 4B) Use watering methods to control visible dust 4C) Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. Double hearing protection will be required by workers where noise levels exceed 103 dBA	4A = L/M 4B = L/M 4C = L/M
5) Loading of Containers	*See General Site Conditions hazard section*	*See General Site Conditions controls section*	L/M
6) Loading Containers onto Rail Cars	*See General Site Conditions hazard section*	*See General Site Conditions controls section*	L/M

Equipment to be Used	**Training Requirements and Competent or Qualified Personnel Names**	**Inspection Requirements**
Hand and power tools, cars/trucks Heavy equipment (excavator, vacuum extractor)	Heavy equipment operator Qualified vacuum extraction operator	User to inspect equipment prior to use. Operator shall daily inspect equipment prior to use during periods of work.

Activity/Work Task: **Soil Sorting System**	***Highest Risk Assessment Code (RAC) from AHA:*** **M**
Project Location: **IAAAP, OU-8**	**Risk Assessment Code (RAC) Matrix**
Contract Number: **W912P9-12-D-0510**	
Date Prepared: **August 2012**	
Prepared by:	
Reviewed by:	

Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "hazard" with identify safety "controls" and determine RAC value as shone above

	RAC Chart
"**Probability**" is the likelihood to cause an incident , near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.	
"**Severity**" is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.	E = Extremely High Risk
	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each "Hazard" on the AHA. Annotate the overall highest RAC at the top of this AHA.	M = Moderate Risk
	L = Low Risk

Notes: (Field notes, Review Comments, etc.)

Personal Protective Equipment (PPE) will be **level D** and consist of:

- Hard hats (ANSI Z89.1)
- Safety Glasses (ANSI Z87.1)
- High visibility vests
- Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
- Gloves: *Leather for general use or as appropriate to exposed hazards*
- Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions
- Protective leg chaps shall be worn by workers who operate chain saws. Chaps must meet ASTM F1897 specifications.

Job Steps	Hazards	Controls	RAC
1) General Site Conditions *(applicable to site preparation, general site conditions, and site cleanup activities)*	1A) Struck by Objects or Equipment	1A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots.	1A = M
	1B) Back strain	1B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person's body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1B = L
	1C) Cuts, abrasions, lacerations	1C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1C = L
	1D) Slips trips falls	1D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1D = M

	1E) Contact with insects and animals 1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1E) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist. 1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the Contractor PM, who will contact the USACE PM for guidance.	1E = L 1F = M 1G = M 1H = L
2) Soil Sorting Equipment Set-up and Operation	2A) Struck by Objects or Equipment 2B) Back strain , pinch points, dropping objects 2C) Cuts, abrasions, lacerations 2D) Slips trips falls 2E) Electrical Shock, unwanted release or exposure to stored energy 2F) Hearing damage 2G) Unwanted contact with chemicals	2A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots. 2B) Inspect materials for slivers, jagged or sharp edges, and burrs, rough or slippery surfaces before handling; Use mechanical devices to move and load heavy items; check the routes to ensure that obstructions and/or slip and trip hazards are removed. Choose an alternate route if clearance is not adequate. Lift with legs and stand up in a smooth, even motion. Do not twist or bend sideways; Two-person rule for moving bulky items or objects weighing more than 50 lbs.; Wear leather gloves 2C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with power tools and equipment prior to use. 2D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread. 2E) Follow Lock Out Tag out procedures. Zero energy must be verified by an NFPA 70E trained worker. The SSHO will initiate the first lock and be the last one to be removed. GFCIs will be utilized on all drop cords and hand held electrical tools. 2F) Don hearing protection in posted areas and/or when operation of noisy equipment. SSHO shall monitor questionable activities producing loud noise and post areas where hearing protection is required. Hearing protection with a minimum 26 dBA Noise Reduction Rating (NRR) will be readily available at the project for workers to don. Person who will or will likely meet or exceed 85 dBA 8-hour time weighted average at once during the course of the project shall be entered in a hearing conservation program, regardless of the use of hearing protection. Subcontractors shall provide objective evidence or their hearing conservation program and a list of affected workers. 2G) Don proper level of PPE. Avoid contact with chemicals and monitor atmosphere for VOCs and combustible landfill gases during monitor well installations. Contact SSHO when concerns arise.	

Equipment to be Used	Training Requirements and Competent or Qualified Personnel Names	Inspection Requirements
Hand and power tools, cars/trucks heavy equipment Operation of soil sorting unit	Heavy equipment operator Documentation of operator training; familiarity with proper operation and limitations of sorting equipment	User to inspect equipment prior to use. Operator shall daily inspect equipment prior to use during periods of work.

Activity/Work Task: **Disposal of Contaminated Soil and Components**	*Highest Risk Assessment Code (RAC) from AHA:*	M
Project Location: **IAAAP, OU-8**	**Risk Assessment Code (RAC) Matrix**	
Contract Number: **W912P9-12-D-0510**		
Date Prepared: **August 2012**		
Prepared by:		
Reviewed by:		

Severity	**Probability**				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "hazard" with identify safety "controls" and determine RAC value as shone above

	RAC Chart
"**Probability**" is the likelihood to cause an incident, near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.	
"**Severity**" is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.	E = Extremely High Risk
	H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each "Hazard" on the AHA. Annotate the overall highest RAC at the top of this AHA.	M = Moderate Risk
	L = Low Risk

Notes: (Field notes, Review Comments, etc.)

Personal Protective Equipment (PPE) will be **level D** and consist of:

- Hard hats (ANSI Z89.1)
- Safety Glasses (ANSI Z87.1)
- High visibility vests
- Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
- Gloves: *Leather for general use or as appropriate to exposed hazards*
- Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions
- Protective leg chaps shall be worn by workers who operate chain saws. Chaps must meet ASTM F1897 specifications.

Job Steps	**Hazards**	**Controls**	**RAC**
1) General Site Conditions *(applicable to site preparation, general site conditions, and site cleanup activities)*	1A) Struck by Objects or Equipment	1A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots.	1A = M
	1B) Back strain	1B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person's body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1B = L
	1C) Cuts, abrasions, lacerations	1C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1C = L
	1D) Slips trips falls	1D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1D = M

	1E) Contact with insects and animals 1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1E) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist. 1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the Contractor PM, who will contact the USACE PM for guidance.	1E = L 1F = M 1G = M 1H = L
2) Loading soil and components into containers (super sacks, gondola cars, intermodals, drums)	*See General Site Conditions hazard section* 2A) Dust 2B) Noise	*See General Site Conditions hazard section* 2A) Heavy equipment operators will work inside enclosed cabs where possible and nearby workers should avoid working directly in any visible dust created by the activity. Dust suppression by wetting from water hoses or water truck may be directed by the SSHO. Contact the SS and SSHO where concerns exist. 2B) Workers will don directed level of hearing protection warranted for noisy conditions. Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. The SS and/or SSHO will post areas where high noise conditions exist requiring the use of plugs or muffs. Double hearing protection will be required by workers where noise levels exceed 103 dBA.	2A = M 2B = M
3) Loading containers onto trucks or rail cars	*See General Site Conditions hazard section* 3A) Dust 3B) Noise – hearing loss	*See General Site Conditions hazard section* 3A) Heavy equipment operators will work inside enclosed cabs where possible and nearby workers should avoid working directly in any visible dust created by the activity. Dust suppression by wetting from water hoses or water truck may be directed by the SSHO. Contact the SS and SSHO where concerns exist. 3B) Workers will don directed level of hearing protection warranted for noisy conditions. Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. The SS and/or SSHO will post areas where high noise conditions exist requiring the use of plugs or muffs. Double hearing protection will be required by workers where noise levels exceed 103 dBA.	3A = M 3B = M
4) Transportation of containers through public	4A) Interference or hazard to public	4A) Secure loads. Follow all federal and state regulations for transportation on public roads and railways. Notify all required regulators (states, DOT) before transporting. Follow all emergency guidance and contingency plans.	4A = L

Equipment to be Used	**Training Requirements and Competent or Qualified Personnel Names**	**Inspection Requirements**
Hand and power tools, cars/trucks/rail heavy equipment	Heavy equipment operator DOT certified driver	User to inspect equipment prior to use. Operator shall daily inspect equipment prior to use during periods of work.

Activity/Work Task: **Soil Sampling**	***Highest Risk Assessment Code (RAC) from AHA:*** **M**
Project Location: **IAAAP, OU-8**	
Contract Number: **W912P9-12-D-0510**	
Date Prepared: **August 2012**	
Prepared by:	
Reviewed by:	

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "hazard" with identify safety "controls" and determine RAC value as shone above

	RAC Chart
"**Probability**" is the likelihood to cause an incident , near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.	
"**Severity**" is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.	E = Extremely High Risk H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each "Hazard" on the AHA. Annotate the overall highest RAC at the top of this AHA.	M = Moderate Risk L = Low Risk

Notes: (Field notes, Review Comments, etc.)

Personal Protective Equipment (PPE) will be **level D** and consist of:

- Hard hats (ANSI Z89.1)
- Safety Glasses (ANSI Z87.1)
- High visibility vests
- Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
- Gloves: *Leather for general use or as appropriate to exposed hazards*
- Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions

Job Steps	Hazards	Controls	RAC
1) Collect surface soil samples and process water samples using hand tools, such as scoops and trowels.	1A) Back strain	1A) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person's body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1A = L
	1B) Cuts, abrasions, lacerations	1B) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1B = L
	1C) Slips trips falls	1C) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1C = M
	1D) Contact with insects and animals	1D) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist.	1D = L
	1E) Unwanted contact with chemicals and radiation	1E) Don proper level of PPE. Avoid contact with chemicals and monitor atmosphere for VOCs. Contact SSHO when concerns arise	1E = M

	1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the contractor PM, who will contact the USACE PM for guidance.	1F = M 1G = L 1H = L

Equipment to be Used	Training Requirements and Competent or Qualified Personnel Names	Inspection Requirements
Sample equipment and hand tools.	Applicable sampling procedures	None

Activity/Work Task: **Decontamination of Structures, Equipment and Materials**	***Highest Risk Assessment Code (RAC) from AHA:*** **M**
Project Location: **IAAAP, OU-8**	**Risk Assessment Code (RAC) Matrix**
Contract Number: **W912P9-12-D-0510**	
Date Prepared: **August 2012**	
Prepared by:	
Reviewed by:	

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each "hazard" with identify safety "controls" and determine RAC value as shone above

	RAC Chart
"**Probability**" is the likelihood to cause an incident, near miss, or accident and identified as: Frequency, Likely, Seldom, of Unlikely.	
"**Severity**" is the degree of outcome if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, and Negligible.	E = Extremely High Risk H = High Risk
Step 2: Identify the RAC as E, H, M, or L for each "Hazard" on the AHA. Annotate the overall highest RAC at the top of this AHA.	M = Moderate Risk L = Low Risk

Notes: (Field notes, Review Comments, etc.)

Personal Protective Equipment (PPE) will be **level D** and consist of:

- Hard hats (ANSI Z89.1)
- Safety Glasses (ANSI Z87.1)
- High visibility vests
- Steel or Composite toed safety boots at or above the ankle (ANSI Z41)
- Gloves: *Leather for general use or as appropriate to exposed hazards*
- Hearing Protection (with Noise Reduction Rating (NRR) rating of 26 or higher) shall be worn as applicable to noise hazard conditions

Job Steps	Hazards	Controls	RAC
1) General Site Conditions *(applicable to site preparation, general site conditions, and site cleanup activities)*	1A) Struck by Objects or Equipment	1A) Familiarize workers with the work area and traffic patterns at the job site, Check mirror positions, check back up alarms, and identify blind spots.	1A = M
	1B) Back strain	1B) Use mechanical lifting device where possible, two person lifting if object exceeds 50 lbs or is awkward, do not exceed maximum manual lifting limit of 50 lbs or 1/3 person's body weight (whichever is less). Females should not exceed the maximum manual lifting limit of 40 lbs.	1B = L
	1C) Cuts, abrasions, lacerations	1C) Wear gloves and long sleeve shirts to avoid contact between material and skin. Be familiar with hand and power tools prior to use.	1C = L
	1D) Slips trips falls	1D) Identify trip and fall hazards, cords, uneven slopes and terrain, materials and debris on ground surface, observe ground when carrying materials, wear footwear with adequate tread.	1D = M
	1E) Contact with insects and animals	1E) Avoid contact with insects and spiders; do not approach or come in contact with living or dead animals. Contact the SSHO where issues exist.	1E = L

	1F) Inclement weather 1G) Heat or Cold Stress 1H) Unexploded ordnances (UXO)	1F) When inclement or adverse weather poses a threat to persons or property at the project site (e.g., sustained winds 25 mph or greater, electrical storms, heavy precipitation, or extreme heat or cold), the SS and SSHO will evaluate the conditions and decide, with input from other personnel, whether to halt work, use compensatory measures, or proceed. 1G) Workers will be trained to recognize common heat and cold stress signs and symptoms. The SS and/or SSHO will assess heat/cold stressors when conditions warrant. Contact the SS and SSHO where concerns exist. 1H) STOP WORK if UXO is or may have been encountered. Mark the location and contact the Contractor PM, who will contact the USACE PM for guidance.	1F = M 1G = M 1H = L
2) Decontamination of structures using high pressure water sprayer, grit blasting or scabbling.	*See General Site Conditions hazard section* 2A) Skin or eye injury 2B) Dust exposure from grit blasting 2C) Noise	*See General Site Conditions controls section* 2A) Don Level D PPE; do not point at or sprayer high water pressure sprayer at other workers; 2B) Sand may not be used as a grit in blasting 2C) Workers will don directed level of hearing protection warranted for noisy conditions. Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. Double hearing protection will be required by workers where noise levels exceed 103 dBA.	 2A = M 2B = M 2C = L/M
3) Removing building components	*See General Site Conditions hazard section* 3A) Cuts from sharp edges on components 3B) Hot Work – Fire or Burns 3C) Skin or eye injury from flying debris 3D) Exposure to depleted uranium (DU) contaminated surfaces 3E) Noise	*See General Site Conditions controls section* 3A) Don Level D PPE with leather or cut resistant gloves 3B) Complete Hot Work Permit for activities involving torch cutting or cutting that produces sparks or flying metal debris; trained to proper use of torch cutting and use of compressed gas cylinders. 3C) Don safety glasses and proper face shield when torch cutting or mechanical cutting through metal components 3D) *Adhere to requirements of Radiological Survey AHA* 3E) Workers will don directed level of hearing protection warranted for noisy conditions. Personnel working within 15 feet of the heavy equipment will don hearing protection (plugs). Single hearing protection will have a NRR of 26 or higher. Double hearing protection will be required by workers where noise levels exceed 103 dBA.	 3A = L 3B = M 3C = L 3D = L/M 3E = L/M
4) Removal and replacement of Line 1 Building 1-63-6 air filter	*See General Site Conditions hazard section* 4A) Cuts from sharp edges 4B) Exposure to DU contaminated surfaces	*See General Site Conditions controls section* 4A) Don Level D PPE with leather or cut resistant gloves 4B) *Adhere to requirements of Radiological Survey AHA*; follow proper procedure for bagging and tapping filter	 4A = L 4B = L/M
5) Routing decontamination rinse water and storm water through ion filter exchange filter and/or GAC	*See General Site Conditions hazard section* 5A) Exposure to DU contaminated surfaces	*See General Site Conditions controls section* 5A) *Adhere to requirements of Radiological Survey AHA*	L/M
6) Sampling ion exchange filter and/or GAC	*See General Site Conditions hazard section* 6A) Exposure to DU contaminated surfaces	*See General Site Conditions controls section* 6A) *Adhere to requirements of Radiological Survey AHA*	L/M

Equipment to be Used	Training Requirements and Competent or Qualified Personnel Names	Inspection Requirements
Hand and power tools, cars/trucks Heavy equipment	Heavy equipment operator Radiological Survey Equipment	User to inspect equipment prior to use. Operator shall daily inspect equipment prior to use during periods of work. Qualified Radiological Engineer/Technician

Appendix B

Site Safety and Health Plan

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FINAL

SITE SAFETY AND HEALTH PLAN IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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FINAL

SITE SAFETY AND HEALTH PLAN IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

February 2013

Prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:

North Wind Services, LLC
Under Contract No. W912P9-12-D-0510

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SITE SAFETY AND HEALTH PLAN
IOWA ARMY AMMUNITION PLANT
OPERABLE UNIT 8,
DEPLETED URANIUM CONTAMINATED SOIL
AND STRUCTURE REMEDIATION

Plan Approved by:

	02/06/2013
Micah F. Nielsen Health and Safety Manager, NWS 208-557-0823	Date

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ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienist
AEC	Atomic Energy Commission
AHA	Activity Hazard Analysis
AIDS	Acquired Immune Deficiency Syndrome
APP	Accident Prevention Plan
APR	air-purifying respirator
bpm	beats per minute
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CWA	controlled work area
dB	decibels
dBA	decibel A-weighted
DOD	Department of Defense
DU	depleted uranium
EKG	Electrocardiogram
EPA	Environmental Protection Agency
EZ	exclusion zone
°F	degrees Fahrenheit
FS	Firing Site
FUSRAP	Formerly Used Sites Remedial Action Program
HIV	Human Immunodeficiency Virus
HMX	cyclotetramethylene tetranitramine
HSO	Health and Safety Officer
Hz	Hertz
IAAAP	Iowa Army Ammunition Plant
mg/m^3	milligrams per cubic meter
MSDS	material safety data sheet
NCP	National Contingency Plan

NIOSH	National Institute of Occupational Safety and Health
OSHA	Occupational Safety and Health Agency
OU	operable unit
PEL	permissible exposure limit
PM	Project Manager
PPE	personal protective equipment
qt/hr	quarts per hour
RDX	cyclotrimethylene trinitramine
RG	remediation goal
RPM	Radiation Protection Manger
ROD	Record of Decision
SPF	sun protection factor
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SZ	support zone
TBD	to be determined
TLV	threshold limit value
TNT	2,4,6-trinitrotoluene
USACE	U.S. Army Corps of Engineers
WBGT	wet-bulb globe temperature

Site Safety and Health Plan
Iowa Army Ammunition Plant Operable Unit 8,
Depleted Uranium Contaminated Soil and Structure Remediation
Middletown, Iowa

1. INTRODUCTION

This Site Safety and Health Plan (SSHP) establishes the safety and health procedures, guidelines, and requirements that will be used to safely perform the activities necessary for the remedial design/remedial action for Operable Unit (OU)-8 at the Iowa Army Ammunition Plant (IAAAP) near Middletown, Iowa. This SSHP, along with the Accident Prevention Plan (APP), has been prepared in accordance with all local, state, and federal regulations and the safety and health requirements of the U.S. Army Corps of Engineers (USACE) (EM 385-1-1 and the ER-385-1-92). The APP, with the SSHP included as an appendix, is a supporting document to the Work Plan (USACE, 2013). This SSHP contains information about the hazards involved in performing the work, as well as the specific actions and equipment that will be used to protect workers and visitors at the project site.

Changes and modifications to this SSHP are permitted and will be made in writing with the knowledge and concurrence of the Health and Safety Officer (HSO).

Except in emergency situations, no deviations from this SSHP may be implemented without prior notification and approval of the project HSO. Changes in working conditions may necessitate modifications to the SSHP.

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2. SITE BACKGROUND

The IAAAP is a government-owned, contractor-operated facility located approximately 10 miles west of Burlington, Iowa and the Mississippi River. The IAAAP consists of approximately 19,000 acres, of which approximately one-third is occupied by active or formerly active munitions production or storage facilities. The remaining property is either forested (7,766 acres) or leased for agricultural use (7,107 acres).

The primary activity at IAAAP since 1941 has been to load, assemble, and pack a variety of conventional ammunition and fusing systems for the U.S. Department of Defense (DOD). From 1947 to 1975, portions of the IAAAP facility were under the control of the U.S. Atomic Energy Commission (AEC) for weapons-assembly operations. The IAAAP was listed on the National Priorities List in 1990.

Historical AEC activities resulted in contamination of soil at outdoor firing sites where tests of depleted uranium (DU) surrogates for weapon components were performed. DU is present as metallic uranium and as chemical weathering products of metallic uranium in soil. Soil contaminated with metallic and weathered DU poses a risk to human health and the environment.

AEC performed manufacturing operations that resulted in DU contamination of structure components in two buildings in the Line 1 portion of IAAAP. Contaminated components are located in Building 1-11 and Building 1-63-6.

The Formerly Used Sites Remedial Action Program (FUSRAP) Record of Decision (ROD; USACE, 2011) presents the selected remedy for the remediation of soil and structures at specific (i.e., former AEC) areas at IAAAP. The specific areas for which this selected remedy applies include Line 1 Structures; the Firing Sites Area (consisting of five subareas); Yards C, G, and L; and Warehouse 3-01. The selected remedy addresses soil and structures that are radiologically contaminated as a result of the AEC operations. USACE is authorized by Congress as the lead agency implementing the selected remedy under the authority of FUSRAP.

The selected remedy is the final remedy for the FUSRAP areas of the IAAAP (OU-8). Six other OUs have been defined at IAAAP; they are being addressed by other U. S. Army programs.

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3. DESCRIPTION OF SELECTED REMEDY

The selected remedy was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.), as amended by the Superfund Amendments and Reauthorization Act and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] §300.430(a)(1)(iii)(A)). This decision is based on the Administrative Record file located at the Burlington, Iowa Public Library and at the USACE, St. Louis District FUSRAP Project Office.

No principal threat wastes, as defined by the NCP, are present at the FUSRAP areas of IAAAP. The principal contaminant of concern for the FUSRAP areas is DU. The selected remedy for DU-contaminated soil is removal by excavation and physical treatment prior to off-site disposal. Additionally, DU will be removed from structures using decontamination and/or removal and off-site disposal.

The main components of the selected remedy for soil (ROD – Alternative 4) include:

- Excavation of DU and DU-contaminated soil to meet the industrial remediation goal (RG) at Firing Sites 1 and 2 (FS-1, FS-2); Firing Sites 3, 4, and 5 (FS-3, FS-4, FS-5); the Firing Site 6 Area (FS-6); and the Firing Site 12 Area (FS-12). Excavation will not be conducted at Yards C, G, and L or Firing Site 14 (FS-14).
- Physical treatment of DU and DU-contaminated soil excavated from FS-1 and FS-2; FS-3, FS-4, and FS-5; FS-6; and FS-12 via soil sorting.
- Materials exceeding the DU RG will be disposed of at a properly permitted off-site facility. Materials meeting the DU RG may be used as backfill, as appropriate.
- Site restoration, including backfilling, grading, and re-vegetation.
- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.
- Five-year reviews for FUSRAP areas where contaminants remain above levels acceptable for unlimited use and unrestricted exposure to ensure continued protectiveness of human health and the environment under industrial land use. Industrial land use will be verified during each 5-year review.

The main components of the selected remedy for structures (ROD – Alternative S3) include:

- Decontamination of structural surfaces and/or replacement of structural components (e.g., Building 1-11 floor grate and Building 1-63-6 air filters) to achieve the industrial RG for structures.
- Disposal of DU-contaminated materials at a properly permitted off-site facility.
- Continued industrial land use supported by use restrictions and out grants administered by the U.S. Army as part of its land management responsibilities.
- Five-year reviews for structures if they exceed levels appropriate for unlimited use and unrestricted exposure to ensure continued protectiveness of human health under industrial land use. Industrial land use will be verified during each 5-year review.

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4. KEY PROJECT AND CONTACT PERSONNEL

Table 4-1 provides a list of key contact personnel involved in this project. Personnel responsibilities and lines of authority are included in Section 5 of the APP.

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5. HAZARD/RISK ANALYSIS

5.1. Hazard Assessment and Mitigation

All hazards or possible hazards that may be present on the site will be brought to the attention of the Site Safety and Health Officer (SSHO) or Field Project Engineer. The SSHO will assess the hazard and employ appropriate mitigation remedies as necessary.

5.2. Hazards of Concern

The primary hazards of concern associated with this project are:

- Physical hazards,
- Chemical hazards, and
- Biological hazards.

5.2.1. Physical Hazards

Physical hazards and recommended controls are addressed in the Activity Hazard Analyses (AHAs) presented in Appendix A of the APP. The physical hazards include:

- Electrocution or fire from contact with live, buried, or overhead utility lines;
- Slips, trips, and falls;
- Noise from heavy equipment and demolition and excavation activities;
- Crushing hazards working around heavy equipment;
- Heat/cold stress;
- Sun exposure;
- Inclement weather conditions with electrical storms; and
- Biological hazards.

5.2.2. Chemical Hazards

The following chemicals may be encountered during this project:

- DU – inhalation, ingestion hazard;
- Heavy metals; and
- Explosives, including cyclotrimethylene trinitramine (RDX), 2,4,6-trinitrotoluene (TNT), and cyclotetramethylene tetranitramine (HMX).

The sub-sections below contain brief chemical descriptions of these compounds.

5.2.2.1. Depleted Uranium - Related Risk and Health Hazards

Uranium is a natural occurring radioactive element present in nearly all rocks and soils, and can be released into the environment through natural wind and water erosion. Naturally occurring uranium is weakly radioactive and contains a mixture of three isotopes: (1) U-234 (half-life of 200,000 years), (2) U-235 (half-life of approximately 700 million years), and (3) U-238 (half-life of approximately 5 billion years). DU is a mixture of the same natural occurring uranium isotopes. However, much of the more hazardous U-234 and U-235 isotopes have been removed; hence, DU is less radioactive than natural occurring uranium. Though natural uranium and DU differ in radioactivity, they are chemically identical. Exposure to uranium often occurs via ingestion and has the greatest toxicological effects on the kidneys. <u>Health effects to the kidneys are due to chemical effects and not radiation</u>. Ingested uranium will also target bone marrow and the lymphatic system. Most ingested uranium will typically pass through the body in a few days via urine and/or feces.

5.2.2.2. Heavy Metals

Heavy metals are naturally occurring, as well as byproducts from industrial processes. Table 5-1 includes heavy metals and their health effects, as described by the Agency for Toxic Substance and Disease Register.

5.2.2.3. Explosives

Low levels of explosives were detected in the soil during the remedial investigation. Table 5-2 discusses the explosives that may be present and their associated hazards, as described by the Agency for Toxic Substance and Disease Register.

5.2.2.4. Nuisance Dust Related Risk and Health Hazards

Normal use of construction equipment in excavating, staging, and/or loading of soils can create dust. The environment around the project can also be affected. Increased dust concentrations can be of concern to both workers and those in the general vicinity of the project. Dust generated during construction is often referred to as "nuisance dust" or "fugitive dust," and generally does not result in any significant health effects at typical exposure levels. However, generating large quantities of nuisance dust can create short-term respiratory problems for the workers. Complaints and/or punitive repercussions could occur if the dusts migrate to adjacent areas causing building occupants to complain and in some instances, property loss due to damage from dust settling into sensitive equipment.

Nuisance dust may contain varying amounts of crystalline silica. Silicosis, an incurable, progressive lung disease caused by overexposure to dust containing crystalline silica has heightened the awareness of nuisance dust in the work place. The Occupational Safety and Health Agency (OSHA) set a nuisance dust limit of 15 milligrams per cubic meter (mg/m^3) (total) and 5 mg/m^3 (respirable). The American Conference of Governmental Industrial Hygienists (ACGIH) has set nuisance dust limits of 10 mg/m^3 (total) and 3 mg/m^3 (respirable). Primary entry routes are the eyes, inhalation, and ingestion. Potential acute health effects include eye irritation, redness or burning, coughing, difficulty breathing, abdominal cramps, nausea, and/or vomiting.

5.2.3. Radiological Hazards

Alpha radiation emitted from DU is the primary radiological hazard at the IAAAP site. All living creatures are exposed to low levels of ionizing or alpha radiation every day that occur naturally in the environment. Alpha radiation is too dense to pass through skin and therefore, skin acts as a barrier. If alpha particles are inhaled or ingested into the body, the particles can cause damage to internal tissue.

Overexposure to high amounts of alpha radiation can lead to cancer, mental retardation, and death. Inhalation of uranium can deposit radioactive material intimately within the internal linings of the lung where it is primarily an alpha-emitter and may potentially lead to lung cancer if deposited in the deep portions of the lung.

5.2.4. Biological Hazards

Biological hazards that could be encountered during this project include contact with insects, arachnids, snakes, irritating plants, and blood-borne pathogens. The insect and arachnid biologic hazards that may be encountered are described in Table 5-3, the plant biological hazards that may be encountered are described in Table 5-4, and the animal biological hazards are described in Table 5-5.

5.2.5. Blood-borne Pathogens

Anyone that is trained in first-aid/cardiopulmonary resuscitation (CPR) and assists in an emergency assumes the risk of coming in contact with blood-transmitted diseases. Blood-borne pathogens are microorganisms such as viruses or bacteria that are carried through blood and can cause diseases in people. The OSHA Blood-borne Pathogen Standard, 29 CFR 1910.1030, discusses first responders but effects anyone who can reasonably expect to come in contact with blood or infectious materials as part of his or her job (CPR and first-aid providers). Universal precautions should be taken in the treatment of body fluids/materials as infectious, with emphasis on engineering and work practice controls. The OSHA standard stresses hepatitis B and C, Human Immunodeficiency Virus (HIV), and universal precautions.

5.2.5.1. Hepatitis B and C

Hepatitis is the inflammation of the liver. While there are several types of the hepatitis virus, hepatitis B is transmitted primarily through "blood-to-blood" contact. The symptoms of hepatitis B are much like a mild flu. Initially, there is a feeling of fatigue, possible stomach pain, loss of appetite, and even nausea. Eventually, jaundice develops and darkened urine often occurs. After exposure to hepatitis B, individuals do not display noticeable symptoms for 1 to 9 months. Hepatitis C is a chronic liver disease that progresses at a slow rate without symptoms or physical signs in the majority of patients during the first two decades following infection.

5.2.5.2. Human Immunodeficiency Virus

HIV attacks the body's immune system, weakening it to the extent that it cannot fight other deadly diseases. Once a person is infected with HIV, it may be years before Acquired Immune Deficiency Syndrome (AIDS) actually develops. AIDS is a fatal disease with no known cure. There are three stages to AIDS/HIV. The first stage is when the person is infected. They may show few or no symptoms of the illness for many years. The second stage eventually starts to weaken the body's immune system and the person begins to suffer from swollen lymph glands, weakness, fever, weight loss, headaches, and/or other lesser diseases. In the third and final stage, the body becomes unable to fight off life-threatening diseases and infections.

5.2.5.3. Precautions for Blood-borne Pathogens

Under the principle of "universal precautions," all blood and bodily fluids should be considered infectious. All skin and mucous membranes should be considered to have possible points of entry for pathogens. This approach will be used in all situations where exposure to blood or potentially infectious materials is possible. Precautions include, but are not limited to:

- Minimize the amount of splashing, spraying, and splattering if an injury occurs,
- Always wash hands before leaving the work area,
- Thoroughly wash hands and other vulnerable areas as soon as possible following an exposure incident,
- Confine loose hair and clothing when working areas with a potential for exposure to blood-borne pathogens,
- Avoid harsh, abrasive soaps as these may open fragile scabs or other areas, and
- Do not eat or drink before washing hands and exiting the work area.

6. FIELD PROJECT ORGANIZATION

A project organization chart and the responsibilities of key project personnel are stated in Section 5 of the APP.

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7. PROJECT TRAINING REQUIREMENTS

Project specific training requirements are stated in Section 7 of the APP.

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8. PERSONAL PROTECTIVE EQUIPMENT

The contractor or subcontractor will provide field personnel with appropriate personal protective equipment (PPE) and protective clothing, and will ensure that all PPE and protective clothing are kept clean and well maintained. Specific PPE requirements are addressed in each task-specific AHA in the APP.

This section presents the types of PPE that may be used for the project. Requirements for task and activity-specific levels of PPE are presented in the AHAs located in Appendix A of the APP. The selection of PPE was completed after a thorough evaluation of hazards present at the site during each phase of the operation. All persons entering the site area must use the required PPE according to established procedures in this plan. Levels of protection that could potentially be used to protect against chemical and physical hazards at this site are described in Table 8-1.

8.1. PPE Program Effectiveness

Based on the inhalation hazard and potential chemical exposures on this site, Level D, Modified Level D, or Level C PPE is considered adequate for the work to be accomplished at the site. Ongoing real-time monitoring of airborne contamination may occur. Level D or Modified Level D will be an adequate range for general site investigations. Level C respirator protection may be used if airborne DU levels approach the threshold limit value (TLV) established by ACGIH or radioactive airborne levels approach undesirable levels.

Areas with airborne radioactive contamination in excess of 10 CFR 20, Attachment B, Table 1, Column 3 concentrations, or where an individual present without respiratory protection in the area could exceed an intake of 0.6% of the annual limit on intake per week (12 derived air concentration hours/week), are posted "Caution - Airborne Radioactivity Area." Respiratory protection may be required in these areas based on measured or expected concentrations and/or duration of activity. The Radiation Protection Manger (RPM) will establish personnel air sampling requirements, as necessary, and determine the need for respiratory protection based upon actual site conditions and the activity being conducted.

Employees will monitor the efficiency of their PPE that they use in the field. If breakthrough or durability of materials becomes an issue, the use of these items will be stopped and another brand or type of material will be used. Every effort will be made to ensure that site personnel can work efficiently and safely.

8.2. Respirators

Respirator users are responsible for completing appropriate respirator training, fit testing, and medical surveillance before initial respirator use and annually thereafter. Users are responsible for being clean-shaven prior to reporting to a job site where respirator use is or may be required, cleaning and inspecting their respirators prior to each use, properly labeling and storing their respirators between uses, changing cartridges according to the established schedule, leaving the area immediately in the event of a break through, and reporting any medical issues related to respirator use to the SSHO.

A Respiratory Protection Plan is included in Section 10.6 of the APP.

8.3. Medical Provider

The contractor will establish a contract with a medical provider to serve the project location. This information is included in the APP.

8.4. Respirator Selection and Use

The HSO will develop a written program for respirator selection and use at the project sites. All Project Managers (PMs) and SSHOs must ensure that this program is adhered to and may not be changed without written approval of the HSO. The Respiratory Protection Program will comply with 29 CFR 1910.134, "Respiratory Protection." The program is detailed in the APP.

8.5. Medical Evaluations

Employees who are required to wear respiratory protection will have a medical evaluation completed before the respirator fit test or prior to using a respirator when fit testing is not required. Medical evaluation is also required when an employee voluntarily uses a negative pressure air-purifying respirator (APR). Medical evaluation is not required when an employee voluntarily uses a filtering face piece respirator (e.g., dust mask).

Employees assigned to tasks requiring the use of respirators will be identified by the PM and evaluated medically for respirator use. Employees will be evaluated by a licensed physician to determine their ability to wear a respirator during their assigned job duties in accordance with 29 CFR 1910.134.

8.6. Respiratory Fit Testing

After receiving a medical clearance, employees using a tight-fitting respirator face piece (negative or positive pressure) must pass an appropriate fit test before initial use and annually thereafter. Additional fit testing will be conducted whenever there are changes in the employee's physical condition that may affect the fit, or if a change in the respirator face piece is needed for any reason. Fit testing is not required when an employee voluntarily uses a filtering face piece respirator (dust mask). The fit test will be conducted using the same size, style, and model of respirator face piece that will actually be used by the employee. Qualitative fit tests or quantitative fit tests will be administered using OSHA-accepted protocol. Appendix A of OSHA's Respiratory Protection Standard (29 CFR 1010.134) includes three qualitative fit test protocols. A qualitative fit test may be used for all positive pressure respirators and for negative pressure APRs that must have a protection factor of 10 or less. A quantitative fit test will be used for supplied air respirators and self-contained breathing apparatuses used in negative pressure mode (demand mode) or full-face APRs that require a protection factor greater than 10.

Employees must contact their training coordinator to schedule a respirator fit test before initial use, annually, and when additional fit testing is required. Only individuals trained in fit testing protocols will be allowed to perform respirator fit testing. All fit test records will be sent to and maintained by the training coordinator.

9. MEDICAL SURVEILLANCE

9.1. Medical Examination

All personnel performing on-site work that may result in exposure to contaminated related health and safety hazards will be enrolled in a medical surveillance program. They will have successfully completed a pre-placement physical examination and annually thereafter. This examination was designed to meet the requirements of 29 CFR 1910.120 requirements for hazardous waste site operations. The medical surveillance program examination may consist of the following:

- Medical and occupational history questionnaire, which includes information on past gastrointestinal, hematological, renal cardiovascular, reproductive, immunological, and neuralgic problems;
- Information and history of respiratory disease and personal smoking habits;
- Physical examination;
- Blood pressure measurements;
- Complete blood count and differential to include hemoglobin and hematocrit determinations, red cell indices, and smear of peripheral morphology;
- Blood urea nitrogen and serum creatinine;
- Comprehensive metabolic panel;
- Chest x-ray (if warranted);
- Pulmonary function test;
- Audiogram;
- EKG (Electrocardiogram) for employees *over* 45 years old or when other complications indicate the necessity;
- Drug and alcohol screening; and
- Visual acuity.

The medical surveillance provided to the employees includes a judgment by the medical examiner of the ability of the employee to use either positive or negative pressure respiratory equipment. Any employee found to have a medical condition that could directly or indirectly be aggravated by exposure to these chemical substances or by the use of respiratory equipment will not be employed for the project. A copy of the medical examination will be provided at the employee's request. The employee will be informed of any medical conditions that would result in work restriction or that would prevent them from working at hazardous waste sites.

Contractors will certify that all their employees have successfully completed a physical examination by a qualified physician.

9.2. First Aid and Medical Treatment

At least two on-site personnel should be trained in American Heart Association first-aid treatment skills and CPR (every 2 years) or the American Red Cross CPR (renewed annually) and first-aid (every 2 years). The first-aid course includes blood borne pathogen training and prevention.

9.3. Medical Restriction

Should an occupational injury or illness occur that restricts an employee's ability to function at full capacity, these employees will be assigned with light-duty assignments whenever possible to allow them to continue to be productive.

9.4. Medical Records

Medical and personal exposure monitoring records will be maintained according to the requirements of 29 CFR 1910.1020 and will be kept for a minimum of 30 years. Employee confidentiality will be maintained.

10. EXPOSURE MONITORING

During all phases of the project, controls will be in operation to minimize exposure to anticipated hazards.

Exposure monitoring for non-radiological contaminants/chemicals is not required. It is unlikely that personnel could be overexposed to non-radiological contaminants while conducting the tasks outlined in the Work Plan (USACE, 2013). If changing conditions warrant, the SSHO and/or Field Project Engineer will ensure appropriate exposure monitoring is conducted.

Past environmental sampling has indicated that uranium concentrations in IAAAP water, sediment, and soil are not sufficient to require personnel exposure monitoring. If conditions warrant, monitoring for external exposure and/or breathing zone air sampling will be conducted.

Based on the known hazards, it is expected that work can be performed in Level D or Modified Level D PPE throughout the majority of the project.

10.1. Noise

Occupational noise is a significant health hazard. Chronic noise induced hearing loss is a permanent sensor neural condition that cannot be treated medically. It is initially characterized by a declining sensitivity to high frequency sounds, usually at frequencies above 2,000 Hertz (Hz). Exposure of a person with normal hearing to workplace noise at levels equal to or exceeding the permissible exposure limit (PEL) may in time cause a shift in the worker’s hearing threshold. Such a shift is called a standard or significant threshold shift and is defined as a change in hearing thresholds that average 10 decibels (dB) or more at 2,000, 3,000, and 4,000 Hz in either ear. Workers who experience significant threshold shifts are required by OSHA to be fitted with hearing protection and to be trained in their use.

Noise will be generated by the operation of heavy equipment use during excavation and treatment of soils onsite. The noise generated by this equipment may exceed 85 decibel A-weighted (dBA). The hearing conservation program will comply with the OSHA Occupational Noise Exposure Standards (29 CFR 1910.95).

In addressing industrial noise and the hearing conservation program, the components are identification, recognition, evaluation, control, and training. The SSHO onsite may evaluate the site for unsafe noise levels (85 dB) utilizing a SPER Scientific Noise Meter Model 8400-29.

All personnel will wear hearing protection when noise levels reach 85 dBA or greater. All efforts will be made to find a location onsite where noise measurements indicate levels less than 85 dBA for field personnel to supervise and direct site activities. Noise levels greater than 103 dBA are not anticipated for this project; however, if they are encountered, the SSHO will require double hearing protection. The SSHO will examine noise survey data to determine the extent of hearing protection necessary for this project. All project personnel required to wear hearing protection regularly will be in a hearing conservation program. Baseline audiometric testing is conducted and repeated annually to evaluate for changes in the standard threshold shifts. All site personnel will be provided with hearing protection. Training on the advantages, disadvantages, attenuation of various types of hearing protectors, instruction on their selection, fitting, use, and care; the purpose of audiometric testing; and an explanation of the test procedures will be reviewed with each person.

The proper way to insert earplugs is to first roll the earplug up into a small, thin "snake" with your fingers. Secondly, pull the top of the ear up and back with your opposite hand to straighten out the ear canal. The rolled earplug should slide right in. Then hold the earplug in place with your finger and count aloud while waiting for the earplug to expand and fill the ear canal. Your voice will sound muffled when the plug has made a good seal.

The contractor will conduct time and activity sensitive noise surveys to monitor noise levels during all site field efforts, which will include the types of equipment running at various times. The specific activity and sound levels will be recorded during times when both single and multiple pieces of equipment are in use, and this data will be used to establish work zones where hearing protection is essential at all heavy machinery sites.

All personnel entering the work zone will be required to wear hearing protection in accordance with the SSHP. "Caution, Hearing Protection Required in this Area" signs will be posted at safe, low noise level locations from the field activities. Table 10-1 identifies the ACGIH TLVs for noise.

11. HEAT AND COLD STRESS

11.1. Heat Stress

When working during the summer months or in warmer climates, heat stress hazards must be evaluated and managed, and environmental factors that could contribute to the risk of heat related illnesses should be reviewed. The goal is to maintain the body core temperature within the normal ranges of 98.6 degrees Fahrenheit (°F) to 100.4°F. Heat stress monitoring will be initiated in the following instances:

- Ambient temperatures reach 75°F,
- Exertion level is raised and sustained for several hours to several days for the task,
- Acclimatization and individual risk factors of the field personnel, and
- Time that personnel are exposed to the heat and recovery time.

Individual risk factors that could affect a person's ability to work in hot environments include:

- Individual not acclimated to working in the out of doors or in the heat;
- Exposure over a period of 2 to 3 days to any of the following: increased heat exposure, increased exertion levels, or lack of quality sleep;
- Individual in poor physical shape;
- Excess body weight;
- Individual suffering from minor illness (i.e., cold-like symptoms);
- Individual taking prescription drugs, over the counter medications, or supplemental aids;
- Consumption of alcoholic beverages in the past 24 hours;
- Prior history of heat illness;
- Current skin disorders (i.e., heat rash or sunburn) that could prevent effective sweating;
- Age (greater than 40 years old); and
- Clothing or PPE required for the task.

11.1.1. Clothing

The OSHA PPE level for this project is Level D, unless air monitoring shows airborne contaminants are a hazard. Ideally, clothing should allow free movement of cool dry air over the skin's surface to maximize heat removal by both evaporation and convection. If a change in PPE status is required, more frequent and/or expanded rest periods and heat stress monitoring will be necessary unless activities are scheduled early in the day before ambient temperatures in the work area reach 75°F.

11.1.2. Screening Threshold Based on Wet-Bulb Globe Temperature

The wet-bulb globe temperature (WBGT) thermometer will be used to assess the ambient temperature in the work zone of field personnel. The WBGT is influenced by air temperature, radiant heat, air movement, and humidity. It can be used to estimate, but cannot fully account for, all interactions between the worker and the environment. The work pattern, job demands, and variances in work demands should be evaluated over an 8-hour shift average. The goal is to balance the work/rest periods with adequate hydration to ensure that the field personnel will not have a core body temperature that exceeds 100.4°F.

Table 11-1 presents the screening criteria for heat stress exposure and is based on the ability to achieve a resting metabolic work rate at varying temperatures. There is little risk of excessive exposure to heat stress if conditions are above the action limit but below the TLV. If there are any signs or complaints of heat related symptoms, then the screening criteria should be reconsidered.

It is recommended to use the QUESTemp 32 Thermal Environmental Monitor for field monitoring. The QUESTemp 32 monitor incorporates a dry bulb sensor to measure ambient temperature, a wet bulb sensor to account for evaporative cooling as an indication of the effects of humidity on an individual, and a globe sensor provides an indication of the radiant heat exposure on an individual due to either direct light or hot objects in an environment and coverts these measurements to a single WBGT Index.

11.1.3. Work Demands

Various levels of physical exertion will be required by field personnel over the course of this project. Table 11-2 identifies the level of exertion in conjunction with some of the site-specific tasks to be performed. The work demand will be used along with ambient temperature to determine adequate fluid intake and replacement and the maximum work period followed by rest (sitting in a shaded area) in minutes (see Table 11-2) for standard field attire and working conditions.

11.1.4. Determining Compliance with the Exposure Levels

Table 11-3 can be used to select the appropriate column of work demand level with the WBGT to compare with the heat stress exposure values in Table 11-1 to determine the correct work and recovery interval. Recovery does not necessarily mean a complete break from work but could involve performing light tasks, as listed in Table 11-2. Table 11-3 details the work/rest/hydration guidelines for the acclimated healthy worker that has not had heat stress or dehydration prior to this task and will have several hours to rest afterwards.

11.1.5. Work/Rest Guidelines When Wearing PPE

When wearing Tyvek suits with hoods and foot coverings or boots and gloves, ambient temperatures and the work rest ratios have been modified as shown on Table 11-4. Every worker who will be working in semipermeable clothing when the temperatures exceed 68°F will be personally monitored. Personnel monitoring can be accomplished by checking the heart rate, recovery heart rate, oral temperature, or extent of body water loss, as discussed below:

- To check the heart rate, count the radial pulse for 30 seconds at the beginning of the rest period. If the heart rate exceeds 110 beats per minute (bpm), shorten the next work period by one-third and maintain the same rest period.

- The recovery heart rate can be checked by comparing the pulse rate taken at 30 seconds with the pulse rate taken at 2.5 minutes after the rest break starts. If the pulse has dropped by at least 10 bpm and is less than 90 bpm, then it is considered a satisfactory recovery time and heat stress is not presently a threat. If the heart rate has not dropped sufficiently, then the individual is under too much stress and the work/rest ratios must be modified.

- Oral temperatures can be checked with a clinical thermometer (digital is preferred for field conditions) after working but before drinking any fluids. If the oral temperature taken under the tongue exceeds 99.6°F, shorten the next work cycle by one-third.

- Body water loss can be measured by weighing the worker on a scale at the beginning and end of each workday. The worker's weight loss should not exceed 1.5% of total body weight in a workday. If weight loss exceeding this occurs, then fluid intake should be increased.

11.1.6. Physiological Assessment Monitoring

Since the majority of the work will be conducted outside during the summer and fall months, heat stress may affect the safety and health of field personnel. The ambient air temperature will be measured at 4-hour intervals during the day using a WBGT index monitor placed at a work location with similar conditions as those experienced by the workers for temperatures below 75°F. WBGT readings will increase to every 2 hours when the ambient air readings reach 75°F. The SSHO should assess the condition of the employees, specific weather conditions, work tasks, and other environmental factors and conditions to determine when to begin monitoring.

Physiological monitoring, which will occur if workers show signs of excessive heat strain, will include taking pulses from site workers manually, using a battery operated blood pressure cuff, or using a fingertip pulse oximeter. Signs of excessive heat strain will be assessed during the rest periods for each worker. Excessive heat stress can be recognized by one or more of the following stress indicators:

- A sustained heart rate greater than 180 bpm minus the individual's age in years for persons with normal cardiac performance;

- Recovery heart rate after resting for a minute greater than 110 bpm; and

- Sudden complaint of severe fatigue, nausea, dizziness, or lightheadedness.

With any of these symptoms, the worker should stop working, rest in a cool location with circulating air, and drink cool fluids.

11.1.7. Heat Illnesses and Health Effects

The body reacts to heat by increasing blood flow to the skin surface, which allows the heat to be carried away from the internal organs to the surface of the body. The body also reacts to heat by perspiring, which cools the body as the sweat evaporates from the skin. Heat stress will occur when the body cannot control its internal temperature. Factors that lead to heat stress include air temperature, work rate, humidity, and clothing worn while working. Heat stress can affect individuals in different ways and some are more susceptible to it than others. Heat related illnesses include:

- **Heat Rash** is one of the most common complaints when working in hot environments and can be identified by a red rash in areas where clothes are restrictive. As sweating increases, the rash papules create a prickly sensation (sometimes called prickly heat) with moderate to severe itching. Heat rash occurs most commonly around waistbands and neckbands where skin is persistently wetted by un-evaporated sweat. It can cause heat intolerance if 20% of the skin surface is affected. In most cases, the heat rash will disappear when the individual returns to a cool environment and wet articles of clothing are removed.

- **Heat Cramps** are painful muscle cramps or spasms that have been attributed to an electrolyte imbalance caused by sweating. Heat cramps can be caused by too much or too little salt in the body. Cramps are an indicator that there has been a lack of fluid replenishment and may indicate that the person is not fully acclimated to the hot working conditions. Rest in a cool place and alternate water with commercial electrolyte replacement liquids every 15 to 20 minutes until symptoms subside.

- **Heat exhaustion** symptoms include headaches, dizziness, or lightheadedness; weakness; mood changes (irritability); confusion or the inability to think straight; upset stomach; stomach cramps; and pale, clammy skin. When these symptoms are recognized, act immediately because if heat exhaustion goes untreated, it may lead to heat stroke or death. Move the victim to a cool shaded area to rest. Loosen and remove any excess clothing. Have the person drink cool water (about one cup every 15 minutes). Move the person to an air conditioned environment if available or move to a shaded area, then cool person's skin by fanning, spraying with cool water, or applying a wet cloth to the skin. Call 911 for emergency help if the person does not feel better in a few minutes.

- **Heat Stroke** occurs when the body's internal cooling mechanisms fail and the core body temperature rises to critical levels. The occurrence of heat stroke may be difficult to predict but is usually attributed to prolonged exposure to high temperatures, prolonged and overwhelming heat stress, accumulative heat stress due to strenuous activities in hot environments, or predisposing factors such as illness, poor health, or medications. Heat stroke symptoms include pale, dry skin with no sweating, hot red skin that looks sunburned, mood changes (irritability), confusion, seizures, and unconsciousness. This is a medical emergency and can lead to death. Call 911 immediately for emergency help. Begin cooling the victim’s body aggressively by moving the person to a cool, shaded, or air conditioned area; and then loosening and/or removing any excess clothing. If alert, have the person drink cool water (one cup every 15 minutes). Cool the person's body by fanning, spraying with cool water, placing ice packs under the armpits, or covering with a wet sheet until medical help arrives. Heat stroke could progress to possible death.

The following key points should be discussed with personnel about heat stress:

- The human body functions best at approximately 98.6°F and works naturally at maintaining a "normal" temperature.

- The body will use stored energy for physical work, turning about three-fourths of the energy into heat and only one-fourth into motion.

- The harder the body works, the faster it generates heat and the more the body has to get rid of. In hot weather with high humidity and work clothing, the transfer of excess body heat to the atmosphere is slowed, increasing the risk of heat stress.

- When the body produces heat that raises the internal body temperature, the heart rate quickens and vessels expand to carry more blood to the outer layers of the skin to gradually release body heat into the environment.

- If excess heat is not released fast enough this way, then sweat glands draw water from the bloodstream to make sweat on to the skin's surface where it evaporates and releases heat.

- When more blood has to flow to the body’s surface for cooling, less blood is available to the muscles, brain, and other internal organs. With prolonged sweating, less water is available in the bloodstream for the transport of nutrients to the organs, transport of wastes, lubrication of joints, and cooling of the body later,

- The continual loss of water increases the chance of experiencing heat illness symptoms.

- Drinking small amounts of water frequently (i.e., 6 to 8 ounces every 15-20 minutes) is more effective than taking large amounts less often. Avoid drinks with caffeine (which acts as a diuretic) and sugar (which blocks the transfer of fluids to the bloodstream). Hourly fluid intake should not exceed 1 ½ quarts.

- Do not rely on thirst as the signal to drink. Most people do not feel thirsty until the fluid loss has reached 2% of body weight, which is already affecting the body.

- If you notice heat illness symptoms, stop and rest to stop generating heat, get fluids, and tell a supervisor as soon as possible. A person with a fluid loss of 8% of body weight is likely to have a core temperature of 104°F and is in serious risk of heat stroke.

11.1.8. Engineering Controls and Work Practices

When planning field work, the following guidelines will be followed to prevent heat related injuries:

- Adjust work schedule to minimize consecutive days of heavy work, especially if other heat stressors exist.

- Plan and provide adequate hydration for all personnel.

- Keep in mind the location of the work (e.g., sun, shade); rest in the shade or in enclosed or windy areas.

- Remove PPE required for the task or excess clothing during breaks.

- Acclimatization can take 7 to 14 days depending on the physical condition of the worker.

- Identify personnel that have previously suffered from heat exhaustion, overweight personnel, persons taking medication, ill individuals, or those who have admitted to consumption of alcoholic beverages within 24 hours.

- Plan adequate time for lunch breaks and use the “buddy” system to ensure meals are eaten.

- On hot days, remove hard hats unless specific safety reasons exist to keep them on (i.e., during heavy equipment operations).

- Provide job site training to ensure all personnel can recognize the warning signs and symptoms of heat stress.

- Schedule additional personnel to work on the project so that personnel can alternate work if wearing PPE.

- Alternate job tasks between varying degrees of physical demand throughout the day.

- Wear light-colored, light-weight, non-restricting clothing.

- Bottled drinking water and electrolyte replacement beverages will be maintained on site in a clean, insulated cooler that keeps the liquids cool. Site personnel are encouraged to drink small amounts of water (8 ounces) frequently.

- When working in hot environments, daily tailgate meetings will include training on the characteristics and symptoms of heat stress, contributing heat related injuries, and contributing factors and prevention.

- When possible on hot days, work will be scheduled early in the day (at sunrise), stopped for the day during the midafternoon, and personnel may return to the job later in the day (but before dusk) when the heat index is not as intense.

- Schedule breaks in cooler, shaded locations and use cooling devices if available.

- Use the buddy system to monitor for signs and symptoms of heat related illness and to encourage adequate hydration.

- At the initial site safety indoctrination, instruct personnel to start hydrating 1 to 2 days before the start of the project and to avoid alcoholic and caffeinated beverages that can dehydrate the body.

- When possible, park vehicles downwind so not to obstruct wind flow across the site.

- Personnel not acclimatized should notify the SSHO so as to allow for additional breaks, as necessary.

- Additional breaks should be allowed at the beginning of the work week for all site personnel that have spent a considerable amount of time indoors over the weekend to re-acclimate them to field conditions.

It is the responsibility of the SSHO and each crewmember to ensure that temperature stress controls are adequate for site conditions and tasks. All crewmembers, specifically the SSHO, are empowered and expected to stop or modify work and take any precautionary measures in order to prevent temperature related illnesses. NEVER ignore anyone's signs or symptoms of heat-related disorders. Inform co-workers to stop working immediately and tell the field manager if they become lightheaded, confused, weak, and faint or have a pounding heart or trouble breathing.

11.2. Cold Stress

Additional cold weather hazards exist from working on snow or ice covered surfaces. Slips, falls, and material handling hazards increase under these conditions. Every effort must be made to ensure walking surfaces are kept clear of ice. Exposure to low temperatures may be a factor during winter field activities, and can be a concern at other times of year if the conditions are right. Relatively cool ambient temperatures and wet or windy conditions increase the potential for cold injury to personnel. The SSHO will be responsible for obtaining meteorological information to determine if additional cold stress administrative controls are required. If necessary, and as applicable, ACGIH guidelines will be followed for work-warm rest regimens in cold environments.

11.3. Ultraviolet Radiation

When working outdoors, employees can be exposed to ultraviolet radiation with the potential for sunburn over a period of time, which could lead to health effects such as skin cancer. Workers should be encouraged to limit sun exposure whenever possible by standing in shady areas away from reflective surfaces (i.e., asphalt or concrete parking lots, water or sandy surfaces). Workers will be encouraged to wear light colored work clothes with a built in sun protection factor (SPF) and/or apply sun screen with an SPF of 15 or higher (appropriate to their skin type) approximately 30 minutes before exposure to sun and reapplied every 2 hours or in accordance with the manufacturer's recommendation.

If sunburn occurs, redness will develop 2 to 6 hours after exposure with peak painful effects experienced at 12 to 24 hours after sun exposure. Other common symptoms that may occur include chills, fever, nausea, or vomiting.

Sunburn blisters indicate a second degree burn and may require medical treatment if they cover a large portion of the body, cause persisting severe pain, result in a high fever, or if the skin condition is not noted in a few days. Sunburn should be treated by applying cool compresses to the affected skin and apply aloe to the affected skin; avoid breaking skin blisters as it slows the healing process and increases the risk of infection. Employees will be instructed to stay out of the sun while they are sunburned. Skin screenings for changes in the skin’s appearance, presence of moles, or changes in moles or other skin variations that could indicate pre-cancer or cancer should be evaluated in the employee’s annual physical.

11.4. Severe Weather Conditions

Field personnel will follow standard safety guidelines for severe weather. When there are warnings or indications of impending severe weather (i.e., heavy rains, thunderstorms, damaging winds, tornadoes, hurricanes, floods, lightning, hail, etc.), weather conditions will be monitored using a weather station that is part of the National Oceanic and Atmospheric Administration weather radio all hazards network (or similar notification system) or arrange for the Army Ordinance point of contact to contact site personnel if weather conditions change. At the daily safety meeting, weather conditions and the location of buildings or other appropriate places of refuge will be discussed so that appropriate precautions can be taken to protect personnel and property from the effects of the severe weather.

If any individual sees lightning and/or hears thunder, there is already a risk of being struck. Louder or more frequent thunder indicates that lightning activity is approaching, which increases the risk for injury or death. If the time delay between seeing the flash (lightning) and hearing the bang (thunder) is less than 30 seconds, site personnel should be in or seek a safer location (i.e., a vehicle or grounded building). Personnel will be made aware that this range method has severe limitations due to the difficulty of associating the thunder to its corresponding flash.

High winds, rainfall, and cloud cover often act as precursors to actual cloud-to-ground strikes for notifying individuals to take action. Many lightning casualties occur at the beginning of a storm as it approaches because people ignore the precursors. Lightning casualties also occur after the perceived threat has passed. Generally, the lightning threat diminishes with time after the last sound of thunder; however, it may persist for more than 30 minutes. When thunderstorms are in the area but not overhead, the threat of lightning still exists regardless if it is raining, sunny, or if clear skies are visible.

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12. STANDARD OPERATING PROCEDURES, ENGINEERING CONTROLS, AND WORK PRACTICES

12.1. Site Rules and Prohibitions

Safety procedures, controls, and work practices will be used at the project work site to prevent or reduce personnel exposure or injuries. The use of hazard controls will follow the hierarchy of engineering the hazards, administratively controlling hazards, and implementation of PPE. In most cases, the control of hazards will involve each control. Basic standard operating safety procedures, controls, and work practices are summarized in Table 12-1.

12.2. Work Permit Requirements

The contractor will obtain and coordinate with USACE to obtain all permits necessary for the safe execution of this project prior to the commencement of the project. Copies of all applications and permits will be provided to the USACE and Environmental Protection Agency (EPA), and additional copies kept onsite during active work.

12.3. Material Handling Procedures

Soil excavation, material handling, and treatment processing activities will be initiated and sequenced beginning in a topographic upgradient direction and proceeding in a downgradient direction. This will prevent recontamination of remediated areas.

Throughout the excavation and soil handling activities, stormwater and erosion control measures will be maintained both upgradient and downgradient of the excavation areas to minimize the potential for stormwater run-on and run-off.

12.4. Emergency Response

Emergency response plans detailing the procedures, tests, and emergency notifications for spills, fires, and evacuation routes are stated in Section 10.2 of the APP.

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13. SITE CONTROL MEASURES

During all phases of the scope of work, controls (primarily measurements of surface and airborne radioactivity and dust suppression with water) will be implemented to minimize the DU dust exposure. DU dust has a high density and does not easily disperse like many other materials (e.g., asbestos). Physical containment and proper work practices will be sufficient to prevent untoward spread of dusts outside the immediate working zone. All due caution will be exercised by field staff to avoid actions that would tend to transport project derived dusts from leaving the work zone.

The PM and SSHO should be consulted regarding equipment layout at the project site to minimize hazards from equipment. Equipment layout at the project site should reflect the nature of the hazard present and be mitigated by the use of engineering controls (i.e., barriers, guards, and isolation); administrative controls (i.e., roped-off restricted areas or controlled access); and qualifications of operators and those assisting in the operation of the equipment, when required.

Good housekeeping will be maintained at all times during the course of the project. This includes maintaining working and walking surfaces to minimize tripping hazards, stacking or storing materials and equipment in a central location when not in use, and regularly cleaning up debris and trash that may accumulate at the project site.

The perimeter of the IAAAP installation is fenced to control access to the site by unauthorized personnel.

All visitors to the site will be required to sign-in and explain their reason for visiting the work site. Site control and security will be maintained by personnel at the project location during all activities to prevent unauthorized personnel from entering the controlled work area (CWA). The CWA will be based on the potential hazards, complexity of work tasks, duration of project tasks, and location and number of non-project personnel near the project area.

Where workers will likely encounter debris, an exclusion zone (EZ) buffered by a contamination reduction zone (CRZ) with a contamination reduction corridor will be established for entering and exiting the CRZ (established for higher-hazard contamination areas). Figure 13-1 illustrates a generalized configuration of an EZ. This figure represents the general configuration of work zones and is not intended to provide an exact layout or configuration of all equipment or zone sizes. Several factors may influence the need to change zone configurations, sizes, and locations. These factors include the site being investigated, project tasks being conducted, site monitoring data, and changing wind direction. Additionally, entrance and egress points may change based on these same factors.

Visitors may be admitted into work areas outside the EZ/CRZ if they are on official business, have received site-specific training or orientation by the field project engineer or designee, have documented evidence (i.e., training record or cards) for all site-specific training requirements for the site they wish to access, and wear required PPE for the area.

13.1. Exclusion Zone

The EZ is the area where contamination or potential contamination exists. Since this area has the potential for workers to be exposed to site contaminants and safety hazards, all field personnel entering this area will wear the appropriate PPE (minimum of Level D) and adhere to the training and medical surveillance requirements presented in this document. Field personnel entering the EZ will enter and exit through the established entry and exit control points. Gross decontamination will take place near the “hotline” in the EZ before proceeding to the support zone (SZ). The EZ will be demarcated by using lines, placards, and hazard tape and/or signs, or will be enclosed by physical barriers such as chains, fences, or ropes.

13.2. Contamination Reduction Zone

The CRZ will be located between the EZ and the SZ. It is the area where field staff and equipment will undergo gross decontamination and will serve as a control point for entry and exit into the EZ. The CRZ will serve as a buffer to reduce the probability of transporting contaminants as well as the possibility of being affected by other existing hazards. It will provide additional assurance that the physical transfer of contaminants via personnel or equipment is limited through a combination of decontamination procedures and a minimum required distance between the EZ and SZ.

13.3. Support Zone

The SZ is the area outside the EZ and CRZ and is considered free from recognized site hazards and contaminants and will not be delineated. Support equipment (i.e., project vehicles, supplies, etc.) will be located in this area. Since eating is permitted in this area, potentially contaminated personal protective clothing, equipment, and samples will not be permitted beyond the EZ or CRZ. The location of the SZ at each site will depend on a number of factors, including:

- Accessibility—topography, open space available, locations of roads, or other limitations;
- Visibility—line of sight to all activities in the EZ is preferable;
- Wind direction—the support facilities preferably should be located upwind of the EZ. Shifts in wind direction and other conditions may be such that an ideal location based on wind direction alone does not exist; and
- Resources—water, electricity, or places of refuge.

13.4. Site Security

As discussed above, the IAAAP perimeter is fenced. Contractor personnel will maintain site security and will prevent unauthorized personnel from entering work areas. Contractor and subcontractor vehicles will all be clearly marked with their company name on the side for quick identification.

Where chemical or physical hazards beyond existing conditions are created, the following measures will be implemented. To maintain security at the site locations during working hours, the SSHO will:

- Control all site entrances/exits through the appropriate work control zones;
- Establish a personnel identification system, including limitations to an individual's approved activities;
- Coordinate traffic control measures (if necessary);
- Be responsible for enforcing entry/exit requirements;
- Use caution tape and temporary fencing where feasible; and
- Post warning signs and use caution tape around the perimeter of the SZ if the use of temporary fencing is not feasible.

To maintain security during nonworking hours, the SSHO will secure the site prior to leaving at the end of a working day. All equipment and supplies will be secured or stored in locked facilities, and any open holes and trenches will be placed in a safe configuration, barricaded, or roped off.

13.5. Site Communications

Primary means of external communication devices are telephones, cell phones, radios, and computer networks. External communication systems between on-site and off-site personnel are necessary to:

- Coordinate emergency response efforts,
- Report to senior management concerning site activities, and
- Maintain contact with essential off-site personnel.

Verbal communication can be impeded by on-site background noise and the use of PPE. Thus, it is vital that pre-arranged signals of communication be arranged prior to the initiation of site activities, particularly when heavy equipment work is involved.

A Hazard Communication Plan is presented in Section 10.8 of the APP.

13.6. Safety and Health Inspections

Safety and health inspections are discussed in Section 8 of the APP.

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14. PERSONAL HYGIENE AND DECONTAMINATION

A personal hygiene and decontamination station will be set up in the CRZ for the purpose of donning and doffing disposable coveralls and other PPE used inside the EZ. The CRZ will have facilities to wash hands and face that will include disposable wet wipes (at a minimum). Site workers will wash their hands, face, and exposed skin surfaces with soap and water upon leaving the work zone and prior to ingestion of food or liquids. A portable hand washing facility with potable water, soap, and paper towels will be located in the CRZ and the SZ.

A second alternative will be available for DU decontamination on the workers' hands. Washing hands with standard soap and water does not always remove all heavy metal contamination. The National Institute of Occupational Safety and Health (NIOSH) developed a quick and easy hand wipe technology to notify workers if they have uranium on their hands along with a decontamination wipe, which removes 98% of heavy metal residues from the skin (NIOSH, 2012). Hygiene wipes will be used onsite prior to washing hands.

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15. EQUIPMENT DECONTAMINATION

All equipment used during site activities will be surveyed in and out of the designated work areas. Equipment and vehicle tires will be cleaned and free of any caked-on mud prior to demobilization from the site. Every effort will be made to keep roads clear of soils and sediment during debris transport.

15.1. Respirator Decontamination

The cleaning and sanitizing of respirators will be accomplished in the following manner:

1. The apparatus is broken down into its components, as described in the manufacturer's schematic display that accompanies the unit. Each of the components will be inspected for any defects, excessive wear and tear, etc.

2. Thoroughly wash the face-piece and mask components in a disinfecting cleaning solution at a water temperature not exceeding 120°F. The components will be scrubbed with a sponge, wipes, or soft brush to remove dust, dirt, or other contaminants.

3. Thoroughly rinse all component pieces in warm water.

4. Air dry all components thoroughly, inspect for defects, reassemble units, and store properly until the next use.

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16. EMERGENCY EQUIPMENT AND FIRST AID

Fire extinguishers (type A:B:C), spill kits, and first-aid kits will be maintained in all vehicles and in the SZ onsite.

16.1. Logs, Reports, and Recordkeeping

The PM will ensure maintenance of the logs and records that relate to all aspects of SSHP implementation. These records will be available upon request by the USACE contracting officer representative. They will include, at a minimum:

- Site-specific indoctrination,
- Tailgate meetings,
- Equipment maintenance,
- Exposure assessment monitoring (if deemed necessary), and
- Contractor monthly summary record of injuries/illnesses and work hour exposure.

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17. REFERENCES

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29 CFR 1010.134, *Code of Federal Regulations*, Title 29, “Labor,” Part 1010, “Respiratory Protection Standard,” Office of the Federal Register.

29 CFR 1910, 2002, Title 29, “Labor,” Part 1910, “Occupational Safety and Health Administration,” Code of Federal Regulations, Office of the Federal Register.

40 CFR 300, 2000, *Code of Federal Regulations*, Title 40, “Protection of Environment,” Part 300, “National Oil and Hazardous Substances Pollution Contingency Plan,” Office of the Federal Register.

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18. FIGURES

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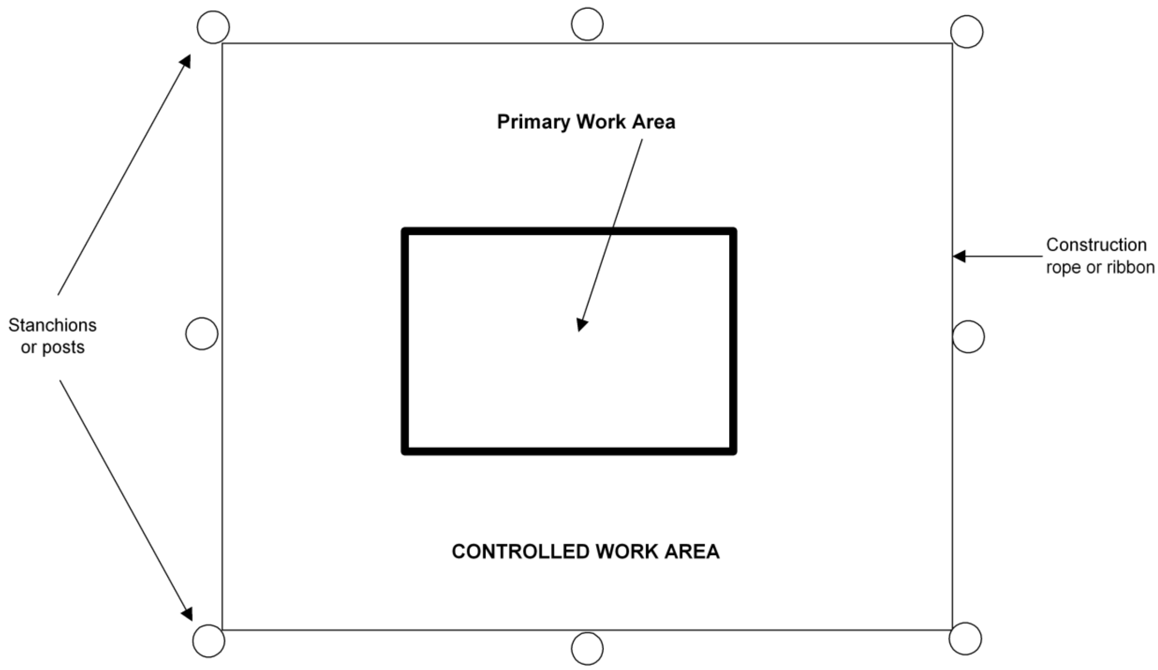

Figure 13-1. Configuration of work control zones (EZ, CRZ, and SZ).

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19. TABLES

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Table 4-1. Contact information for project personnel.

Key Project Position	Contact Information
USACE PM	To be determined (TBD)
USACE Contracting Officer Representative	TBD
PM	TBD
Field Project Engineer	TBD
HSO	TBD
SSHO	TBD
Radiation Safety Officer	TBD
Emergency – Police Department, Fire Department, Ambulance	911
Great River Medical Center	Great River Medical Center 1221 S. Gear Ave. West Burlington, IA 52655-1679 (319) 768-1000 Call 911 for an ambulatory emergency
Poison Control Center	800-222-1222
EPA Superfund Hotline	800-424-9346
EPA National Response Center (to report releases to the environment in excess of a reportable quantity)	800-424-8802

Table 5-1. Heavy metal health effects.

Metal	Health Effect/Potential Hazards
Antimony	Eye, skin, nose, throat, mouth irritant, dizziness, headache, vomiting, diarrhea, insomnia
Arsenic	Cancer, respiratory irritation, hyperpigmentation of the skin
Barium	Kidney damage, paralysis, abnormal heart rhythm, lung damage
Cadmium	Difficulty breathing, nausea, vomiting, diarrhea, cancer, chest tightness, headache, chills, muscle aches
Chromium	Eye and skin irritation, lung fibrosis
Lead	Lassitude, kidney disease, hypotension, abdominal pain
Mercury	Brain damage, kidney damage, lung damage, nausea, vomiting, increased blood pressure
Silver	Argyria, breathing problems, lung and throat irritation, stomach pain
Thallium	Nausea, diarrhea, vomiting, abdominal pain, liver and kidney damage, tremor, convulsions

Table 5-2. Explosives health effects.

Explosive	Health Effect/Potential Hazard
HMX	Liver and central nervous system damage
RDX	Seizures, possible carcinogen, skin and eye irritant
TNT	Anemia, abnormal liver function, enlarged spleen, skin irritation, possible carcinogen

Table 5-3. Biological Hazards - Insects and Arachnids.

Insects and Arachnids	Illness/Reaction	Symptoms/Treatment	Prevention
Mosquitos 	Encephalitis – Inflammation of the brain (viral)	Headache, irritability, seizures, stiff neck, fever No treatment available	• Stay indoors at dawn and dusk • Wear long sleeve shirt and pants • Use insect repellant • Empty standing water • Avoid shady places and grassy areas • Stay in open breezy places • Keep moving
	Meningitis-Inflammation of the thin lining covering the brain and spinal cord (viral)	Fever, stiff neck, headache, fatigue, rash, sore throat No treatment available	
	West Nile Virus	Fever, headache, body aches, rash, stupor, tremors, convulsions, vision loss, paralysis	
Bees, Hornets and Wasps 	Mild redness and swelling to anaphylactic shock	Mild reactions – redness, pain, and inflammation to site of sting/apply paste of Adolf Meat Tenderizer in first 15 minutes and apply ice to affected area Severe allergic reaction – rapid constriction of airway-call 911	• Watch for and avoid nests in remote wooded areas • Most active in warm weather • If you see several hovering around look for nest and avoid • May strike suddenly and inflict multiple stings • Carry wasp and hornet spray in vehicle
Fire Ants 	Bite to get a grip and then stinging (from the abdomen) toxic alkaloid venom	Bite causes stinging and swells into a bump. Some people will have allergic reactions (anaphylaxis). Apply meat tenderizer paste or a solution of half bleach and half water (1st 15 minutes) to reduce pain. Rubbing aloe vera juice or antihistamine/topical creams reduces itching	• Fire ants nest in soil near moist areas such as watered lawns, highway edges and river banks. • Watch where you walk and don't stand in one place very long if you see any ant activity
Ticks 	Lyme Disease	Black legged deer tick & very small. Bulls eye rash, muscle aches and joint aches, arthritis and pain if untreated	• Ticks hide in shady moist ground, on long grasses and in woods. They cannot jump or fly but attach by direct contact. Look for them on back of knee, groin, navel, armpit, ears or nape of neck • Wear light colored clothes • Wear long pants and long sleeves • Spray clothing with insect repellant with DEET
	Rocky Mountain Spotted Fever	Deer tick, symptoms include severe headache, fatigue, deep muscle pain, chills, nausea and rash	

Table 5-3. (continued).

Insects and Arachnids	Illness/Reaction	Symptoms/Treatment	Prevention
Scorpions 	Sting with their tails and resembles a bee sting	Burning sensation at first but if allergic reaction call 911. Can cause cardiac and respiratory problems	• Wear field boots and long pants to deter sting • Do not reach into dark crevices • Careful moving rocks and wood
Spiders Brown/Black Widow 	Affects the nervous system and causes pain in the lymph nodes Black or brown shiny with red or orange spot under side of abdomen	Minor burning at time of bite with appearance of small puncture. Within an hour, intense pain is felt at the site of the bite which spreads quickly with sweating, muscle spasms, slurred speech and poor coordination	• No effective first aid or treatment. Seek medical treatment • Avoid usual habitat - wood piles, under eaves, in meter boxes or other undisturbed places
Brown Recluse 	Dark violin marking on head and thorax Not aggressive- bites when disturbed	The venom kills tissue at the site of the bite. The majority of bites heal without severe scarring. May feel stinging sensation with intense pain. Affected area becomes red and volcano lesion forms. Recovery may take several months	• Shake out clothing and shoes • Inspect PPE before use • Be careful opening card board boxes • Wear gloves reaching into dark crevices

Table 5-4. Biological Hazards - Plants Causing Skin Irritations.

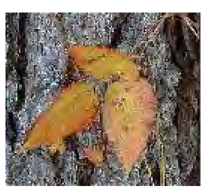
Plant	Description	Reaction/ Symptoms	Preventative Measures
Poison Ivy	  Summer Fall Thrives in weather conditions and light. Contains Urushiol oil, which causes sensitivity and allergic reactions	Blistering at site of contact within 12 hours followed by severe itching and burning and can last 1 to three weeks	Contact with Urushiol Oil can occur in three ways: • **Direct contact**- touching the sap of the plant • **Indirect contact**- touching something on which Urushiol is present such as on animals fur, clothes, tools, or anything objects come in contact with • **Airborne contact**- burning puts Urushiol particles in the air. Sensitivity will change from season to season Rubbing the rash will not spread it and the oil is not in the blisters • AVOID plants; learn to recognize them • Avoid direct burning of brush and wood, trimming of brush • Wash clothing after working in locations where these plants could or are located
Poison Oak	  Summer Fall Is usually a shrub though sometime becomes a vine, Leaves come in threes. Middle leave has distinct stalk and are shiny. Loses its leaves in winter making it difficult to recognize	Contains Urushiol Oil and has the same symptoms as above	

Table 5-4. (continued).

Plant	Description	Reaction/ Symptoms	Preventative Measures
Poison Sumac	 A slender shrub. Grows in the bogs of the Northeast and Midwest and in the swampy areas of the Southeast. Each leaf has 7 to 13 leaves and fruit grows between the leaves	Contains Urushiol Oil and has the same symptoms as above	• Wash hands, face and other exposed areas at the beginning of each break and at the end of the workday
Wild Parsnips	 Root vegetable related to a carrot. Rosettes grow close to the ground and bear leaves averaging 6 inches in height.	Contains furanocoumarin and causes phytophotodermatis, a chemical burn that symptoms include redness, burning, tingling, blisters	• Wear protective clothing, wash area immediately and keep out of sunlight

Table 5-5. Biological Hazards – Animals.

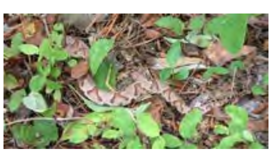
Poisonous Snakes	Description and Habitat	Reaction/Symptoms	Preventative Measures and First Aid
Cottonmouth 	Large aquatic snake, are generally olive, brown or black and heavy bodied. More active at night. Found in wetlands, rivers, lakes. They get their name from their defensive habit of gaping their mouths open to expose the white lining of the mouth	Can be aggressive. May strike but not inject venom. Venom is hemotoxic, causing swelling and necrosis near the site of the wound, may be fatal if not treated promptly	• Watch were you place your hands and feet when removing debris • Wear boots at least 10 inches tall • Leave snakes alone; stay back at least 6 feet • Have a companion when working in the field • Be alert for dry ground and open sunny areas where snakes like to sunbathe *First Aid* • Note the color and shape of the snake's head to help with treatment Take a picture of the snake if possible but DO NOT try to catch the snake • Seek medical attention and stay calm
Copperhead 	Can grow over 4 feet long, have patterns of brown crossbands over the body, which can be copper, orange or brown. Has pits on both sides of face to detect body heat from prey. Found in wooded areas among rocks or on edges of streams or ponds. They are good swimmers. Are nocturnal during the summer	Not aggressive and bite only when threatened. Venom is rarely fatal. It lashes out to warn and injects little venom. Symptoms of bite may include pain, swelling, weakness, breathing difficulty, nausea, vomiting, fever or unconsciousness	

Table 5-5. (continued).

Poisonous Snakes	**Description and Habitat**	**Reaction/Symptoms**	**Preventative Measures and First Aid**
Eastern Diamondback Rattlesnake 	Color is grayish brown patterned with light-centered dark diamonds bordered by a row of yellow or cream colored scales. A dark line runs through the eyes to the back of the jaw. Dry habitats from wooded areas to sandy beaches. Often live in gopher tortoise burrows or in stumps	Diamondbacks lurk motionless in shadows for hours. When they are disturbed, their warning rattle is loud and clear. 50% of bites are dry with no venom injected. Symptoms may include pain, severe swelling, bruising, blistering, headache, abdominal pain, yellow vision, numbness in digits	• Wash the bite with soap and water • Immobilize the bitten area and keep it lower than the heart DO NOT: • No ice or cooling on the bite • No tourniquets • No incisions in the wound A light dressing can be placed across the bite of a coral snake but that is the only snake bite that should be covered with any kind of dressing
Dusky Pygmy Rattlesnake 	Small, grey with irregular black blotches with orange blotches by the head. Rattle sounds like an insect buzz. Lives near lakes and marshes, in dry habitats. Lives in gopher tortoise tunnels	Bite is not fatal but can be extremely painful and in some cases can cause serious local tissue damage and nausea, vomiting and vertigo	
Eastern Coral Snake 	Coral Snakes are highly venomous, medium- sized snakes. Their patterning and coloration consists of bands of dark-red, yellow, and black. They vary from well-drained pine woods to comparatively moist areas near ponds or streams. Coral snakes are secretive. They hide under leaves or mulch and in logs or stumps, and even among blades of grass	Despite their relatively small size, their venom is a powerful neurotoxin, quite capable of killing an adult human. Any bite from a coral snake should be considered life threatening and immediate treatment should be sought. Once the neurotoxin takes effect, it causes the neurotransmitters between the brain and muscles to malfunction. Initially symptoms are slurred speech, double vision, difficulty swallowing, but can quickly progress to muscular paralysis, and even respiratory or cardiac failure if not treated	
Timber Rattlesnake 	Measures between 3-4 feet, 6 inches long. Color patterns vary but all have dark, thick and wavy crossbands or stripes. Its habitat is generally forests and rugged terrain where it is cooler and damper. This snake is on the threatened list in many states	Though generally not lethal, swelling and tissue damage may occur from a bite. Like all other venomous snakes, it can control the amount of venom that is delivered	

Table 5-5. (continued).

Poisonous Snakes	Description and Habitat	Reaction/Symptoms	Preventative Measures and First Aid
Rodents Hantavirus Pulmonary Syndrome	Hantavirus infection can occur after inhaling infectious aerosols from rodent saliva or excreta. A greater number of infected mice leads to a higher risk for transmission to humans	HPS typically begins with headache, fever, and muscle pain soon followed by pulmonary edema (fluid in the lungs), which often leads to severe respiratory distress	• Safely clean up rodent-infested areas • Air out infested spaces before cleanup • Spray areas of infestation and all excreta, nesting, and other materials with household disinfectant or 10% bleach solution, then clean up, seal in bags, and dispose • Avoid sweeping, vacuuming, or stirring dust until the area is thoroughly wet with disinfectant • Wear rubber gloves; disinfect gloves before removal, and wash hands afterwards • In areas where plague occurs, spray insecticide on trapped rodents and nesting materials to prevent fleas from abandoning rodents to find new hosts

Table 8-1. Required protective clothing and safety equipment.

Level	Protective Clothing
A	Level A protection is not required during this project
B	Level B protection is not required during this project
C	All field personnel will have required Level C PPE available on site for the duration of field activities. Level D, or modified Level D, PPE with the addition of: • APR, full- or half-face, with high-efficiency particulate air, organic vapor, or combination P100 or N100 cartridges based on the contaminant and nature of the exposure • Additional PPE, as prescribed by the Radiation Safety Program and/or AHA
Modified Level D	• Tyvek coveralls • Nitrile butyl rubber outer gloves (or other, depending on the contaminant of concern – SSHO to specify) • Work clothing – Long pants, sleeved shirt • Safety-toed boots (ANSI Z41) • Safety glasses or goggles, as required (ANSI Z87.1) • Hard hat, where overhead hazards exist (ANSI Z89.1) • Hearing protection (as required if >85 dBA) • Gloves (leather for material handling or material as specified by the SSHO for other contaminants) • Nitrile gloves will be worn by personnel who may come in contact with waste or contaminated environmental media • Chain saw operator will don chaps, leather gloves and a face shield with safety glasses or goggles.
D	• Work clothing – Long pants, sleeved shirt • Safety-toed boots (ANSI Z41) • Safety glasses or goggles, as required (ANSI Z87.1) • Hard hat, where overhead hazards exist (ANSI Z89.1) • Hearing protection (as required if >85 dBA) • Gloves (leather for material handling or material as specified by the SSHO for other contaminants) • Nitrile gloves will be worn by personnel who may come in contact with waste or contaminated environmental media.

Table 10-1. ACGIH TLVs® for noise.

	Duration per Day	Sound Level dBA[2]
Hours	24	80
	16	82
	8	85
	4	88
	2	91
	1	94
Minutes	30	97
	15	100
	7.5[3]	103
	3.75[3]	106

Notes:
[1] No exposure to continuous, intermittent, or impact noise in excess of a peak C-weighted level of 140 dB.
[2] Sound level in decibels are measured on a sound level meter, conforming as a minimum to the requirements of the American National Standards Institute Specifications for Sound Level Meters, SI.4 (1983) Type S2A, and set to use the A-weighted network with slow meter response.
[3] Limited by the noise source - not by administrative control. It is also recommended that a dosimeter or integrating sound level meter be used for sounds above 120 dB.

Table 11-1. Screening criteria for heat stress exposure*.

Cycle of Work and Recovery	TLV (WBGT in °F)				Action Limit (WBGT in °F)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75% to 100%	87.0	82.4	--	--	82.4	77.0	--	--
50% to 75%	87.8	84.2	81.5	--	83.3	78.8	75.2	--
25% to 50%	89.6	86.0	84.2	82.4	85.1	80.6	77.9	76.1
0 to 25%	90.5	88.7	86.9	86.0	86.0	84.2	82.4	80.6

*Based on WBGT in °F.

Notes referenced from TLVs for Chemical Substances and Physical Agents and Biological Exposure Indices (ACGIH, 2011).

- *Acclimated:* Physiological adaptations to become used to working in the heat. Full heat acclimation takes up to 3 weeks of continued physical activity under heat stress conditions working 5 of the 7 days in a week.
- *Un-acclimated:* Working less days or at a greater work demand than the acclimated person.
- --: Not applicable.
- The goal is to ensure that the workers' core body temperature does not go above 100.4°F.
- Length of the breaks will be determined by physical factors of each worker including site conditions, workers' fitness, cooling systems available, and variance in work demands.

Values in the table are applied by reference to the work-rest regimen and assume 8-hour workdays in a 5-day work week with conventional breaks.

Table 11-2. Levels of exertion.

Category	Examples
Rest	Sitting
Light or easy work	Sitting with light manual work with hands or hands/arms, standing with some light arm work. Examples: driving, labeling samples, taking field notes, field monitoring and site supervision.
Moderate work	Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work or light pushing and pulling. Constant walking at a normal pace. Examples: Sorting debris for recycling or landfill disposal or removal of hazardous materials from buildings
Hard or heavy work	Intense arm and trunk work, carrying, shoveling, manual sawing, pushing and pulling heavy loads, walking at a fast pace. Examples: Lifting and/or carrying larger demolition articles into bucket of front end loader, removing barracks furniture

Table 11-3. Work/rest/hydration guidelines.

Exertion	Easy or Light Work		Moderate Work		Hard or Heavy Work	
WBGT Index (°F)	Work/Rest (Minutes)	Water Intake (quarts per hour [qt/hr])	Work/Rest (minutes) Continuous Work	Water Intake (qt/hr)	Work/Rest (Minutes)	Water Intake (qt/hr)
78 – 81.9	NL	½	NL	¾	40/20 (Max 70 min w/o break)	1
82 – 84.9	NL	½	50/10 (Max 150 min w/o break)	¾	30/30 (65)	1-¼
85 – 87.9	NL	¾	40/20 (100)	1	30/30 (55)	1-¼
88 – 89.9	NL	¾	30/30 (80)	1-¼	20/40 (50)	1-¼
90 +	50/10 (180)	1	20/40 (70)	1-½	10/50 (45)	1-¼

Notes:

- NL- no limit to work time per hour, can sustain work for a least 4 hours at a time in the specified heat category.
- The work-rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hours of work in the specified work category.
- Fluid needs can vary based on individual differences (+/- ¼ qt/hr) and exposure to full sun or full shade.
- Rest means minimal physical activity (sitting or standing) in the shade if possible.
- Caution: Affected workers are encouraged to drink at least ½ cup every 20 minutes but hourly fluid intake should not exceed 1 ½ quarts.
- Daily fluid intake should not exceed 12 quarts.

Table 11-4. Work/rest/hydration guidelines for workers wearing PPE.

Exertion	Easy or Light Work		Moderate Work		Hard or Heavy Work	
WBGT Index (°F)	Work/Rest (Minutes)	Water Intake (qt/hr)	Work/Rest (minutes) Continuous Work	Water Intake (qt/hr)	Work/Rest (Minutes)	Water Intake (qt/hr)
68 – 71.9	NL	½	50/10	¾	30/30	1
72 – 74.9	NL	¾	40/20	¾	30/30	1-¼
75 – 77.9	50/10	¾	30/30	1	20/40	1-¼
78 – 89.9	50/10	¾	30/30	1-¼	20/40	1-¼
90 +	40/20	1	20/40	1-½	10/50	1-¼

Notes:

- NL- no limit to work time per hour, can sustain work for a least 4 hours at a time in the specified heat category.
- The work-rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hours of work in the specified work category.
- Fluid needs can vary based on individual differences (+/- ¼ qt/hr) and exposure to full sun or full shade.
- Rest means minimal physical activity (sitting or standing) in the shade if possible.
- Caution: Caution: Affected workers are encouraged to drink at least ½ cup every 20 minutes but hourly fluid intake should not exceed 1 ½ quarts.
- Daily fluid intake should not exceed 12 quarts.
- Electrolyte replacement drinks are also provided such as Gatorade® or PowerAde®.
- Only modesty garments should be worn under PPE.

Table 12-1. Safety procedures, controls, and work practices.

Title	Description
Hazard Communication	The SSHO will maintain an inventory and active chemical management process for chemicals brought to the work site, including: • Maintain copies of all material safety data sheets (MSDSs) for chemicals to which employees are potentially exposed. The MSDSs will be maintained at the project site and will be on hand before or as the chemicals arrive onsite. • Ensure an adequate manufacturer's label is in place on each chemical container, or label chemical containers with the chemical's identity and hazard warnings. • Store all chemicals properly in accordance with their MSDSs. Consider compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions, which will be addressed in each MSDS.
The Buddy System	The "buddy" system (two or more person system) will be used at the site when personnel have entered into an EZ. The buddy system requires each employee to assess and monitor his or her "buddy's" mental and physical well-being during the course of the workday and serves as a check for accountability. A buddy must be able to provide assistance; verify the integrity of PPE; observe their partner for signs and symptoms of heat stress, cold stress, or contaminant exposure; and notify other personnel if emergency assistance is needed. Workers need to be able to see or hear and effectively communicate with their buddy at all times when in the EZ.

Table 12-1. (continued).

Title	Description
Established Eating and Drinking Area	No chewing, eating, applying skin products, or drinking is allowed within work areas. As a minimum, all personnel will wash their hands prior to eating.
Material Handling	Material handling tasks pose a significant injury hazard to workers. Employees will use safe lifting techniques for manual material handling tasks. Whenever heavy or bulky material is to be moved, the material handling needs will be evaluated in terms of weight, size, distance, and path of movement to select the safest method for handling the material. When possible, materials will be handled using mechanical devices or handling aids as a preference to using manual material handling.
Electrical Safety	Only authorized qualified electricians will be allowed to install, modify, or work on electrical supply systems. This includes installation of a temporary electrical supply or modification of permanent electrical supply equipment. Project field personnel may utilize the electrical supply systems once installed for field use. The following precautions will be observed: - Prior to use, all electrical equipment, power tools, and extension cords will be inspected for damage. Damaged or defective electrical equipment will be removed from service immediately. - All electrical wiring or systems will be considered energized unless under the protection of lockout/tagout. - Extension cords will be equipped with a third wire ground.
Equipment Guarding	Hand and power tools will be used, inspected, and maintained according to the manufacturer's recommendations. The tools will be inspected, tested, and determined to be in safe operating condition before use. Defective tools will be removed from service and secured to prevent use until the tool has been returned to a safe condition. Power tools and equipment designed to accommodate guards will be equipped with such guards.
Tree and Brush Removal	The use of heavy equipment (e.g., dozers) is expected to be the primary form of tree felling and brush removal. Workers handling fallen trees and brush will don Level D PPE with hardhat, safety glasses, high visibility vests, leather gloves, and steel-toed (or equivalent) boots. Long sleeved shirts will be worn. No personnel may climb into a tree at any time unless they are a qualified tree worker working under the direction of a certified arborist.
Illumination	The project will perform outside work activities under normal daylight conditions or supplementary light plants will be provided to adequately illuminate the work area.
Housekeeping	Practice good housekeeping at all times. Place tools in the designated storage location after use. Put waste materials in the appropriate waste receptacle.
Work Site Sanitation	It is expected that bathroom and hand washing facilities will be available at each site. If not, restroom facilities and facilities for washing hands and face will be available for field personnel at the project site. All personnel will be required to wash their hands and face before eating or drinking in the SZ.

Attachment 1

Employee Training Acknowledgement Form

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EMPLOYEE TRAINING ACKNOWLEDGEMENT FORM

Accident Prevention Plan/Specific Safety and Health Plan

Project personnel signed below have read and/or reviewed the SSHP/APP and all appendices, understand it, and agree to comply with the requirements listed in the SSHP/APP.

Project Name:	**Project Number:** **Contract:**

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

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Addendum 1 to the APP Section 10.12 Radiation Safety Program
SITE-SPECIFIC RADIATION PROTECTION PLAN (SSRPP)
Iowa Army Ammunition Plant
Operable Unit 8,
Depleted Uranium Contaminated Soil and Structure Remediation

Revision 1

TABLE OF CONTENTS

A. INTRODUCTION

A.1. Scope

This Site-Specific Radiation Protection Plan (SSRPP) applies to radiological work being performed under the Remedial Action/Remedial Design (RA/RD) Work Plan at Iowa Army Ammunitions Plant (IAAAP) Operable Unit 8 (OU-8) located in Middletown, IA. This plan describes an RA that addresses depleted Uranium (DU) contaminated soil and structures resulting from U.S. Atomic Energy Commission (AEC) operations previously conducted at the IAAAP. This Plan augments the Accident Prevention Plan (APP) - Site Safety and Health Plan (SSHP) specifying the radiological controls for worker protection. When differing controls and Personal Protective Equipment (PPE) requirements are identified between this SSRPP and the APP-SSHP, the more stringent requirements will always apply.

A.2. Description of Work Tasks

Work tasks for OU-8 remediation include: mobilization and demobilization; clearing vegetation; radiological surveying; soil removal and segregation; soil sorting system; loading of contaminated soil, transportation of soil, disposal of contaminated soil and components; soil sampling; and decontamination of structures, equipment, and materials; and site restoration. For each activity/work task identified, an activity hazards analysis (AHA) was performed to identify hazards present and to provide guidance to eliminate or mitigate these hazards. The description of work tasks and their respective AHA is provided in Appendix A of the APP.

B. PREPARATION, APPROVAL AND MODIFICATIONS

B.1. Preparation and Review

This plan was prepared by:

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B.2. Modifications

Modifications to this document are to be made only by the assigned RPM and Project Manager.

C. RADIOLOGICAL CONDITIONS AND HAZARDS

DU is the main contaminant at the IAAAP. DU contains 99.80% by weight U-238 with a corresponding activity of 90.14 %. As a result, U-238 is the primary nuclide of concern. The primary radiation exposure pathways to workers associated with this project are ingestion, dust inhalation, and external gamma radiation exposure. The radiological risks were the basis for the development of the DU soil remediation goals (RG). This was largely due to most of the DU existing as fragments that are not readily bioavailable via usual chemical exposure pathways.

The existing characterization data is representative of the site and gives an indication of radiological conditions that must be taken into account when considering radiological controls, and keeping exposures As Low as Reasonably Achievable (ALARA). The existing data provides sufficient information to establish appropriate radiological controls for the project.

Table 1 lists each remediation areas and their specific radiological conditions with associated gamma data.

Table 1. Soil Remediation Areas/Structures Associated Radiological Conditions.

Soil Remediation Area or Structure	Radiological Conditions/Gamma Survey Results
Firing Site 12-Soil	DU-contaminated soil present in significant quantities. Gamma readings from 16,000 counts per minute (cpm) to exceeding 100,000 cpm.
Firing Sites 1 and 2-Soil	Small soils area previously remediated with MARSSIM survey and sampling results completed.
Firing Sites 3, 4, and 5-Soil	Contains DU fragment with readings ranging from 16,000 to 185,000 cpm left in place.
Firing Sites 6-Soil	DU-contaminated soil from fragment previously removed. Samples taken of the contaminated soil area indicated possible explosives contamination and aluminum and chromium metal contamination in the soil limited to one area.
Firing Sites 12-Structures	The two structures are a bunker adjacent to FS-9 and the FS-12 Control Building. Sludge in the basement of the bunker contains 427 pCi/g uranium activity and will need remediation.
Line 1-Building 1-63-6	Air filter in the heating, ventilation, and air condition (HVAC) system will be removed and replaced and the nearby portion of the heating, ventilation, and air condition (HVAC) system will need a radiological evaluation.
Line 1-Building 1-11	Floor grate previously identified with elevated gamma readings and contamination readings of 76,037 disintegrations per minute (dpm)/100 cm^2.

D. BASIS OF PLAN

D.1. Record of Decision ARARs

The IAAAP Site currently operates under the United States Army Corps of Engineers (USACE), Saint Louis District Formerly Utilized Sites Remedial Action Program (FUSRAP) Project Office. This RA work is the final remedy for the FUSRAP areas of IAAAP, designated as Operable Unit (OU)-8. This Comprehensive Environmental Response, Compensation, and

Liability Act (CERCLA) RA will proceed in accordance with the signed OU-8 Record of Decision (ROD).

D.2. Regulatory Considerations and Applicable Standards-DoD, USACE, FUSRAP Standards

The ROD identifies the following project applicable regulatory requirements in 10 CFR 20, Subpart E, Nuclear Regulatory Commission (NRC) Radiological Criteria for License Termination, Endangered Species Act for the Indiana Bat, and 10 CFR 20 Subpart B, Radiation Protection Programs. The design documents address these requirements and ensure compliance is incorporated into the project work activities. The design is developed in accordance with the following requirements manuals: DOD EM 385-1-1, Safety and Health Requirements Manual, USACE ER-380-1-18, Engineering Regulation, and USACE EM 385-1-80, Radiation Protection Manual.

Low levels of radiological contamination are expected at the site. Control of radiological work will be performed in accordance with the North Wind Radiation Protection Program which meets the requirements of EM-385-1-80, USACE Radiation Protection Manual. Negative assessment data radiological monitoring data (area surveys, air sampling, etc.) will be collected to verify that regulatory limits of 10CFR 20 are not met or exceeded.

D.3. Radiological Safety Overview

Radiation Protection Program implementation will include radiation safety practices that focus on prevention of internal dose through contamination controls, verified by ongoing monitoring until project completion. Radiation safety practices will be documented by monitoring site conditions to demonstrate compliance with this site-specific plan. All monitoring will be documented on approved survey forms, and maintained in corporate archives upon completion of the project. This site-specific operational approach will provide consistent implementation of applicable procedures, meet regulatory requirements and ensure radiation safety for all on-site employees.

E. ENGINEERING/WORK/ADMINISTRATIVE CONTROLS TO ADDRESS RADIOLOGICAL HAZARDS

E.1. Radiological Protection Coverage

The Site Radiation Safety Officer (SRSO) or designee will be present during intrusive field activities in any RCA. The SRSO is responsible for providing oversight for radiological work and implementation of the SSRPP. For consistency purposes, the title of SRSO is used throughout the IAAAP documents and this Plan.

E.2. Training

Training will consist of radiological worker training designed to familiarize all site workers with specific radiological hazards, controls, and emergency response. Personnel will also be trained on proper survey techniques (frisking) to perform personnel and equipment monitoring upon exit from any RCA. A practical evaluation consisting of donning and doffing PPE, reading postings, understanding radiation work permits (RWPs), etc. will be given for all personnel who will be performing radiological work as part of Radworker Training. This training will be administered to field personnel on-site by the SRSO or qualified radiation safety personnel prior to the employee starting field work.

E.3. Postings

A RCA will be established around work areas where intrusive construction activities are conducted. The established area(s) will provide the primary means to control and monitor radiological conditions of work areas, personnel, and equipment.

A Radiological Buffer Area (RBA) or Contamination Reduction Zone (CRZ) will be established between any RCA and the Support Zone (SZ). This zone provides a "buffer" area where personnel enter and exit the RCA, for employee or equipment frisking and decontamination, if required.

The SZ is considered to be free of surface contamination.

E.4. Anti-Contamination Clothing

Workers in the general construction area will be required to wear Level D PPE.

<u>Level D</u>

Steel Toe Boots

Hard Hat

Reflective Safety Vest, and

Safety Glasses

Based on radiological conditions evaluated by the SRSO, personnel in the RCA may be required to wear the following PPE (Level D Modified or Level C):

<u>Level D Modified</u>

Steel Toe Boots

Hard Hat

Reflective Safety Vest

Safety Glasses

Latex Overboot (as required by SRSO)

Nitrile or Latex "inner" glove (as required by SRSO), and

Breathable cotton Tyvek (or similar as required by SRSO)

<u>Level C</u>

Steel Toe Boots

Hard Hat

Reflective Safety Vest

Safety Glasses

Latex Overboot (as required by SRSO)

Nitrile or Latex "inner" glove (as required by SRSO)

Tyvek (or similar) disposable coverall when worker is likely to physically encounter removable contamination (as required by SRSO), and

NIOSH-approved, full-face air-purifying respirator (APR), when determined by SRSO that airborne radioactivity concentration has a potential to exceed 2 E-11 μCi/ml, DAC for U-238 (Level C).

The level of PPE will be addressed in the AHA and PPE requirements will be described in the RWP applicable to the specific work activity. Upon concurrence from the SRSO, PPE requirements listed above may be upgraded or downgraded by the on-site professional health and safety staff as necessary to protect the workers.

E.5. Internal Exposure Control

When dust is generated or when significant concentrations of airborne radioactivity are detected, controls will be implemented to reduce such concentrations, using primary measurements of surface and airborne radioactivity and dust suppression with water. DU dust has a high density and does not easily disperse. Dust suppression methods will be utilized during excavation to maintain airborne radioactivity ALARA**.**

Based on dust suppression requirements, soil conditions, and air monitoring data obtained from previous projects, it is not expected that average airborne radioactivity concentrations will exceed 2 E-11 μCi/ml, DAC for U-238. Therefore, respiratory protection will not initially be required unless otherwise directed by the SRSO.

E.6. Air Monitoring

Low Volume Air Samplers (LVAS) will be operated in close proximity to the work being performed inside the RCA to monitor airborne radioactivity concentrations; the LVAS will be positioned such that data collected is representative of the general work area. LVAS filters will be changed routinely (daily, at each shift, etc.), at a frequency sufficient to achieve a Minimum Detectable Activity (MDA) at or lower than 10% of the Derived Air Concentration (DAC) for U-238 (2 E-11 μCi/ml) listed in 10CFR 20 Appendix B Table 1, to assess operational work zone airborne concentrations.

Breathing Zone Air Samplers (BZAS) may be utilized to sample airborne radioactivity concentrations in workers' breathing zones if LVAS indicates airborne radioactivity concentrations $\geq$ 10% of the DAC for U-238 listed in 10CFR 20 Appendix B Table 1.

In general, the air sampling techniques (LVAS) utilized for radioactive particulates in the general work area are as follows:

- Samples will be obtained using an air sampling pump with flow rate sufficient to meet the detection sensitivity required for the anticipated duration of the operation.
- Air is drawn through a borosilicate glass microfiber (GF) or mixed cellulose ester (MCE) filter in a cassette.
- The air sampling pump flow rate will be measured before and after collection to correct for filter loading.
- Air sampling pumps will be placed in the work area at the beginning of the shift and remain until the end of the potentially contaminating work.
- The filter apparatus will be mounted at approximately 3 to 5 feet off the ground.

- Placement of the air sampling pump in relation to the work area will be based on wind direction, generally in the downwind position.
- Following the sample collection, the air filters will be analyzed for gross alpha and beta radioactivity using an appropriate instrument (e.g., Ludlum 3030 or equivalent).

E.7. External Exposure Control

External exposure monitoring of personnel is not required based on characterization dose rates and the anticipated short duration of the project. Exposure monitoring by dosimetry will be required if ongoing dose rates survey results warrant additional exposure monitoring and expected cumulative exposure for the worker will be <10% of the occupational dose limit listed in 10CFR20 (500 mrem/year).

External exposure monitoring of personnel may be performed utilizing Optically Stimulated Luminescence Dosimetry (OSLD's) worn by personnel performing construction/intrusive activities. For personnel performing functions within the RCA which are short term in duration as determined by the SRSO, an evaluation will be made by the SRSO to determine if dosimetry issuance is required. Dosimetry reports will be maintained in corporate records at the completion of the project.

All personnel who are issued dosimetry will be asked to provide prior exposure history for the current calendar year, prior to the issuance of dosimetry. The form used to document this (site specific and not NRC Form 5), will be signed by the employee, and kept on-site with personnel records.

E.8. Radiation and Contamination Surveys

Radiological survey instruments are used to measure the real-time radiological conditions in the RCA to enable rapid response in an appropriate method to changing radiation or contamination levels.

Radiological survey monitoring may be performed using some or all of the following instrumentation (or equivalent):

- a portable survey exposure rate meter - Ludlum 12 with G-M pancake probe 44-9
- an alpha/beta survey instrument - Ludlum 2360 with a 43-89 probe with datalogger
- an alpha/beta survey counter – Ludlum 2929
- Bicron micro R Meter
- alpha performance check source
- beta performance check source
- gamma performance check source
- LVAS for work area air monitoring
- lapel sampler for personnel breathing zone

The exposure rate meter is capable of measuring background levels of radiation (expected to be 0-50 μR/hr). The survey instruments will allow the SRSO to evaluate current radiological conditions, and respond as appropriate to any change in conditions due to construction activities.

Background radiation levels/operational response will be evaluated for each instrument daily by taking readings at an on-site location that will provide minimal background interference. Instrument checks will be performed daily and results will be recorded in project logbooks or through the use of approved control charts.

Personnel contamination surveys (frisking) will be performed as workers exit RCAs. Surface contamination will be measured using hand-held instruments, such as with the Ludlum Model 2360/43-89 or equivalent. The instrument will be used to monitor personnel contamination at a designated work area egress point. Contamination surveys will be performed on all equipment or material prior to being placed in service, and prior to release from the site for unrestricted use, per EM-385-1-80, Table 6-4, Acceptable Surface Contamination Levels. Surface contamination will be measured with direct reading instruments such as the Ludlum Model 2360/43-89, or equivalent, and with wipes for removable activity that are analyzed using a Ludlum 3030 or equivalent.

E.9. Decontamination Procedures

Personnel will exit the RCA at designated areas and comply with posted exit instructions for doffing PPE, monitoring, etc. If contamination greater than background is detected on PPE or skin, contact Radiation Safety Personnel to evaluate area of suspect contamination and utilize appropriate decontamination methods to remove contamination.

If contamination on equipment or materials is detected above limits set forth in 10CFR 835 Appendix D contact Radiation Safety Personnel to evaluate area of suspect contamination and utilize appropriate decontamination methods to remove contamination.

E.10. Radiation Action Limit

If gamma radiation survey results indicating exposure rates > 1000 µr/hr (1 mr/hr) are reached, the following actions will be implemented:

- Suspend work activities in affected area,
- Reconfigure source term geometry to obtain exposure rates which will be <1000 µr/hr action limit.

Work activities will be allowed to resume when exposure rates are <1000 µr/hr following source term reconfiguration.

E.11. Contamination Action Limits

Contamination Action Limits as established in Table 6-4 of EM-385-1-80 include:

- Personnel surveys indicate detectable activity levels on skin, modesty or street clothing.
- Personnel surveys indicate levels on PPE exceeding the contamination levels for the posted condition.
- Surveys within an RBA indicate removable contamination, on any surface, in excess of 20 dpm/100 cm^2 alpha, and 1,000 dpm/100cm^2 beta/gamma.
- Surveys within a CA indicate removable contamination, on any surface (excluding soil), in excess of 2,000 dpm/100 cm^2 alpha, and 100,000 dpm/100cm^2 beta/gamma.
- Excavation of any unexpected item will cause an operational pause (Stop Work) to establish proper radiological controls for handling such items.

Limits listed above are derived from EM-385-1-80, Table 6-4, Acceptable Surface Contamination Levels.

Should any of these limits be reached, the following actions will be taken:

- Suspend work activities in affected area
- Notify the SRSO personnel
- Post per requirements of EM-385-1-80
- Perform additional contamination surveys to determine radiological conditions.

Work activities will be allowed to resume following evaluation by the site radiation safety officer.

E.12. Airborne Radioactivity Action Limit

The Airborne Radioactivity Action Limit for U-238 is 10% of Derived Air Concentration (DAC) Limit (2E-11 µCi/ml). This limit is derived from 10CFR 20, Appendix B, Table 1. If limits are exceeded or suspect, the following actions will be taken:

- Intrusive activities will be suspended if work area air samples, counted for gross alpha activity 72 hours (or more) after collection, or by alpha spectroscopy analysis (appropriately decayed), indicate Airborne Activity greater than the limit listed above.
- Perform additional air monitoring to determine radioactive airborne concentrations.
- Monitor personnel for contamination, and determine if additional internal monitoring is required based on survey results.
- Perform radiation walkover surveys of soil to determine radiological conditions and areas which may be the source of airborne contamination.
- Isolate and post areas where elevated radioactivity is identified, to possibly allow for additional sampling and prevent further intrusive activities.

Work activities will be allowed to resume when airborne concentration levels are within the limit listed above.

E.13. Shipment and Receipt of Packages Containing Radioactive Material

Sealed radioactive sources will be used, handled, and stored in a manner commensurate with the hazards associated with operations involving the sources. Each accountable sealed radioactive source will be inventoried at intervals not to exceed six months. This inventory will:

- Establish the physical location of each accountable sealed radioactive source;
- Verify the presence and adequacy of associated postings and labels; and
- Establish the adequacy of storage locations, containers, and devices.

Except for sealed radioactive sources consisting solely of gaseous radioactive material or tritium, each accountable sealed radioactive source will be subject to a source leak test upon receipt, when damage is suspected, and at intervals not to exceed six months. Source leak tests will be capable of detecting radioactive material leakage equal to or exceeding 0.005 µCi.

An accountable sealed radioactive source is not subject to periodic source leak testing if that source has been removed from service. Such sources will be stored in a controlled location and subject to source leak testing prior to being returned to service, unless it is located in an area that is unsafe for human entry or otherwise inaccessible. An accountable sealed radioactive source found to be leaking radioactive material will be controlled in a manner that minimizes the spread of radioactive contamination.

Packages containing check sources are exempt from Department of Transportation (DOT) specification, marking, packaging, labeling, and shipping paper and certification requirements provided the source or its container are marked *radioactive* and the exposure rate on the external surface of the outer package is less than 0.5 mR per hour. Ensure the following statement is enclosed with the package: This package conforms to the conditions and limitations specified in 49CFR173.324 for radioactive material, excepted package-instrument or articles, UN2910.

Addendum 2 to the APP Section 10.34 Munitions and Explosives of Concern Encountered During Site Activities
Iowa Army Ammunition Plant
Operable Unit 8,
Depleted Uranium Contaminated Soil and Structure Remediation

Revision 0

Iowa AAP Firing Site 12, UXO Construction Support

Attachments

June 2013 IAAAP FS-12 MEC Probability Assessment

1.1 INTRODUCTION

This Munitions and Explosives of Concern (MEC) Avoidance and Construction Support Plan discusses surface and subsurface MEC anomaly avoidance procedures and construction support techniques to be used while conducting hazardous, toxic, radioactive waste (HTRW)-related activities during investigative, design, and remedial actions to be completed at the Iowa Army Ammunition Plant (IAAAP). The MEC avoidance and construction support procedures contained in this plan were developed in accordance with the United States Army Corps of Engineers (USACE) EM 385-1-97 “Explosives Safety and Health Requirements Manual” (USACE 2008). These procedures will be performed and adhered to by all personnel during HTRW field activities conducted at IAAAP. All Contractors and subcontractors will work closely with the USACE staff assigned to IAAAP projects to ensure a safe working environment and to ensure the equipment, supplies, and other resources needed to provide MEC avoidance and MEC construction support are present on-site.

Anomaly avoidance procedures will be utilized during HTRW-related field investigation activities at IAAAP that have the potential for encountering MEC. These activities include, but are not limited to, surveying and mapping, clearing and grubbing, environmental and natural resource assessments, surface and subsurface soil sampling, boring and drilling, groundwater monitoring, test pits, and trenches. The purpose of avoidance during field activities is to avoid any potential surface MEC and subsurface anomalies during sampling, drilling, investigative, or excavation activities. For anomaly avoidance on an HTRW site with potential MEC, unexploded ordnance (UXO) team consisting of a minimum of two personnel, one of who must be a qualified UXO Technician II or above. This individual will be the team leader. The team must be on site during all investigative activities.

For MEC support during construction activities, the appropriate personnel will be provided based on the project-specific conditions. When the probability of encountering MEC is low (e.g., current or previous land use leads to an initial determination that MEC may be present), a two-person UXO team consisting of a minimum of two qualified UXO personnel (one UXO Technician III and one UXO Technician II) will provide on-site UXO standby support in case the construction contractor encounters a suspected MEC item.

No intrusive work will be allowed if a determination is made that the probability of encountering MEC is moderate to high (current or previous land use leads to a determination that MEC was employed or disposed of in the parcel of concern [e.g., open burn and open detonation areas, impact areas, maneuver areas, etc.]). Intrusive anomaly investigation and/or MEC removal requires the creation of a ESS/ESP, MEC Removal WP and other related documents prior to commencement of work.

2.1 BACKGROUND

2.1.1 Location

The former Burlington Atomic Energy Commission Plant (BAECP) consisted of approximately 1,600 acres of the current Iowa Army Ammunition Plant (IAAAP), which consists of approximately 19,100 acres and is located in eastern Iowa, approximately six miles west of Burlington, Iowa. Because IAAAP is a current active installation, the area has changed little since BAECP was closed. Each of the pieces of land controlled by AEC during the 50's through 70's has subsequently been used by the Army for similar activities. All of the land is currently owned and under the control of the Army. The area of the plant which is the subject of this work is Firing Site 12.

2.1.2 Site History

Firing Site 12 (FS-12) is comprised of 25 acres and was constructed by the Atomic Energy Commission (AEC) in 1964. The AEC used FS-12 to conduct hydroshots test of depleted uranium (DU) between December 1965 and December 1973. In 1975, the AEC performed a remediation at FS-12, by excavating soils at the detonation point, known as "ground zero", and scraping a few inches of topsoil off an area of a couple hundred square meters around the periphery of ground zero. After the remediation, the AEC turned over operations of FS-12 to the Army in 1975, which used the site for static function testing of conventional weapons, not containing depleted uranium until November 2000. Munitions known to have been function tested at FS-12 include Javelin and TOW warheads, detonators, and anti-personnel/ anti-tank mines. The discovery of depleted uranium (DU) in November 2000 at the site halted all Army testing at FS-12. Since the site has been inactive, a Preliminary Assessment (PA) was conducted in December 2001 to address the DU and UXO hazards associated with FS-12. The PA and work plan for FS-12 assessed the probability of encountering UXO as low due to previous use as a test site for munitions. Records indicate that clear zones were plowed on FS-12 prior to function tests and operating procedures were in place to ensure accountability and destruction of munitions tested at the site. No UXOs were uncovered during the plowing of the site, discovered during the PA, and none have been reported since the site has been inactive

3.1 UXO TEAM

3.1.1 UXO team Qualifications

MEC avoidance and construction support activities will be completed by personnel with UXO Technician training and appropriate documentation, in accordance with Department of Defense Explosives Safety Board (DDESB) Technical Paper 18 (DDESB 2004). The typical UXO team will consist of a minimum of two qualified UXO personnel, one of which must meet the qualifications of for a UXO Tech III. The UXO Team will provide on-site UXO standby support in case the construction contractor encounters a suspected MEC item. The team may include additional UXO-qualified personnel, depending on project-specific and task-specific conditions and requirements.

3.1.2 Responsibilities

The UXO team members have the following responsibilities for MEC avoidance and construction support procedures during HTRW field investigations in areas with potential or suspected MEC:

- Provide the ordnance expertise to identify and avoid all possible MEC-related hazards and act as the UXO Safety Officer (UXOSO) for the project during HTRW field activities.
- Conduct a surface access survey and a subsurface survey for anomalies as required.
- Establish and delineate surface MEC or subsurface anomaly-free ingress/egress lanes and work areas.
- Conduct MEC safety briefings for all site personnel and visitors.
- Reporting of all surface and subsurface potential MEC encountered to the appropriate authority for proper response and disposition. The appropriate authority will be designated in writing in the Facility-Wide WP.
- Work closely with the USACE/Contractor personnel on all MEC-related matters.

3.1.3 Authority

The designated site UXOSO has final on-site authority on all munitions and MEC matters. The UXOSO will report to and communicate directly with the Project Manager.

4.1 UXO CONSTRUCTION SUPPORT

The UXO team will monitor all excavation activities in areas with a UXO potential. One member of the team will be positioned to the rear and upwind of the excavation equipment for continuous visual observation of activities. If the construction contractor unearths or otherwise encounters suspected MEC, all excavation activities will cease. The UXO team will assess the item to determine its status. If it is determined to be UXO/MEC/MPPEH, all work will cease until it has been dealt with and the MEC probability assessment been re-evaluated.

The UXO team is not tasked or authorized to perform investigation or disposition of MEC during safety support of construction activities. In the event that ordnance is encountered that cannot be avoided or, based on its fuzing or current condition, presents an imminent hazard requiring immediate attention, the UXO team will notify Milton (Butch) G. Hicks, U.S. Army Safety and Occupational Health Specialist, 319-753-7978. Mr. Hicks will notify the appropriate authority of the MEC discovery and the UXO team will safeguard the site pending arrival of the appropriate authority.

4.2 MEC SAFETY

If MEC is encountered during any phase of work on IAAAP, the USACE Project Manager will immediately be notified. In general, the following MEC safety protocols will be followed:

- The cardinal principle to be observed involving ordnance, explosives, ammunition, severe fire hazards, or toxic materials is to limit the exposure to a minimum number of personnel, for the minimum amount of time, to a minimum amount of hazardous material consistent with a safe and efficient operation.
- The age or condition of a MEC item does not decrease the effectiveness. MEC that has been exposed to the elements for an extended period of time becomes more sensitive to shock, movement, and friction because the stabilizing agent in the explosives may be degraded.
- Consider MEC that has been exposed to fire as extremely hazardous. Chemical and physical changes to the contents may have occurred that render it more sensitive than it was in its original state.
- DO NOT touch or move any ordnance items regardless of the markings or apparent condition.
- DO NOT visit a MEC site if an electrical storm is occurring or approaching. If a storm approaches during a site visit or during site operations, leave the site immediately and seek shelter.
- DO NOT use radio or cellular phones in the vicinity of suspect MEC items.
- DO NOT drive vehicles into a suspected MEC area; use clearly marked lanes.
- DO NOT walk across an area where the ground cannot be seen. If dead vegetation or animals are observed, leave the area immediately due to the potential of contamination by a chemical agent.

- DO NOT carry matches, cigarettes, lighters or other flame-producing devices into a MEC site.
- Always assume MEC items contain a live charge until determined otherwise.
- DO NOT touch, move, or jar any MEC item, regardless of its apparent condition.
- DO NOT be misled by markings on the MEC item stating “practice bomb,” “dummy,” or “inert.” Even practice bombs have explosive charges that are used to mark and/or spot the point of impact; or the item could be marked incorrectly.

5.1 MPPEH INSPECTION

MPPEH procedures will be IAW DoD 4140.62, EM 385-1-97 and EM 1110-1-4009.

5.1.1 MPPEH Inspection and MDAS Storage Requirements

All MPPEH will be assessed and its explosives safety status determined and documented prior to transfer within the DoD or release from DoD control. Prior to release to the public, MPPEH will be documented by authorized and technically qualified personnel as Material Documented as Safe (MDAS) after a 100% inspection and an independent 100% re-inspection to determine that it is safe from an explosives safety perspective.

All suspected MPPEH will be 100% inspected by the UXO Field Team. Two separate UXO qualified personnel will conduct the inspections prior to removing any material from where it was discovered. At a minimum a UXO Technician II will conduct a 100 percent inspection and a UXO Technician III will conduct a 100% re-inspection within the clearance grid to determine if the item is MDEH or MDAS and ensuring it does not contain an explosive hazard. The MDAS will then be segregated from other scrap and both will be placed in temporary secure staging areas.

If items are determined to be MEC or MDEH during the inspection/re-inspection process all work will cease and the area will be evacuated. The local POC, Milton (Butch) G. Hicks, U.S. Army Safety and Occupational Health Specialist, 319-753-7978 will be notified. Mr. Hicks will notify the appropriate authority of the MEC discovery and the UXO team will safeguard the site pending arrival of the appropriate authority.

Inspected and certified MDAS will be secured in a locked container until final disposition to prevent comingling MDAS with material that has not been inspected. The container will be secure and lockable, clearly labeled on the outside with the following information: Unique identification that will start with USACE/Installation Name//0001/Seals unique identification and continue sequentially for each additional container used for the same project site. The seal will be attached in such a manner that the container cannot be opened without damaging the seal.

5.1.2 MDAS Certification

One of the two UXO Technicians will certify the debris is free of explosive hazards and the other will verify the MPPEH inspection process has been followed.

The DD form 1348-1A used to document the description of the container will be used as the certification/verification documentation for each container. All DD 1348-1A's must clearly show the typed or printed names of the individuals, organization, signature, and home office and field office phone number(s) of the persons certifying and verifying the debris as free of explosive hazards. Also, the following must be present on the Form:

a. Basic material content (Type of metal; e.g., steel or mixed).
b. Estimated weight.
c. Unique identification of each of the containers and seals stated as being turned over.
d. Location where munitions debris or range-related debris was obtained.
e. Seal identification, if different from the unique identification of the sealed container.

The following certification/verification will be entered on each DD 1348-1A for turnover of munitions debris and will be signed by both UXO Technicians:

" This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, is free of explosive hazards, engine fluids, illuminating dials and other visible liquid HTWR materials."

The chain of custody for the certified MDAS must be maintained and final disposition of the certified and verified materials. The certified and verified material will only be released to an organization that meets the requirements in EM 385-1-97, I.11.C

If the chain of custody is broken, the MDAS reverts to MPPEH and must undergo a second twice 100 percent inspection, a second 100 percent re-inspection, and be documented to verify its explosives safety status.

MDAS is no longer considered MPPEH as long as the chain of custody remains intact. A legible copy of inspection, re-inspection, and documentation must accompany the material through final disposition and be retained on file for a period of three (3) years.

Department of Defense Explosives Safety Board (DDESB). 2004. Minimum Qualifications for Unexploded Ordnance (UXO) Technicians and Personnel. DDESB Technical Paper 18. December.

DoD. 2010. DoD Ammunition and Explosives Safety Standards. Manual 6055.09-M. August.

DoD. 2008. Management and Disposition of Material Potentially Presenting an Explosive Hazard (MPPEH). DoD 4140.62. November.

USACE. 2006. Ordnance and Explosives Response. USACE Engineering Pamphlet EP 1110-1-18. April.

USACE. 2008. Explosives Safety and Health Requirements Manual. USACE Engineering Manual EM 385-1-97. September.

MEC Probability Assessment

This assessment is used to determine the probability of encountering MEC during USACE projects. The probability will be scored as: "No probability", "Low probability", or "Moderate to High probability". Results of the assessment will determine what action if any is needed. See EM 385-1-97, Chapter III for appropriate response.

Site Name / Location	Project #	Date
Firing Site-12 Iowa Army Ammunition Plant	W912P9-13-R-0713	10 June 2013

Site History and Project Description

Brief description of site history that supports/justifies assessment scoring and project activities to be conducted:

Firing Site 12 (FS-12) is comprised of 25 acres and was constructed by the Atomic Energy Commission (AEC) in 1964. The AEC used FS-12 to conduct hydroshots test of depleted uranium (DU) between December 1965 and December 1973. In 1975, the AEC performed a remediation at FS-12, by excavating soils at the detonation point, known as "ground zero", and scraping a few inches of topsoil off an area of a couple hundred square meters around the periphery of ground zero. After the remediation, the AEC turned over operations of FS-12 to the Army in 1975, which used the site for static function testing of conventional weapons, not containing depleted uranium until November 2000. Munitions known to have been function tested at FS-12 include Javelin and TOW warheads, detonators, and anti-personnel/ anti-tank mines. The discovery of depleted uranium (DU) in November 2000 at the site halted all Army testing at FS-12. Since the site has been inactive, a Preliminary Assessment (PA) was conducted in December 2001 to address the DU and UXO hazards associated with FS-12. The PA and work plan for FS-12 assessed the probability of encountering UXO as low due to previous use as a test site for munitions. Records indicate that clear zones were plowed on FS-12 prior to function tests and operating procedures were in place to ensure accountability and destruction of munitions tested at the site. No UXOs were uncovered during the plowing of the site, discovered during the PA, and none have been reported since the site has been inactive.

The current MEC Probability Assessment has rated this site as Moderate/high. There is a possibility of encountering UXO, however, the MEC probability assessment should be rated as low probability based on the prior PA, operating procedures to account for munitions tested, and that no UXOs have been reported since the site went inactive.

Excavation will be conducted at Firing Site-12 at the Iowa Army Ammunition Plant (IAAAP), pursuant to the IAAAP Formerly Utilized Sites Remedial Action Program (FUSRAP) Record of Decision (ROD) (USACE 2011) and the Remedial Design / Remedial Action Work Plan (RD/RAWP) (USACE 2013a), to remove depleted uranium (DU) fragments and associated contaminated soil. The majority of soil volume associated with this excavation is expected to occur in the "General Excavation Area" (GEA) at the Firing Site 12 (FS-12) Area and the collection of samples on the perimeter of the GEA.

MEC Probability Assessment

Table Z.1 - Munitions Type

Physical or historical evidence suggests High/low Explosives (i.e., pyrotechnics, Riot control filler, propellants, or Chemical Agent) regardless of configuration may be located on site.	10
Small Arms Ammunition. Physical or historical evidence supports that no military munitions other than small arms were used on the site.	2
Physical or historical evidence supports that no military munitions or small arms ammunition were used on site.	0

Circle the highest score that applies to the site.

Table Z.2 - Hazard Source

Physical or historical evidence supports the site is a former or active range (practice or Live), for Open Burning/Open Detonation of Munitions, munitions burial pit, or the site is a former or active munitions maintenance, manufacturing, or demilitarization facility.	5
Physical or historical evidence supports the site was a firing point, munitions storage or transfer point, or small arms range.	2
Physical or historical evidence supports that no military munitions or small arms ammunition were used on site.	0

Circle the highest score that applies to the site.

Table Z.3 – MEC Assessment

Total score from tables 1 and 2	
Combined score from tables 1 and 2 = 8 - 15	Moderate to High probability
Combined score from tables 1 and 2 = 1-7	Low probability
Combined score from tables 1 and 2 = 0	No probability

Circle the probability assessment.

Safety Representative — Concur — Non-Concur

Name/Title — *Signature*

David L. Rose
Ordnance and Explosive Safety Specialist

Installation Commander or Designee — Concur — Non-Concur

Name — *Signature*

Chris Bryant
Chief - Military Munitions Remediation Section/GS-0018-13

FINAL

FINAL STATUS SURVEY PLAN FOR THE FUSRAP AREAS AT THE IOWA ARMY AMMUNITION PLANT

MIDDLETOWN, IOWA

February 2013

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

FINAL

FINAL STATUS SURVEY PLAN FOR THE FUSRAP AREAS AT THE IOWA ARMY AMMUNITION PLANT

MIDDLETOWN, IOWA

February 2013

prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

with technical assistance from:

Science Applications International Corporation
under Contract No. W912P9-12-D-0506, Delivery Order 0001

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ACRONYMS AND ABBREVIATIONS

ε_i	instrument efficiency
α	Type I decision error
β	Type II decision error
Δ	shift
Δ/σ	relative shift
σ	standard deviation
AEC	Atomic Energy Commission
AF	area factor
ANL	Argonne National Laboratory
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
Bi	bismuth
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response and Compensation Liability Act
CFR	*Code of Federal Regulations*
cm	centimeter
cm^2	square centimeter
cm^3	cubic centimeter
COC	contaminant of concern
cpm	counts per minute
cpm/μR/hr	counts per minute per microroentgen per hour
CR	cancer risk
Cs	cesium
DA/DF	Demolition Area/Deactivation Furnace
DCGL	derived concentration guideline level
$DCGL_{EMC}$	derived concentration guideline level of elevated measurement comparison
DOD	Department of Defense
DOE	Department of Energy
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DSR	dose-to-source ratio
DU	depleted uranium
EDA	Explosive Disposal Area
EMC	elevated measurement comparison
FS	firing site
FSA	firing site area
FSS	Final Status Survey
FSSP	Final Status Survey Plan
ft	foot or feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
FY	fiscal year
g	gram
GPS	global positioning system
GWS	gamma walkover survey

ACRONYMS AND ABBREVIATIONS (Continued)

H_0	null hypothesis
H_a	alternative hypothesis
HSA	historical site assessment
IAAAP	Iowa Army Ammunition Plant
IDA	Inert Disposal Area
IL	investigation level
L1FWWI	Line 1 Former Waste Water Impoundment
LAP	load, assemble, and pack
LBGR	lower bound of the gray region
m	meter
m^2	square meters
m^3	cubic meters
MARSSIM	*Multi-Agency Radiation Site Survey and Investigation Manual*
MDA	minimum detectable activity
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
$MDCR_{surveyor}$	minimum detectable count rate of the surveyor
MDER	minimum detectable net exposure rate
mg	milligram
mrem	millirem
mrem/yr	millirem per year
NAD	normalized absolute difference
NaI	sodium iodide
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NIST	National Institute of Standards and Technology
NORM	naturally occurring radioactive material
NUREG	U.S. Nuclear Regulatory Commission Regulation
PA	Preliminary Assessment
pCi	picocurie(s)
pCi/g	picocuries per gram
pCi/m^2	picocuries per square meter
PRAR	Post Remedial Action Report
Pu	plutonium
Ra	radium
RAC	remedial action contractor
RCOPC	radiological constituent of potential concern
RESRAD	RESidual RADioactive (computer model)
RG	remediation goal
RI	remedial investigation
ROD	*FUSRAP Record of Decision for the Iowa Army Ammunition Plant*
RPD	relative percent difference
RSR	risk-to-source ratio
SU	survey unit
TEDE	total effective dose equivalent
Th	thorium
U	uranium
UCL_{95}	95 percent upper confidence limit

ACRONYMS AND ABBREVIATIONS (Continued)

USACE	U.S. Army Corps of Engineers
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency

DEFINITIONS

Acceptance Criterion	*Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM)* term for the derived concentration guideline levels (DCGLs), used in statistical testing.
Area	A very general term that refers to any portion of a site, up to and including the entire site.
Class 1 Area(s)	Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination above the remediation goal (RG).
Class 2 Area(s)	Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the RG.
Class 3 Area(s)	Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the RG, based on site operating history and previous radiation surveys.
Data Quality Assessment (DQA)	The scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended use.
Data Quality Indicator (DQI)	Measurable attribute of the attainment of the necessary quality for a particular decision.
Data Quality Objective (DQO)	Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.
Derived Concentration Guideline Level	A derived, radionuclide-specific activity concentration within a survey unit (SU) corresponding to the release criterion.
Final Status Survey (FSS)	Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities, if any, in preparation for release.
Impacted Area	Any area that is not classified as non-impacted. Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.
Investigation Level (IL)	A radionuclide-specific level based on the release criterion or a fraction of the release criterion that, if exceeded, triggers some response such as further investigation or remediation.
Land Area	Any parcel of land being considered.
Site	Any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation.
Survey Unit	A physical area consisting of structure, pile or land areas of specified size and shape for which a separate decision will be made as to whether or not that area exceeds the release criterion.

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this Final Status Survey Plan (FSSP) is to provide the basis for conducting radiological final status survey (FSS) of soil and structures within the Formerly Utilized Sites Remedial Action Program (FUSRAP) areas at the Iowa Army Ammunition Plant (IAAAP). The FSSP will also provide the basis for conducting surveys to determine if treated soil meets the remediation goal (RG) for re-use as backfill or if the soil requires disposal at an off-site facility.

The objective of sampling and/or survey activities is to obtain radiological data of sufficient quantity and quality to evaluate the suitability of material for clearance, for off-site disposal, or on-site re-use as FUSRAP backfill.

The ultimate objective of the FSS process is to validate that the FUSRAP areas at IAAAP do not present a current or potential threat to public health or the environment. This objective is met for soil or structures at the IAAAP when:

- The site(s) have been determined to have potential for containing contaminated material (i.e., be impacted) by Atomic Energy Commission (AEC) operations and an FSS has verified that any depleted uranium (DU)-contamination meets RGs set forth in the *FUSRAP Record of Decision for the Iowa Army Ammunition Plant* (ROD), (USACE, 2011) or
- The sites have been determined to be impacted by AEC operations, material with DU-contamination above the RGs has been removed, and an FSS has verified that any residual DU-contamination meets RGs.

1.2 SCOPE

The plan provides guidance in the following areas:

- Determining whether the land area or structure has been impacted by AEC operations;
- *Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM)* (DOD, 2000) classification of an impacted site or impacted portions of a site;
- Planning and execution of FSS;
- Survey data analysis; and
- Survey reporting.

For the purposes of this plan, structures include (but are not limited to):

- Buildings and portions of buildings including interior & exterior surfaces, roof areas, and foundations;
- Footings and retaining walls;
- Pavement; and
- Other similar items where surficial contamination is of concern.

1.3 APPLICABILITY

This plan is applicable to all portions of the IAAAP that were used for AEC operations.

Items such as tools and equipment that are to be released for unrestricted use are beyond the scope of this document.

RGs involving volumetric contamination of structure materials will be addressed by the U.S. Army Corps of Engineers (USACE) on a case-by-case basis using concepts consistent with those defined herein.

1.4 BACKGROUND

In July 2002, portions of the IAAAP used by the former AEC were designated by the USACE to be subject to the FUSRAP. Consequently, additional investigations have been conducted by USACE at areas identified as potentially AEC-contaminated. According to the fiscal year (FY) 2005 Installation Action Plan, the USACE will respond to all releases and threats of releases of hazardous substances, pollutants, or contaminants, with the exception of ground and surface water contamination, at all FUSRAP areas (USACE, 2005).

The ROD was signed in September 2011. This document established the RGs for the sole FUSRAP contaminant of concern (COC) at the IAAAP, DU. The RGs are 150 picocuries per gram (pCi/g) for soil and 23,000 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) for structures. Soils and structures that meet these RGs are deemed to have met the criteria set forth in the Selected Remedy, and are thus protective of human health and the environment. Soil will be treated on site and soil that does not meet the RG will be sent to an off-site waste disposal facility.

FSSs consistent with MARSSIM (DOD, 2000) will be conducted to demonstrate that land areas, including excavations, meet the soil RG, that structure surfaces meet the structure RG, that re-use soil meets the soil RG, and that DU-contaminated material is segregated for appropriate subsequent disposal. For the purposes of comparison, the concentration of uranium (U)-238 as reported by the analytical laboratory will be used as a surrogate for DU concentrations. This reported value of U-238 will be directly compared to the RG for evaluation of whether the soil survey unit (SU) passes or fails. In the case of structure RGs, the summation of gross alpha and gross beta activity concentrations will be compared to the RG to determine if the structure SU passes or fails.

The guidance found in the MARSSIM, the *Guidance on Systematic Planning Using the Data Quality Objective Process* (USEPA 2006), and the applicable decision document will be used to demonstrate compliance with RGs.

1.5 OUTLINE OF PROCESS

The process consists of the following general steps:

- Identify the derived concentration guideline levels (DCGLs). For IAAAP, the DCGL will be set at the RG established in the ROD (USACE, 2011) for soil and /or structures, as applicable,
- Determine whether the land area or structure has been impacted by AEC operations,
- Characterize and classify land areas, impacted structures or impacted portions of structures based on contamination potential,
- Design the FSS,
- Execute the FSS,
- Evaluate the survey data, and
- Prepare the FSS report.

The details of the process are described in subsequent sections.

2.0 BACKGROUND

The IAAAP is an active, government-owned, contractor-operated facility engaged in load, assemble, and pack (LAP) of large-scale ammunition, including projectiles, mortar rounds, mines, and warheads. The IAAAP has several LAP operations lines and ammunition storage yards (along with other miscellaneous operations) spread across more than 19,000 acres. All of the IAAAP land is currently owned and under the control of the U.S. Army, although portions of the facility were previously under control of other tenant organizations, including AEC. Use restrictions and out-grants administered by the U.S. Army as part of its land management responsibilities limit the IAAAP to industrial/military land use. Currently, American Ordinance, LLC is the government contractor at IAAAP and manufactures a wide variety of artillery and tank munitions for the United States. Less than one-third of the IAAAP property is occupied by active or formerly active munitions production or storage facilities. The remaining property is generally either forested (7,766 acres) or leased for agricultural use (7,107 acres) (IAAAP, 2006). Past munitions production at the IAAAP has resulted in contamination of soil and ground water and discharges of waste water containing explosives and their byproducts to surface water (USACE, 1998).

The IAAAP was initially developed in 1941 for production of ammunition supplies to support World War II. Production ceased in 1945 before resuming in 1949. Production activities have since continued to the present but at a reduced level during peace time. Day & Zimmerman Corporation operated the plant from 1941 to 1946. Plant operations reverted to Army control from 1946 to 1951. The Army continues to own the IAAAP which has been operated by Mason & Hanger Corporation, now American Ordnance, LLC, since 1951. The former AEC operated at Line 1 from 1948 through mid-1975.

The U.S. Army Toxic and Hazardous Materials Agency's (USATHAMA's) installation assessment of the IAAAP indicated that, prior to the construction of the IAAAP, the area was primarily farmland (USATHAMA, 1980). In November 1940, the area was acquired by the Office of the Quartermaster General as the site for the Iowa Ordnance Plant. Since operations began in 1941, the site has used explosives and lead-based initiating compounds to produce a wide variety of ordnance items. Beginning in 1949, portions of the Iowa Ordnance Plant were used by AEC to fabricate explosive components for nuclear weapons. In March 1949, it was decided that certain weapon-assembly operations (non-nuclear components) would also be conducted at the site (Poole and Harrison 1954; Mitchell 2003). The Line 1 Area, Warehouse 3-01, West Burn Pads Area (South of the Road), portions of the firing site area (FSA), and Yards C, G, and L came under AEC's jurisdiction in 1947. Collectively, these AEC areas were operated as the Burlington Atomic Energy Commission Plant. The Burlington Atomic Energy Commission Plant, as well as the remaining portions of the Iowa Ordnance Plant, were collectively renamed the IAAAP in 1963.Throughout the remaining years, the IAAAP has tested, assembled, conducted surveillance of, and disassembled a wide variety of weapons.

A Preliminary Assessment (PA) (USACE, 2001) was completed by the USACE in 2001 to determine the need for further action by the USACE, under FUSRAP, to ensure protection of human health and the environment at the IAAAP. The PA focused on the review of wastes generated by AEC activities. As part of the assessment, site visits were performed as well as a review of existing and recently declassified information relating to AEC operations.

An aerial radiological survey of the entire IAAAP and selected off-base areas was conducted in October 2002 (USACE, 2005) to assess, within the limits of the detector system, the nature and extent of gamma-emitting radioisotopes, both man-made and natural. The survey objective was to identify areas that had been affected by a release of objects containing man-made radioactive isotopes. Results of the survey would also be used to ensure that there is no radiological risk in areas that are thought to be free of contamination and to provide information for further site assessments by FUSRAP. Radiological constituents of potential concern (RCOPCs) for this survey included DU (primarily U-238), radium (Ra)-226, plutonium (Pu)-239, and associated fission products. Cesium (Cs)-137 was used as an indicator of long-lived fission products. Results of the aerial radiological survey indicated the presence of anthropogenic sources at Yard E, the Coal Pile at the heating plant and at firing site (FS)-12. DU was identified at Yard E, and is the FUSRAP contaminant at FS-12. The low activity at FS-12 resulted in poor statistics for the net spectrum; however, the spectrum was consistent with DU. The radioactivity observed at the Coal Pile is from bismuth (Bi)-214, which is a U-238 progeny and is a natural component of the coal (USACE, 2005). No unidentified areas that would require being addressed under FUSRAP were identified during this survey (USACE, 2005).

In February 2003, USACE conducted a site reconnaissance survey to determine the radiological status of Yard L warehouse buildings L-37-1, L-37-2, and L-37-3. The survey applied only to the actual building interior and exterior structures. The survey confirmed the absence of radiological activity above background, both removable and fixed, in or on the warehouse surfaces. Results of the survey and historical information indicated that the warehouses were not impacted (USACE, 2005).

In August 2004, USACE conducted a radiological screening survey to investigate selected areas at the IAAAP that were identified and defined within the PA as warranting further investigation for potential radioactive contamination (USACE, 2005). The areas warranting investigation were further defined in a letter from the FUSRAP to the U.S. Environmental Protection Agency (USEPA) Region VII, dated February 3, 2004 (USACE, 2005). These areas were identified as the Explosive Disposal Area (EDA) including the West Burn Pads Area, the Inert Disposal Area (IDA), the Demolition Area/Deactivation Furnace (DA/DF), and the Line 1 Former Waste Water Impoundment (L1FWWI). As a result of this survey, above-background Cs-137 contamination was verified at the cap extension area of the IDA. In addition, above-screening-level results were found at the Deactivation Furnace and confirmed to be to naturally occurring radioactive material (NORM) in the concrete. The survey did not identify any areas of elevated DU.

The ROD defines the nature and extent of DU-contamination at the IAAAP. (USACE, 2011) According the ROD, DU contamination is present at portions the FSs to a depth of approximately two feet (ft) and adhered to structural surfaces in two buildings at Line 1.

3.0 ORGANIZATION AND RESPONSIBILITIES

The USACE (or its designee) is responsible for the implementation of the FSS as detailed in this plan.

FSSs may be performed by USACE, by the remedial action contractor (RAC) with direct oversight by USACE (or a designated USACE representative), or by an independent verification contractor.

The USACE may utilize scans and supplemental survey information to identify biased sampling locations. USACE (or its designee) will collect all biased measurements.

The RAC should generally have no prior knowledge of FSS sampling locations.

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4.0 DATA QUALITY OBJECTIVES

The first step in designing effective surveys is planning. The data quality objective (DQO) process provides systematic procedures for defining the criteria that the survey design should satisfy, including what type of sampling and analysis or measurements to perform, when and where to collect samples or perform measurements, the level of decision errors for the survey, and an estimate of how many samples to collect or measurements to perform.

The minimum outputs required from the DQO process to proceed with a MARSSIM-based FSS are:

- Classify and specify boundaries of the SUs.
- State the null hypothesis (H_0).
- Specify a gray region where the consequences of decision errors are relatively minor.
- Define Type I (α) and Type II (β) decision errors and assign probability limits for the occurrence of these errors.
- Estimate the standard deviation (σ) of the contaminant concentration in the SU.
- Specify the relative shift (Δ/σ).
- Specify the detection limit for all analysis or measurement techniques.
- Calculate the estimated number of samples or measurements (n) and specify sampling or measurement locations.
- Specify the documentation requirements for the survey, including survey planning documentation.

The DQO process includes the following seven steps (USEPA, 2006):

1. State the Problem,
2. Identify the Goals of the Study,
3. Identify Information Inputs,
4. Define the Boundaries of the Study,
5. Develop the Analytical Approach,
6. Specify the Performance or Acceptance Criteria, and
7. Develop the Plan for Obtaining Data.

The DQOs are described, as they apply to FSS of land areas, structures, and/or re-use soil at the IAAAP.

4.1 STATE THE PROBLEM

There are IAAAP sites that contain DU-contamination as a consequence of historical AEC activities. The extent of the contamination at the sites varies based on use history and location. An FSS must be performed for the land areas impacted by AEC activities to determine compliance with the applicable ROD RGs. If the land area is determined to be non-impacted, it can be released for use without remedial actions or FSS being implemented.

DU-contamination in specific areas of the IAAAP may be due to storage or handling of AEC-related materials or from the use of DU in conjunction with explosives. In areas that are impacted due to handling or storage of AEC related materials, the contamination is likely to be relatively homogeneous. However, in areas where DU was used in conjunction with explosives, the contamination that resulted from the detonations likely ended up in isolated locations with contamination being in the form of relatively large DU fragments or very small DU particles. The DU deposits are likely to be relatively isolated from each other so that they form very small areas of elevated activity by themselves (i.e., non-homogeneous contamination). The large fragments will be readily detectable with survey instrumentation. The small particles of DU may be difficult to detect because of their isolation from other contamination and attenuation by cover materials.

Some structures at the IAAAP have a potential to contain surficial DU-contamination as a consequence of AEC activities. Depending on the history of the structure's use, its location, its date of construction, and the history of the surrounding soils, the potential for surficial contamination may exist on the exterior or the interior of the structure. The potential for such DU-contamination must be assessed. If the structure is determined to be impacted by AEC activities, then the levels of residual DU contamination must be determined by FSS to confirm compliance with the RG. If the structure is determined to be non-impacted, it can be released for use without remedial actions or FSS being implemented.

Surficial DU-contamination results in alpha and beta emissions. Alpha radionuclides pose additional challenges in the areas of fixed-point and scanning minimum detectable concentrations (MDCs), application of surface efficiencies, surface cleanliness requirements, etc. when performing surficial contamination measurements. However, beta emissions are more readily detectable and the issues related to alpha emissions are generally less challenging.

Land areas and the materials used in the construction of structures contain NORM. The constituents of this NORM (e.g., U-238) are also present in DU. This means that any land area or structure will contain some level of detectable radioactive contamination irrespective of AEC historical activities.

4.2 IDENTIFY THE GOALS OF THE STUDY

This FSSP will be used to demonstrate that residual DU-concentrations in land areas or on the surfaces of structures at the IAAAP comply with the RGs. In addition, it will be used to determine the disposition of excavated materials as either re-use soil or waste material for off-site disposal.

Compliance will be verified using guidance found in this plan and the MARSSIM. Specifically, compliance will be demonstrated for land areas by:

- Performing gamma walkover surveys (GWSs) to identify gross contamination and small areas of elevated activity.
- Collecting systematic or random surface or excavation surface soil samples in a manner that is consistent with the MARSSIM approach.
- Collecting subsurface soil samples at Class 1 surface soil locations.
- Collecting biased surface soil samples or performing additional investigation in areas that exceed the investigation level (IL) identified during GWSs to determine the source of the increase in gamma radiation.
- Performing statistical tests to verify that the RG is met and that a sufficient number of samples were collected, and therefore that the land area does not present a current or potential threat to public health or the environment.
- Reviewing the data to verify that it is of sufficient quality.

For structures, compliance will be demonstrated on surfaces by:

- Performing surface activity scans to identify gross contamination and any small areas of elevated activity.
- Collecting systematic or random surficial contamination measurements in a manner that is consistent with the MARSSIM approach.
- Performing biased surface measurements on surfaces that exceed the IL identified during surface scans.
- Performing statistical tests to verify that the RG is met and that a sufficient number of samples were collected, and therefore that the structure does not present a current or potential threat to public health or the environment.
- Reviewing the data to verify that it is of sufficient quality.

For treated soil piles, disposition will be determined by:

- Performing GWSs to identify gross contamination and small areas of elevated activity.
- Collecting systematic soil samples in a manner that is consistent with the MARSSIM approach (See Appendix B for piles approach).
- Collecting biased soil samples or performing additional investigation in areas that exceed the IL identified during GWSs to determine the source of the increase in gamma radiation.
- Performing statistical tests to verify that the RG is met and that a sufficient number of samples were collected, and therefore that the treated soil is acceptable for re-use as backfill.
- Reviewing the data to verify that it is of sufficient quality.

To demonstrate that an SU meets the RGs, the following questions must be answered depending on whether the SU is a land area, a structure, or a soil pile:

1. Is the DU-concentration, using U-238 as a surrogate, on land area SUs less than or equal to the RG for soil of 150 pCi/g?
2. Is the total activity, summing gross alpha and gross beta activities, on structure SUs less than or equal to the RG for structures of 23,000 dpm/100 cm^2?
3. Is the DU-concentration, using U-238 as a surrogate, within the treated soil pile less than or equal to the RG for soil of 150 pCi/g?
4. Do soil samples or surficial measurement results satisfy the Sign Test, as applicable, as described in MARSSIM? Note that the Sign Test has been chosen for FSS evaluation since background is a small fraction of the RG for both soils and structures.
5. Is the data adequate to evaluate the acceptability of small areas of elevated DU-contamination, if such areas are found?
6. Is DU limited to the surfaces of the structure SU being evaluated (i.e., no volume contamination is suspected)?
7. Is the residual risk within the Comprehensive Environmental Response and Compensation Liability Act (CERCLA) risk range of 1.0E-6 to 1.0E-4 and residual dose less than or equal to 25 millirem per year (mrem/yr) using the appropriate exposure scenario (e.g., industrial, residential, etc.) and methods consistent with the dose assessment approach described in Appendix D?

8. Is data of sufficient quantity and quality to support the conclusions (i.e., have data quality indicators [DQIs] been met)?

If the answer to any one of these evaluation questions is “no” for any SU, then RGs are not satisfied. Table 1 presents the principal study question of the decision-making process and offers alternate actions that may be taken if any of the evaluation questions result in a “no” answer.

Table 1. Principal Decisions and Alternate Actions

Study Question	Alternate Actions
Do residual levels of DU within the soil or structure SU exceed RGs?	Remediate the SU and re-survey.
	Declare the SU or a portion of the SU inaccessible, if applicable (the SU or portion of the SU would require some institutional controls).
	Collect additional survey data or modify data collection techniques in order to meet DQIs.
Does treated soil meet the re-use criteria for FUSRAP backfill?	Re-treat the stockpile using the physical treatment technology.
	Dispose of material with the waste at an off-site disposal facility.

4.3 IDENTIFY INFORMATION INPUTS

The Data Quality Assessment (DQA) process as described in the MARSSIM and in the *Guidance for Data Quality Assessment* (USEPA, 2000a) will be used to determine if data obtained from environmental data operations are of the right type, quality, and quantity to support their intended use.

The “graded approach” concept will also be used to assure that survey efforts are maximized in those areas where there is the highest probability for DU-contamination or greatest potential for adverse impacts of DU-contamination. Examples of integrating the graded approach into the MARSSIM process include the use of historical site assessment (HSA), site conditions, equipment capabilities, and results as the survey progresses to establish or adjust the degree of scanning coverage of a survey area, SU classification, SU size, sampling frequency, and criteria for the evaluation of elevated measurements.

Impacted areas (areas that have some potential for containing contaminated material) can be subdivided into three classes as described in MARSSIM and shown in Table 2.

Table 2. Criteria to be Used for Survey Unit Classification

Class	Criteria
Class 1 Area(s)	Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination above the DCGL. *Examples include: site areas previously subjected to remedial actions, locations where leaks or spills are known to have occurred, former burial or disposal sites, waste storage sites, and areas with contaminants in discrete solid fragments of material with high specific activity.*
Class 2 Area(s)	Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGL. *Examples include: locations where radioactive materials were present in an unsealed form, potentially contaminated transport routes, areas downwind from stack release points, upper walls and ceilings of some buildings or rooms subjected to airborne radioactivity, areas where low concentrations of radioactive materials were handled, and areas on the perimeter of former contamination control areas.*
Class 3 Area(s)	Any impacted areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual radioactivity at a small fraction of the DCGL, based on site operating history and previous radiation surveys. *Examples include: buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification.*

Field activities and data management for the FSS will consist of:

- Surface gamma scans of surface soil to identify gross contamination and any areas of elevated activity;
- Surface gamma scans of soil as part of physical treatment technology;
- Surface scans (alpha and beta) of structures;
- Collecting biased surface soil samples or surface activity measurements (for structures) to investigate areas of elevated activity;
- Collecting systematic or random samples of surface soil, treated soil, or surface activity measurements;
- Collecting samples of subsurface soil (below 15 centimeters [cm]) in Class 1 SUs, or volumetric samples of structures as required;
- Performing statistical tests; and
- Reviewing the data to verify that it is of sufficient quality and quantity.

Survey activities will be conducted in accordance with USACE approved standard operating procedures. Sampling and survey procedures are documented in the *Remedial Investigation Work Plan for Line 1, Firing Sites Area, Yards C, G, and L, Warehouse 3-01 and the West Burn Pads Area South of the Road* (USACE, 2007). Modifications, additions, or other changes needed to meet project-specific requirements as the survey progresses will be pre-approved by and documented according to USACE specifications.

4.3.1 Detection Issues Related to Depleted Uranium

DU is the FUSRAP contaminant of concern at the IAAAP. DU has associated gamma radiation, which can be used to identify the presence of DU contamination. Therefore, for surveys of land areas, GWSs will be conducted to identify areas of elevated activity.

In the case of land areas where contamination is historically due to large DU fragments or particles resulting from controlled detonations, the DU-contamination may or may not be uniformly distributed (i.e., homogenous) within a given SU or portion of an SU. This will likely depend on distance from the location where the detonation occurred. The contamination is likely to be more uniformly distributed near the detonation site and less uniformly distributed at distances away from the detonation site. For DU-contamination away from the detonation site, the DU-contamination is expected to be present in isolated small areas of elevated activity. Relatively large fragments of DU should have been readily identified during GWSs conducted as part of site characterization and remediated prior to FSS. Therefore, the only DU-contamination that is expected to be present in the SU (if any) are DU particles.

The MDC value listed in U.S. Nuclear Regulatory Commission Regulation (NUREG) 1507 for DU-contaminated soil (56 pCi/g) is considered justifiable and sufficient for surveys to be conducted at IAAAP.

Because over 90 percent of the activity of DU is attributable to U-238, the U-238 concentration will be used as a surrogate for DU for laboratory analysis. Using U-238 as a surrogate allows laboratory analytical results to be compared directly to the soil RG for purposes of FSS.

For surveys of structures, alpha and beta radiation are used to quantify DU. Alpha radiation poses several challenges because it has a very short range (travel distance) in air, and it is easily shielded (attenuated) by a thin layer of materials of moderate density, such as paper. The result is that:

- The survey instrument detector must be in very close proximity to the surface being surveyed (usually about 1 cm or less).
- This close survey distance results in frequent accidental damage to the window of the survey instrument detector.
- The rough, scabbled surfaces frequently encountered in post-remediation situations, exacerbates the previous two conditions already mentioned.
- Survey surfaces must be dry to ensure that moisture is not attenuating the alpha radiation (which would result in biased-low readings).
- Survey surfaces must be relatively clean to ensure that dust and dirt is not attenuating the alpha radiation (which would result in biased-low readings).

In addition, personnel must be vigilant during review of the HSA and during survey execution for indications that alpha or beta surface contamination might have been purposely or inadvertently covered by a surface coating such as paint, glue, flashing, etc.

It must be recognized that the associated decay products for DU do consist of several beta radiation emitting radionuclides, and that measurements for beta radiation are more reliable due to greater range in air and associated penetrating power. Surficial contamination surveys for both alpha and beta measurements will be taken and the total of the activities will be compared to the structure RG for purposes of FSS.

4.3.2 Surface Gamma Scan

DU has associated gamma radiation that can be used to identify the presence of DU-contamination. Surface scans for gross gamma radiation will be performed to identify locations of elevated external radiation that may represent DU-contamination. Instrument response will be continuously monitored during scanning through use of the instrument audible signal. Scanning results will be recorded in counts per minute (cpm).

Following remediation and/or prior to conducting sampling, screening gamma scans will generally be performed for accessible surfaces of Class 1, Class 2, and Class 3 areas at the frequency listed in Table 3.

Table 3. Gamma Walkover Scan Coverage Guidelines

Area Classification	Amount of Coverage	Notes
Class 1	100%	------------
Class 2	10% to 100%	Value based on the amount of concern for the presence of small areas of elevated activity.
Class 3	0 to 10%	Scans are biased towards areas that are most likely to have a contamination potential.

The surveyor will advance at a speed of approximately 0.5 meters (m) per second (2 ft per second) while passing the detector over the surface in a serpentine pattern. Audible response of the instrument will be monitored, and locations of elevated audible response will be flagged for biased sampling. The ambient background for an SU will be determined at the start of the survey and a scanning response that is detectable above the background level (e.g., 1,500 to 2,000 cpm above background) will be set as the IL.

Site survey data will be collected and evaluated. Locations exceeding the IL will be investigated and, if appropriate, remediated. Following any remediation, scanning will be repeated to demonstrate effectiveness of the remedial action. Gamma scan data will also be recorded in real time, using position and data recording methods.

There may be locations where safety considerations or other restrictions prevent access for normal scanning activities. Reasonable efforts to scan such locations will be made. Alternative and innovative approaches (e.g., use of extension poles, detectors mounted on platforms with wheels or skids, placing detectors in protective sleeves, using excavating equipment to position and move detectors, etc.) will be considered.

Table 4 lists radiological field survey instruments that are commonly used (functional and performance equivalents may be used, as determined by a Certified Health Physicist). FUSRAP-specific detection sensitivities have been determined following the guidance of NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC, 1998) using nominal literature values for background, response, and site conditions. Refinements to these detection sensitivity estimates will be made, as necessary, on the basis of actual radionuclide mixtures, instrument response and background data gathered during site survey activities.

Table 4. Typical Gamma Scan Instruments

Description	Application	Approximate Detection Sensitivity (pCi/g)
Ludlum Model 44-10; 2-inch by 2-inch sodium iodide (NaI) gamma scintillation detector	Gamma scans of all surfaces	Thorium (Th)-230 (1122), Ra-226 (1.2), and U-238 (20)[a, b]
Ludlum Model 2221; Scaler/ratemeter (with earphones)	Readout instrument for gamma scintillation detector	N/A

[a] Isotopic detection sensitivity is based on radiological characteristics of that isotope. The presence of other co-located radionuclides tends to increase the sensitivity to some radionuclides due to the detection of surrogates.
[b] Derivation of site specific scan MDCs is presented in Appendix A.

All instrumentation will have current calibration (within the past 12 months, or more frequently if recommended by the manufacturer). Daily field performance checks will be conducted in accordance with instrument use procedures. These performance checks will be performed prior to daily field activities and at any time the instrument response appears questionable. Only data obtained using instruments that satisfy the performance requirements will be accepted for use in the evaluation.

4.3.3 Scan Surveys

Scanning surveys are typically performed before collecting soil samples or performing fixed-point measurements. This precludes fully evaluating an area that may quickly prove to be contaminated above the IL during the scanning process.

Selection of the survey instrument and detector, and specifications for the operation of the pair should meet the following guidelines:

1. The instrument efficiency (ε_i) used for scanning structure surfaces should generally be greater than or equal to 0.15 to optimize counting statistics.
2. Detectors with active probe areas of about 100 square centimeters (cm^2) should be used for surveys of structures, where feasible, to directly compare measurements to the IL.

3. The scan MDC should be less than or equal to the DCGL. The scan MDC is dependent on several variables, but is dominated by source geometry, the selection of the scan speed and distance from the contamination source.
4. The detector should be checked for proper operation frequently during the conduct of the survey. Special consideration should be given to light and gas leaks during structure surface surveys. Note that detectors used for GWSs are typically very rugged, so they do not require as frequent checking as detectors used for structure scanning.
5. The alpha detector should generally be held at a distance of about 1 cm or less from the surface to be evaluated.

The amount of scan coverage will be based on the SU's classification, as outlined in the MARSSIM. Table 5 provides the scan coverage guidelines.

Table 5. Scan Coverage Guidelines

Area Classification	Amount of Coverage[a]	Notes
Class 1	100%	----------
Class 2	10% to 100%	Value based on the amount of concern for the presence of small areas of elevated activity.
Class 3	Professional Judgment	Scans are biased towards areas that are most likely to have a contamination potential.

[a] The coverage guidelines are applied to the entire SU and not to individual surfaces or grid cells.

The audible output of a survey instrument should be used during scanning to assist the surveyor in locating suspect areas. The audible instrument response is generally a factor of ten times faster than the meter response, and this improves the surveyor efficiency.

For structure surveys, the scanning IL should be converted to units of cpm through the use of Equation 1 prior to the start of the survey. This allows the surveyor to immediately determine if a scanning response is suspect and should be investigated.

Equation 1. Conversion of the IL to CPM

$$\text{CPM} = \left[(\text{Investigation Level})(\varepsilon_i)\left(\frac{\text{Probe Area}}{100}\right)\right] + (\text{Field Background})$$

Where: ε_i is the instrument efficiency (cpm/[disintegrations per minute] dpm)

Probe Area is in cm^2

Field Background is in cpm

If a measurement above the IL is identified during scanning, the surveyor should revisit the area at a slower scan speed, and pause for several seconds over the area in question. This is often referred to as a "pat" survey. The instrument reading in cpm is compared to the IL, and the extent of any elevated area(s) are determined and marked on the surface or on a survey map, as appropriate. The scanning of remaining areas may then continue.

The areas that were scanned will be annotated on a survey map and retained for review and historical documentation. The area, general size and shape, and overall activity level (converted to units of dpm/100 cm^2) of locations that exceed the IL will also be annotated on the survey map.

4.3.4 Biased Sampling or Measurements

Biased surface soil samples or surface activity measurements will be collected in representative areas of elevated activity identified during scan surveys in each SU. Additional surveys and representative sampling or measurements will aid in determining the size and activity concentration of the hotspot for later comparison to the derived concentration guideline level of elevated measurement comparison ($DCGL_{EMC}$), if applicable.

4.3.5 Systematic or Random Surface Soil Sampling

The number of systematic or random surface soil samples to be collected and analyzed for each SU will be calculated using MARSSIM guidance. The actual number of samples will be based on SU-specific characterization data, data from similar SUs or will be estimated as described in MARSSIM and will be verified during the FSS survey data evaluation.

The MDC for sample analysis must be less than or equal to the DCGL, with a target of 10 percent to 50 percent of the DCGL. The MDC is dependent on several variables, but is dominated by sample geometry and the selection of the counting times.

4.3.6 Subsurface Soil Sampling

Within Class 1 SUs, subsurface soil samples will be collected at the same locations as surface soil samples to verify that there is not contamination underlying the surface of the ground or base of the excavation. Based upon historical knowledge and prior sampling events, it is deemed unlikely that any DU material will be found at depths below 2 ft. Therefore, within the Class 1 SUs, subsurface soils will be collected at 6-inch depth intervals to a total of 2 ft. Based upon field screening, at least one subsurface sample from each location will be sent for off-site laboratory analysis. The remainder of the samples will be archived and available for laboratory analysis should the need arise.

4.3.7 Sampling Soil Beneath Structures

Sampling of soil beneath structures is not anticipated for this FSS. The structures present at the FUSRAP areas pre-date the use of DU at the IAAAP. Also, given the relatively low solubility of DU and the lack of mechanism to transport the DU beneath structures, the likelihood of finding contamination is very low. However, if soil excavations adjacent to a structure extend to a depth at or below the foundation depth, samples will be collected along the excavation sidewall. These samples will be used to evaluate the need for further sampling beneath the structure.

4.3.8 Fixed-Point Surficial Contamination Measurements

The number of fixed-point surficial contamination measurements to be collected in each SU will be calculated using MARSSIM guidance. The actual number of measurements will be based on SU-specific characterization data, data from similar SUs or estimated as described in MARSSIM and will be verified during survey data evaluation.

4.4 DEFINE THE BOUNDARIES OF THE STUDY

In the MARSSIM, an “area” is a general term that refers to any portion of a site, up to and including the entire site. All areas of the site may not have the same potential for DU-contamination and, accordingly, may not need the same level of survey coverage to demonstrate compliance with RGs.

Classification of areas by contamination potential and then grouping areas into SUs is a critical step in the survey design process. Land areas and structures will be classified during the survey design phase. Classified areas will then be segmented into SUs based upon the guidance in Table 6, Table 7, and Table 8. The area classification (i.e., Class 1, 2, or 3) shall not vary within an individual SU.

Table 6. Maximum Survey Unit Areas – Land Area

Class	Suggested Maximum SU Area
Class 1 SU	2,000 square meters (m^2)
Class 2 SU	2,000 m^2 to 10,000 m^2
Class 3 SU	No limit

Table 7. Maximum Survey Unit Areas – Structures

Class	Suggested Maximum SU Area
Class 1 Structure SU	100 m^2
Class 2 Structure SU	100 m^2 to 1,000 m^2
Class 3 Structure SU	No limit

Table 8. Maximum Pile Volume

Class	Suggested Maximum SU Volume
Class 1	300 cubic meters (m^3)
Class 2	500 m^3
Class 3	Not Anticipated[a]

Soil piles for backfill use that are created by the treatment process have undergone a 100% survey during processing and are assumed to achieve the RG and are therefore assumed to be Class 2.

[a] No materials will be generated from a Class 3 area, piles will not be created.

The horizontal study boundary is therefore defined by the areal extent of the SU. For Class 1 land area SUs, the vertical boundary of the SU is 2 ft below ground surface (bgs) or 2 ft below the excavation surface in remediated areas. Samples will be collected at the surface and at 6-inch depth interval until 2 ft bgs is reached. Based on field screening, subsurface samples will be chosen for laboratory analysis. The remaining samples will be archived. For Class 2 and Class 3 land area SUs the vertical boundary of the SU is 6 inches bgs. Structure SUs are limited to structure surfaces. Each study boundary (i.e., SU) will be evaluated for compliance with RGs on an individual basis.

4.5 DEVELOP THE ANALYTICAL APPROACH

Figure 4-1 illustrates the sequence of events that are followed in the FSS evaluation process for soils, structures, and piles. This is used to determine whether an SU meets RGs or if an alternate action is required. The alternate actions are shown in Table 1 and may include additional remediation, investigation and data gathering, or further treatment.

4.6 SPECIFY PERFORMANCE OR ACCEPTANCE CRITERIA

As part of the DQO process, the null hypothesis for demonstrating compliance of the data with the acceptance criteria (RG for SUs and treated soil) is assessed. Each of the study questions will require the formulation of a null hypothesis. The null hypothesis for each decision will be stated such that data collected during the FSS will allow the hypothesis to be accepted or rejected with a predetermined level of confidence. The null hypotheses for each study question are shown in Table 9.

Table 9. Null Hypothesis for Each Study Question

Study Question	Null Hypothesis
Do residual levels of DU within the soil or structure SU exceed RGs?	The null hypothesis is that residual DU-contamination exceeds the RG. In rejecting the null hypothesis, the alternative hypothesis (H_a) must be accepted, and the finding would be that the SU meets the RG.
Do treated soils meet the re-use criteria for FUSRAP backfill?	The null hypothesis is that residual DU-contamination exceeds the RG. In rejecting the null hypothesis, the alternative hypothesis must be accepted, and the finding would be that the treated material meets the RG.

The Sign Test will be used as appropriate in evaluating the residual contamination in the SU or re-use pile relative to the null hypothesis.

To enable testing of survey data relative to the acceptance criterion, the USACE has established acceptable decision errors for the IAAAP. These are shown in Table 10.

Table 10. IAAAP Decision Errors

Error Type	Decision Error	Confidence Level
Type I Decision Error (α)	**0.05**	95%
Type II Decision Error (β)	0.25 to 0.05 (initially set to **0.20**)	75% to 95%

The Type I decision error provides a 95 percent confidence level that the statistical tests will not incorrectly indicate that an SU satisfies acceptance criteria when, in fact, it does not. The Type II decision error provides a 75 percent to 95 percent confidence level that the statistical tests will not incorrectly indicate that an SU does not satisfy acceptance criteria when, in fact, it does. Type II errors are more a function of labor and survey costs and do not adversely impact public safety or health, and thus are subject to adjustment by USACE as needed.

Approximately 5 percent duplicate and split samples will be collected for field quality control purposes. Data quality indicators for precision, accuracy, representativeness, completeness, and comparability have been established as follows:

- Precision will be determined by comparison of duplicate and split sample values with an objective of a relative percent difference (RPD) of 50 percent or less at 50 percent of the criterion value when reported activities are > 5 times their MDCs; if sample results are < 5 times their respective MDC, the normalized absolute difference (NAD) will be used with an objective of NAD < 1.96;
- Accuracy is the degree of agreement with the true or known, and is evaluated by measuring the agreement between an analytical result and its known or true value. This is generally determined through the use of laboratory control samples, matrix spike analysis, and performance evaluation samples. For FSS, accuracy is measured through the use of the field split soil samples through a comparison of the prime laboratory results versus the results of an independent laboratory.
- Representativeness and comparability are assured through the selection and proper implementation of systematic sampling and measurement techniques; and
- Completeness refers to the portion of the data that meets acceptance criteria and is therefore useable for statistical testing. The objective is 90 percent for this project.

A survey report will document data and processes used to assure compliance with the appropriate ROD criteria as described in Section 8.0. The data review and validation process is described in the *Remedial Investigation Work Plan for Line 1, Firing Sites Area, Yards C, G, and L, Warehouse 3-01 and the West Burn Pads Area South of the Road* (USACE, 2007).

4.7 DEVELOP THE PLAN FOR OBTAINING DATA

Scoping surveys, field screening techniques, surface contamination scans, and the DQA process are used throughout the FSS process to focus efforts and to optimize costs.

Existing survey data should be reviewed in more detail if it appears that it could be used to support the survey design or if it might be of sufficient quality to be included in an FSS data set. If existing data are going to be combined with new data to support a decision, then it should be determined if there are any gaps that can be filled or deficiencies that might be mitigated when designing the new data collection strategy.

5.0 SURVEY PLANNING AND DESIGN

This section provides the guidance to properly plan and design an FSS for land areas, structural surfaces, and soil piles for DU-contamination at the IAAAP. The interpretation of survey results, assessment of the adequacy of the FSS design, and the assessment of data quality are described in later sections.

5.1 IDENTIFY CONTAMINANTS

The FUSRAP contaminant at the IAAAP is DU. DU typically contains about 99.799 percent by weight U-238 with a corresponding activity percentage of 90.14. Therefore, U-238 concentrations will be used as a surrogate for DU for laboratory analysis. Using U-238 as a surrogate allows laboratory analytical results to be compared directly to the soil RG for purposes of FSS.

5.2 ESTABLISH DERIVED CONCENTRATION GUIDELINE LEVELS AND LIMITS

5.2.1 Derived Concentration Guideline Levels for Depleted Uranium

The development of human health RGs for soil and structure surfaces consider carcinogenic effects from exposures to DU. According to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 *Code of Federal Regulations* (*CFR*) §300.430(e)(2)(i)(A)(2)], the acceptable human health exposure levels to known or suspected carcinogens are levels that represent an excess incremental lifetime CR (i.e., above baseline) to an individual of between 1 in 1,000,000 (1.0E-6) and 1 in 10,000 (1.0E-4). The lower limit of the range (1.0E-6) is considered to be USEPA's point of departure CR from which all risk management decisions begin. Risk-based RGs may be revised upward within the target CR range based on a variety of site- or remedy-specific factors such as the reliability of data, quantification or detection limits, background considerations, or other considerations consistent with the remedy selection criteria defined in the NCP [40 *CFR* §300.430(f)(1)(i)]. Therefore, RGs for DU were initially established that equate to the health-conservative end of USEPA's target CR range, or 1.0E-6. To facilitate site-specific risk-management decision making, RGs have also been derived and are presented for DU that target CRs of 1.0E-5 and 1.0E-4. DU is the byproduct remaining after the extraction of U-235 from naturally occurring uranium. DU typically contains about 99.7990, 0.200, and 0.0010 percent by weight U-238, U-235, and U-234, respectively, with corresponding activity percentages of 90.14, 1.45, and 8.40. Natural uranium, by comparison, consists of about 99.284, 0.711 and 0.005 weight percent U-238, U-235, and U-234, respectively, with corresponding activity percentages of 48.6, 2.2, and 49.2 for the stated radioisotopes.

Based on applicable or relevant and appropriate requirement (ARAR) analysis, 10 *CFR* 20.1403(b) and 20.1403(e) are relevant and appropriate to the derivation of remedial goals for restricted release. Because 90.14 percent of the activity of DU is attributable to U-238, a soil RG has been developed for U-238. This approach uses U-238 as a surrogate for DU and facilitates comparisons with laboratory confirmation measurements.

The U-238 RG is health-protective of the cumulative effects from all three DU isotopes. This was done by targeting a total effective dose equivalent (TEDE) of 22.5 mrem/yr (i.e., 90 percent of 25 mrem/yr). The laboratory-measured U-238 concentrations (attributable to DU) for soil (pCi/g) will be compared to the corresponding RG derived for U-238 to evaluate compliance with the RG. Because the TEDE of 22.5 mrem/yr considers contributions from all three uranium isotopes in DU, the RG is protective for exposure to U-234 and U-235, as well as to U-238.

Due to the natural variability in activity percentages present in DU, all confirmatory soil samples will be processed by alpha spectroscopy analysis to determine the isotopic concentrations of all three uranium isotopes present in DU (U-238, U-235, and U-234). The actual concentrations reported in each SU will be used to calculate the actual dose/risk associated with the residual DU.

The soil and structural RGs determined for DU in the ROD (referred to as the DCGL) are both individually and cumulatively protective of the total dose limit of 25 mrem/yr and the CR of 1.0E-4 and will be used for designing FSS, comparison of FSS data, and for determining the requirements for remedial action to be taken at the IAAAP.

The DCGL is the average (or uniform) residual DU-concentration level within an SU that corresponds to the RG. Its use implies that consideration be given to the area of the SU that was considered during the dose modeling used to derive the DCGL. This is clarified in a later discussion of the elevated measurement comparison (EMC).

MARSSIM statistical tests refer to the DCGLs as the “acceptance criterion”. Statistical test results showing compliance with acceptance criterion indicate that residual risk and dose levels are acceptable and the land area or structure does not present a current or potential threat to public health or the environment.

5.2.2 Investigation Levels

When direct comparison of field measurements and the DCGL can be made, the ILs are based upon the DCGLs. ILs are levels of radioactivity identified during scanning surveys or sampling/measurement results that indicate when additional investigations may be necessary (i.e., biased sampling or measurements).

When an IL is exceeded, the first step is to confirm that the initial measurement actually exceeds the particular IL. This may involve taking additional biased samples or measurements in addition to FSS samples or measurements. Depending on the results of the investigation, the SU may require reclassification, remediation, and/or resurvey.

The IL for GWSs cannot be directly related to the DCGL for soil (cpm versus pCi/g); however, modeling a 1 m^2 hotspot uniformly contaminated with DU at 50 pCi/g (assuming approximately 10,000 background cpm) results in approximately 3,000 cpm, therefore, the IL for GWSs is initially set at 3,000 cpm above relative field background. The IL will be re-evaluated as surveys progress based on information collected in the field, including relative background in the survey area.

ILs should generally be established as provided in Table 11. USACE may direct that other ILs be used, on a case-by-case basis.

Table 11. Final Status Survey Investigation Levels

SU Classification	FSS Samples or Measurements	Scanning Measurements
Class 1	> DCGL	> DCGL
Class 2	> DCGL	> 50% of the DCGL
Class 3	> 50% of the DCGL	Note[a]

[a] Any suspect measurement above relative background will be investigated.

5.2.3 Elevated Measurement Comparison

DCGLs are developed for soil using exposure pathway models that assume a uniform distribution of contamination within the modeled SU area. While this represents an ideal situation, non-uniform conditions and small areas of elevated activity[1] may exist in some instances. This is especially true in areas where very small DU particles may have resulted in very small isolated areas of elevated activity from controlled detonations. If a survey design were to rely solely on systematic sampling there would be a potential for small areas within a Class 1 SU that are not detected and which may result in a residual dose above the RGs. Scanning surveys are selected to detect such areas.

Small areas of elevated activity (i.e., in excess of the DCGL) may be acceptable in Class 1 SUs, provided that it can be shown that the RGs are still met. The $DCGL_{EMC}$ presents a simple method to evaluate such areas.

The $DCGL_{EMC}$ is simply the DCGL that has been modified to account for the smaller area of contamination. For example, dose modeling has determined that the modified DCGL for U-238 that evenly contaminates a 2,000 m^2 area at IAAAP is 151 pCi/g, then that same model might also determine that the contamination level necessary to produce the same risk (1.0E-4) for a much smaller area, say 1 m^2, is approximately 2,300 pCi/g. Comparison of a small area of elevated activity directly to the $DCGL_{EMC}$ allows rapid assessment of the acceptability of such an area.

If small areas of elevated activity are found in an isolated area, in addition to residual radioactivity distributed relatively uniformly across the SU, the dose contribution from the small area of elevated activity will be summed with the dose from the entire SU to ensure that the total dose achieves RGs. If there is more than one of these areas, a separate term should be included in the calculation for each area of elevated radioactivity.

In Class 2 or Class 3 areas, neither measurements above the DCGL nor areas of elevated activity are expected. Any measurement at a discrete location exceeding the DCGL in these areas should be flagged for further investigation. Because the survey design for Class 2 and Class 3 SUs is not driven by EMC, the scanning MDC might exceed the DCGL. In this case, any indication of residual radioactivity during the scan would warrant further investigation.

5.3 CLASSIFY AREAS AND SURVEY UNITS

Consistent with MARSSIM, SUs are classified based on a HSA and the results of scoping and characterization surveys. If an adequate amount of historical information and data exists, then the SU may be classified without performing scoping and characterization surveys. Otherwise, scoping or characterization surveys will be performed prior to the SU classification.

SUs under MARSSIM are broken into three classes. A SU is classified as a Class 1 unit when it has or had prior to remediation, a potential for radioactive contamination, or known contamination above the RG.

Class 1 SUs should not exceed 2,000 m^2 for a land area unless approved by USACE.

A SU is classified as a Class 2 unit when it has a potential for radioactive contamination or known contamination, but is not expected to exceed the RG.

Class 2 SUs should not exceed 10,000 m^2 for a land area unless approved by USACE.

[1] Commonly referred to as a "hotspot."

A SU is classified as a Class 3 unit when it is not expected to contain any residual radioactivity, or is expected to contain levels of residual radioactivity at a small fraction of the RG, based on site operating history and previous radiation surveys. There is no limitation to the size of Class 3 SUs.

As a survey progresses, re-evaluation of this classification may be necessary based on newly acquired survey data.

5.4 PREPARE SITE FOR SURVEY ACCESS

All of the IAAAP land is currently owned and under the control of the Army; so consent for access does not need to be obtained from outside parties to investigate an area or structure. Therefore, access agreements are not required at IAAAP. The USACE and its contractors will coordinate with the Army on the following issues prior to accessing an area for FSS:

- Security concerns, locking of the facility or area, and key control, where applicable.
- How grids, survey locations, and surface nomenclature may be marked (or not marked) on survey surfaces,
- What may and may not be moved, repositioned, or dismantled in order to gain access for survey, and notification requirements for such, and
- Cleanliness needs for survey execution and responsibilities for achieving this level of cleanliness.

5.5 ESTABLISH SURVEY LOCATION REFERENCE SYSTEM

A reference coordinate system may be used to facilitate selection of measurement and sampling locations, and to provide a mechanism for referencing a measurement to a specific location so that the same survey data point can be relocated.

For land area SUs, global positioning system (GPS) instruments will provide coordinate (and time) information for GWSs and each sampling location. The product of the GWS will be a data set mapped to display relative levels of gamma radiation across the site for GWSs or individual sample locations.

For structure SUs, the reference coordinate system might be established such that the grid spacing satisfies the survey design requirements for structures (and therefore the grid intersections correspond to the survey data point locations) for Class 1 and Class 2 SUs. For Class 3 SUs, where the survey data points are not systematic, a base reference coordinate system might be established with grid spacing of some fixed value (such as 1 m). Other survey data point locating strategies may be used, as the situation and the available technology dictates.

A reference coordinate system consists of a grid of intersecting lines, referenced to a fixed site location or benchmark. The reference coordinate system used for a particular survey should provide a level of reproducibility consistent with the objectives of the survey.

Reference coordinate system patterns for structures are usually identified numerically on one axis and alphabetically on the other axis. The origin of such systems is generally started at the South-Western most corner of the room or area being investigated. Overhead measurement and survey locations (e.g., ceiling and overhead beams) are referenced to corresponding floor grids.

Reference coordinate systems on structures are usually marked by chalk line or paint along the entire grid line or at grid intersections. Permission from the IAAAP should be obtained prior to using any permanent marking system, and consideration should be given to attenuation caused by painting and weathering concerns.

Following the establishment of the reference coordinate system, a drawing or sketch will be prepared by the survey team. This drawing indicates the reference lines and other pertinent site features and provides a reference compass direction. The process used to develop the reference coordinate system should be recorded in the survey planning documentation.

The reference coordinate system does not dictate the spacing or location of survey measurements.

5.6 DETERMINE THE NUMBER OF DATA POINTS NEEDED

For the situation present at IAAAP, where the contaminant level in background is a small fraction of the DCGL, a background reference area is not used. Instead, the contaminant levels are compared directly to the DCGL value. For this situation, the Sign Test is used. The following steps describe the process for determination of the number of necessary data points for statistical tests.

5.6.1 Specify Decision Errors

USACE has established acceptable decision errors for the FUSRAP areas of the IAAAP in order to enable testing of survey data relative to the acceptance criteria. The Type I decision error to be used is 0.05. This provides a confidence level of 95 percent that the statistical tests will not incorrectly determine that an SU satisfies criteria when, in fact, it does not. The Type II decision error is initially set at 0.20. Type II errors, which could result in excess uncontaminated materials being removed, do not adversely impact public safety or health and thus are subject to change.

5.6.2 Estimate Sample Standard Deviation

Site specific data should be used, when available, to estimate the SU standard deviation. The use of previous survey data to estimate the standard deviation for an SU is discussed in MARSSIM. Choosing an appropriate value for standard deviation is very important. If the value is grossly underestimated, the number of samples will be too few to obtain the desired power for the statistical test, and a resurvey may be recommended. If the value is overestimated, the number of samples determined will be unnecessarily large. Historical, characterization, and preliminary design investigation sample data may be used to estimate the standard deviation. In Class 1 SUs, screening samples collected from remediated areas may also be used to estimate the standard deviation.

5.6.3 Calculate Relative Shift

The relative shift is an expression of the resolution of the measurements in units of measurement uncertainty. It is calculated dividing the shift (Δ) by the standard deviation. Although the RGs have already been established in the ROD and do not need to be derived, the criteria will be referred to as DCGLs to be consistent with MARSSIM. The shift is set equal to the DCGL minus the lower bound of the grey region (LBGR). The DCGL has been determined to be 150 for DU. MARSSIM recommends initially setting the LBGR to one half of the DCGL. The LBGR may be set at the mean concentration of the SU if it is known. When calculating the relative shift, MARSSIM recommends a value between 1 and 3. Since the DCGLs are set as specified in the ROD, and using the overall standard deviation, the LBGR will typically be adjusted so that the relative shift falls within the 1 to 3 range. When using one half of the DCGL as the LBGR, the shift is stated as:

$$\Delta = DCGL - LBGR = 150 - 75 = 75$$

If SU data is available and the overall standard deviation will be calculated rather than using a value based on a similar SU or historical assessment.

5.6.4 Obtain Number of Data Points

The number of data points is calculated differently, depending on the statistical test to be applied. The Sign Test has been chosen for the FSS at IAAAP due to the U-238 background value being such a small fraction of the soil and structure RGs at the site. When a background reference area will not be subtracted from survey measurements, the contaminant levels may be compared directly with the DCGL value.

Sign *p* is the estimated probability that a random measurement from the SU will be less than the DCGL when the SU median is actually at the LBGR. The value of Sign *p* is based upon the relative shift and is taken from Table 12.

Table 12. Values of Sign p

Δ/σ	Sign p	Δ/σ	Sign p
0.1	0.539828	1.2	0.884930
0.2	0.579260	1.3	0.903199
0.3	0.617911	1.4	0.919243
0.4	0.655422	1.5	0.933193
0.5	0.691462	1.6	0.945201
0.6	0.725747	1.7	0.955435
0.7	0.758036	1.8	0.964070
0.8	0.788145	1.9	0.971284
0.9	0.815940	2.0	0.977250
1.0	0.841345	2.5	0.993790
1.1	0.864334	3.0	0.998650

Next, determine the decision error percentiles $Z_{1-\alpha}$ and $Z_{1-\beta}$, represented by the selected decision error levels, Type I and Type II, respectively. The decision error percentiles are selected from Table 13.

Table 13. Percentiles Represented by Selected Values of α and β Errors

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)	α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576	0.10	1.282
0.01	2.326	0.15	1.036
0.015	2.241	0.20	0.842
0.025	1.960	0.25	0.674
0.05	1.645	0.30	0.524

Finally, calculate the number of data points (*n*) using Equation 2.

Equation 2. Calculate n for the Sign Test

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4\ (Sign\ p - 0.5)^2}$$

Where: *n* is the number of data points

Sign p is the estimated probability that a random measurement form the SU will be less than the DCGL when the SU median is actually at the LBGR

$Z_{1-\alpha}$ is the decision error percentile for a Type I error

$Z_{1-\beta}$ is the decision error percentile for a Type II error

The number of anticipated data points should be increased by at least 20 percent to allow for missing or unusable data.

5.7 DETERMINE SAMPLE SPACING

The grid spacing (L) for Class 1 or Class 2 SUs is estimated in one of two ways, depending on the intended shape of the grid.

5.7.1 Triangular Grid Spacing

If a triangular grid is used (preferred), the L is estimated using the following equation.

$$L = \sqrt{\frac{(A)}{(0.866)(n)}}$$

Where: A = the surface area in the SU

n = the number of data point to be taken

5.7.2 Square Grid Spacing

If a square grid is used, the L is estimated using the following equation.

$$L = \sqrt{\frac{(A)}{(n)}}$$

Where: A = the surface area in the SU

n = the number of data point to be taken

Area units or measurements must be used consistently throughout either equation.

5.8 SMALL AREAS OF ELEVATED ACTIVITY

The Sign Test will evaluate whether or not the residual DU-contamination in an area exceeds the DCGL for contamination conditions that are approximately uniform across the SU. These tests may not correctly assess compliance with RGs when small areas of elevated activity are present. Scanning is used to obtain adequate assurance that small areas of elevated activity are identified. If such areas are found, the $DCGL_{EMC}$ may be used to evaluate their impact.

If a scanning technique's MDC is inadequate, then the systematic survey grid spacing may need to be reduced in order to increase the probability of detecting the small areas of elevated activity.

Within the IAAAP, the DCGL is such that the scan MDC will be less than the DCGL except for very small areas of elevated activity, therefore grid spacing corrections should not be required. USACE will provide direction when such corrections are required.

5.9 SCAN COVERAGE REQUIREMENTS

Surface contamination scanning requirements are discussed in Section 4.3.2 of this plan. Table 5 of that section provides guidance on the degree of scanning coverage to be provided based upon the SU classification.

5.10 QUALITY ASSURANCE/QUALITY CONTROL MEASUREMENTS

5.10.1 Quality Assurance/Quality Control Samples (Field Splits and Duplicates)

Field split and duplicate samples or measurements should be obtained at a rate of approximately one in twenty (5 percent) samples. The results of the split and duplicate counts are evaluated in the data evaluation phase of the FSS process, as outlined in DQIs, Section 7.5.

5.10.2 Instrument Performance Checks

Survey instruments shall be verified to be operable and to be performing within established tolerances on each day that they are used. The results of such checks will be documented.

The minimum checks required include:

- The background count rate.
- The count rate of a calibrated, National Institute of Standards and Technology (NIST)-traceable check source (except for sodium iodide [NaI]) detectors which do not require a NIST-traceable source).

The instrument performance checks should be performed both prior to survey measurements and following the completion of the survey measurements for that work shift at a minimum.

Survey personnel are responsible for verifying survey instrument compliance with established tolerances prior to use of the survey instrument. Additionally, compliance will be reviewed during the DQA of the survey data, as discussed in Section 7.1.

5.10.3 In-Process Quality Control Checks

The performance of a survey instrument may degrade during use of the instrument. Proportional counters are particularly sensitive to changes in temperature, humidity, gas quality, and gas flow. Scintillation detectors may show large changes in the count rate with minute light-leaks in the mylar window of the detector. The surveyor should be alert for these conditions and should immediately halt the survey when any abnormal instrument response is suspected.

Instrument operability may be quickly assessed in the field by performing a 1-minute field background count and comparing the result to the field background counts taken at the start of the survey. A difference in excess of 20 percent is suspect, additional investigation should be initiated, and the data collected since the last check should be evaluated to ensure its acceptability.

The results of any such in-process field background quality control checks should be documented, whether acceptable or unacceptable, in FSS documentation.

5.11 LABORATORY ANALYSIS

Surface soil samples will be transferred to a USACE-approved or Department of Defense (DOD) Environmental Laboratory Accreditation Program certified radio-analytical laboratory for analyses in accordance with documented laboratory-specific standard methods. Specific analyses for each sample will include alpha spectrometry. In accordance with MARSSIM, analytical techniques will provide a maximum detection level of 50 percent of the DU-RG, with a preferred target minimum detection level of 10 percent of the RG. U-238 is used as a surrogate for DU. Analytical target detection limits are shown in Table 14.

Table 14. Target Detection Limits

Radionuclide	Maximum Detection Limit	Preferred Detection Limit
U-238	75 pCi/g	15 pCi/g

Analysis of samples will be performed on dried and homogenized soil. High-resolution alpha spectrometry will be used for quantification of U-238. Concentrations in soil will be reported in units of pCi/g. Other quality control activities are incorporated into specific field survey procedures.

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6.0 SURVEY INSTRUMENTATION

6.1 INSTRUMENT SELECTION

A variety of radiological survey instruments and configurations are available for use in the conduct of FSS data collection. General performance requirements for instrumentation are provided in Section 7 in this plan.

The choice of detector type, instrument efficiency, probe size, and scanning speed must be carefully considered to ensure that DQOs will be met.

6.2 INSTRUMENT EFFICIENCY

Instrumentation used for GWSs do not require an instrument efficiency due to the nature of the qualitative information collected with that type of instrument.

For instruments used on structure surveys, the 2π instrument efficiency is used in calculations that convert the instrument response (in cpm) to units of the DCGL. The instrument 2π efficiency is determined at the time of calibration, and is verified regularly as part of instrument performance checks.

6.3 GAMMA SCAN MINIMUM DETECTABLE CONCENTRATION

The derivation of scan MDCs for GWSs at the IAAAP are located in Appendix A to this plan.

6.4 STATIC MINIMUM DETECTABLE CONCENTRATION

The FSS data point (i.e., "fixed-point") survey measurements may also be referred to as "static" measurements.

Prior to performing field measurements, an investigator must evaluate the detection sensitivity of the equipment proposed for use to ensure that levels below the DCGL can be reliably detected.

The minimum level of surficial contamination that may be reliably measured at a specified confidence level (95 percent), based upon characteristics of the detection system and the counting parameters, converted to units of the DCGL is known as the MDC. This is an *a priori* value.

Guidance for the determination of the MDC may be found in:

- NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC, 1998), and
- NUREG-1575, MARSSIM (DOD, 2000).

Requirements for the static MDC are provided in Section 7. The static MDC (in units of dpm/100 cm^2) may be calculated using Equation 3.

Equation 3. Static MDC

$$Static\ MDC = \frac{3 + 3.29\sqrt{(R_b)(t_g)\left(1+\frac{t_g}{t_b}\right)}}{(t_g)(\varepsilon_s)(\varepsilon_i)\left(\frac{\mathrm{Pr}\,obe\ Area}{100}\right)}$$

Where: R_b is the background count rate (cpm)

t_b is the background count time (minute)

t_g is the survey count time (minute)

ε_s is the surface/source efficiency

ε_i is the 2π instrument efficiency (cpm/dpm)

Probe Area is the open area of the detector face (cm^2)

6.5 BETA SCAN MINIMUM DETECTABLE CONCENTRATION

The ability to identify a small area of elevated activity during scanning is dependent upon the surveyor's skill in recognizing an increase in the audible or display output of an instrument. The ability of a surveyor to detect a pre-determined level of contamination with a detector is called the "scanning sensitivity".

The scanning sensitivity for a given situation can be improved by:

- Selecting an instrument with a higher instrument efficiency or a lower background,
- Decreasing the scanning speed, or
- Increasing the size of the effective probe area without increasing the background.

The probability of detecting DU-contamination in the field depends not only on the sensitivity of the survey instrumentation, but is also affected by the surveyor's ability (i.e., human factors).

The beta scan MDC (in units of dpm/100 cm^2) may be calculated using Equations 4, 5, and 6.

When calculating the beta scan MDC, the index of detectability (*d'*) will be set at a value of 1.38 per NUREG-1507 (NRC, 1998), and the surveyor efficiency (*p*) will be assumed to be 0.50.

Equation 4. The Observation Interval

$$i = \frac{w}{s}$$

Where: *i* is the time that the probe face is exposed to a point of contamination (second)

w is the probe face width, in the direction of scanning (cm)

s is the scan speed centimeter (cm per second)

Equation 5. The Minimum Detectable Count Rate (MDCR) (cpm)

$$MDCR = d' \sqrt{b\left(\frac{i}{60}\right)} \left(\frac{60}{i}\right)$$

Where: *d'* is the index of detectability (i.e., 1.38)

b is the background count rate (cpm)

i is taken from Equation 4 (second)

Equation 6. The MDC for Scans

$$MDC = \frac{MDCR}{(\varepsilon_s)(\sqrt{p})(\varepsilon_i)\left(\frac{\text{Probe Area}}{100}\right)}$$

Where: *MDCR* is the minimum increase above background that can be seen reliably, taken from Equation 5 (cpm)

ε_s is the surface/source efficiency

p is the surveyor efficiency (i.e., 0.5)

ε_i is the detector efficiency (cpm/dpm)

Probe Area is the open area of the detector face (cm^2)

Scan parameters should be adjusted such that the scan MDCs meet the guidelines provided.

6.6 ALPHA SCAN MINIMUM DETECTABLE CONCENTRATION

Scanning for alpha emitting radionuclides differs significantly from scanning for beta and gamma emitters in that the expected background response of most alpha detectors is very close to zero. Instead, it is more useful to determine the probability of detecting an area of contamination at a predetermined DCGL for given scan rates.

Given a known scanning rate and a surface contamination IL, the probability of detecting a single count while passing over the contaminated area, is provided in Equation 7.

Equation 7. Alpha Scan Probability

$$P(n \geq 1) = 1 - e^{\frac{(-G)(\varepsilon_i)(d)}{(60)(v)}}$$

Where: P is the probability of observing a single count

G is the IL (dpm/100 cm^2)

ε_i is the detector efficiency (cpm/dpm)

d is the width of the detector face in the direction of scan (cm)

v is the scan speed (cm per second)

When a single count is detected, the surveyor should pause over the suspect area for a minimum of 10 seconds while continuing to monitor the instrument’s audible and visual response. If additional counts are seen, this situation may warrant a static measurement in the area in order to determine the true contamination level.

Scan parameters should be adjusted such that the scan MDCs meet the guidelines provided.

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7.0 INTERPRETATION OF SURVEY RESULTS

This section discusses the interpretation of FSS results for surface soil and structure SUs.

7.1 DATA QUALITY ASSESSMENT

DQA is a scientific and statistical evaluation that determines if the data are of the right type, quality, and quantity to support their intended use. Detailed guidance for the DQA process is provided in *Guidance for Data Quality Assessment* (USEPA, 2000a).

The effort expended during the DQA evaluation should be consistent with the graded approach used in designing the survey.

7.2 REVIEW THE DATA QUALITY OBJECTIVES AND SAMPLING DESIGN

The survey design and data collection documentation should be reviewed for consistency with DQOs. For example, the review should check that the appropriate number of samples were taken in the correct locations, and that they were measured with instruments of the appropriate sensitivity.

7.3 CONDUCT A PRELIMINARY DATA REVIEW

The survey results for surficial contamination on structures should be converted to units of the DCGL, using Equation 8.

Equation 8. Calculate Surface Activity Results in Units of the DCGL

$$\text{Result}\left(\frac{dpm}{100cm^2}\right) = \frac{\left(R_g\right) - \left(R_b\right)}{\left(\varepsilon_s\right)\left(\varepsilon_i\right)\left(\frac{\text{Probe Area}}{100}\right)}$$

Where: R_g is the static data point gross count rate (cpm)

R_b is the average field background count rate (cpm)

ε_s is the surface/source efficiency

ε_i is the instrument efficiency (cpm/dpm)

Probe Area is the open area of the detector face (cm^2)

The survey results should then be inspected for obvious outliers, trends, values that clearly exceed the DCGL, and indicators of inconsistent results. Basic statistical quantities such as the mean, median, and sample standard deviation may be calculated to develop an overall picture of the SU.

The value of the sample standard deviation is especially important. If it is too large compared to that assumed during the survey design, this may indicate an insufficient number of samples were collected to achieve the desired power for statistical testing. Inadequate power can lead to unnecessary remediation.

Unusual or unexpected results should be investigated. Results that exceed the DCGL or administrative levels should be investigated and additional field measurements performed to accurately estimate the magnitude and areal extent of area(s) of elevated activity. This will facilitate comparison to the EMC.

7.4 EVALUATE SMALL AREAS OF ELEVATED ACTIVITY

Survey measurements that exceed the DCGL may not necessarily indicate that RGs have not been met for the SU. If one or more measurements exceed the DCGL, the small areas of elevated activity can be compared to the $DCGL_{EMC}$.

7.4.1 Comparison to the Elevated Measurement Comparison

The EMC is performed for survey data that exceed the DCGL. The EMC is performed for both sample results obtained on the systematic-sampling grid and for locations flagged by scanning measurements. If a sample result (or average of several sample results over the area of elevated activity) passes the EMC, then the small area(s) of elevated activity are acceptable and the SU may pass the FSS evaluation, pending acceptable completion of other tests.

Values for the $DCGL_{EMC}$ are based on the area of the elevated activity and may be derived at the same time as the DCGLs.

If there is a single small area of elevated activity within the SU, the process for the EMC is as follows:

- Determine the area of the elevated activity.
- Determine the average concentration of residual DU-contamination in the area of elevated activity, in units of the DCGL.
- Find the value of the $DCGL_{EMC}$ that corresponds to the area of the elevated activity.
- Compare the average concentration in the small area of elevated activity directly to the $DCGL_{EMC}$. If the $DCGL_{EMC}$ is greater than the average activity, then the small area passes the EMC.

If there are multiple small areas of elevated activity within the SU, the unity rule must be applied. The process for applying the unity rule is as follows (refer to Equation 9):

- Determine the area for each location of elevated activity.
- Determine the average concentration of residual DU-contamination in each area of elevated activity, in units of the DCGL.
- Find the value of the $DCGL_{EMC}$ that corresponds to each area of elevated activity.
- Determine the remaining area of the SU (i.e., subtract the total of all areas of elevated activity from the SU area).
- Calculate the mean of the residual DU-contamination in that remaining area of the SU.
- Apply Equation 9 if the result is less than or equal to 1.0, then the SU passes the EMC.

Equation 9. The Unity Rule

$$\frac{C_1}{DCGL_{EMC1}} + \frac{C_2}{DCGL_{EMC2}} + \cdots \frac{C_n}{DCGL_{EMCn}} + \frac{C_x}{DCGL} \le 1.0$$

Where: C_n is the concentration in the small area (pCi/g)

$DCGL_{EMCn}$ is the $DCGL_{EMC}$ value based upon the area of the small area of elevated activity (pCi/g)

C_x is the mean of the concentration in the remainder of the SU (pCi/g)

DCGL is already defined.

7.5 REVIEW DATA QUALITY INDICATORS

DQIs are established to quantify the amount of error in the data collection process and the analytical measurement system.

The following DQIs have been established for soil and structure FSS:

- Duplicate samples to assess analysis precision (soil only).
- Split samples to assess analysis accuracy (soil only).
- Calibration checks to assess instrument accuracy and instrument bias (soil and structures).
- Instrument background measurement to estimate bias caused by instrument contamination (soil and structures).
- Other – minimum acceptable instrument efficiency (soil and structures).
- Other – static MDC (surficial contamination measurements) (structures only).
- Other – beta scan MDC (surficial contamination measurements) (structures only).
- Other – alpha scan MDC (surficial contamination measurements) (structures only).

Acceptance criteria for the DQIs are provided in Table 15.

Table 15. Data Quality Indicator Summary

DQI Parameter	Purpose	Criteria
Precision	Comparison of duplicate values from sample analytical results.	RPD ≤ 50 at values found to be at least 50% of the DCGL[a]. See Equation 10.
Accuracy	Comparison of split values from sample analytical results.	RPD ≤ 50 at values found to be at least 50% of the DCGL[a]. See Equation 10.
Accuracy and Bias (Instrument calibration check)	Check to ensure that the instrument is responding properly.	Value is ≤ 20% of the counts on a known source (that were determined at the time of calibration).
Bias (Contamination, background check)	Check of the instrument counting rate in office conditions to verify that the detector has not become contaminated.	± 3 standard deviation from the background value determined at calibration.
Instrument Efficiency (ε_i)	Check to ensure that the instrument will provide adequate field response to radiation.	Generally ≥ 0.15
Static MDC	Verify that instrument has adequate resolution.	≤ DCGL. Target of 10% to 50% of the DCGL.
Beta scan MDC	Verify that scans can detect small areas of elevated activity.	≤ DCGL, where feasible.
Alpha scan MDC	Verify that scans can detect small areas of elevated activity.	Probability of detecting a single count ≥ 0.85.

[a] At duplicate values that are within 5 times the minimum detectable activity (MDA), the duplicate is acceptable if the duplicates' value is within 3 MDAs of the first measured value.

NOTE: Precision and accuracy cannot be adequately determined when field measurements are less than 50 percent of the criterion value due to the high degree of variability at background levels.

The RPD should be determined for each duplicate measurement, using Equation 10 (or Table 15 footnote [a]).

Equation 10. Calculating the RPD

$$RPD = \left[\frac{(S - D)}{\frac{(S + D)}{2}} \right] (100)$$

Where: S is the first value (original)

D is the second value (duplicate value)

Survey data and instrument check-in sheets should be reviewed to verify that DQIs were met. Out of tolerance values should be investigated and evaluated. If a DQI is found to have not been met, then USACE should be contacted for a determination of the adequacy of related FSS data.

8.0 VERIFY FINAL STATUS SURVEY DESIGN

An evaluation is performed to determine that the data are consistent with the underlying assumptions of the survey design. Specifically, the procedures described in Section 5.0 are re-performed with actual survey data to verify that an adequate number of survey points were taken to support the desired power of the statistical test to be applied.

The process is fully described in Section 5.0, but is modified here as follows:

- Calculate the sample standard deviation of the contaminant in the SU from actual survey data,
- Determine the relative shift,
- Obtain the number of data points needed, and
- Compare the number of data points actually obtained to the new estimate to ensure that sufficient information is available to support the statistical testing.

Information demonstrating the validity of the initial survey design is included in the FSS Report.

8.1 SELECT THE STATISTICAL TEST

Statistical results are only applied to measurements made at discrete locations (i.e., static measurements). Biased survey measurements are not included in statistical tests, as they alter the underlying assumptions of the tests.

The Sign Test described in MARSSIM Section 5.5.2.3 will be used since background is a small percentage of the RG. In this situation, any natural radioactivity in the surveyed materials will have contributed to the results of the survey measurements, and the mean of the residual DU-contamination in the SU may be overestimated to some degree. The natural background radioactivity is small when compared to the DCGL, and application of the Sign Test is reasonable and may be the most beneficial test overall.

The selected statistical test is applied in accordance with the guidance and examples provided in the MARSSIM to the survey data, and conclusions about the SU are drawn.

Results of such tests are included in the FSS Report.

8.2 DRAW CONCLUSIONS FROM THE DATA

The DQOs identified a decision (Section 4.2) and a decision rule (Section 4.5). The decision rule is used to compare the FSS results to the decision.

If it is determined that the SU meets RGs, then the survey effort is essentially complete. If not, then an alternate action is taken. Options for alternate action are provided in Table 1 of Section 4.2. Alternate actions may lead to remediation, followed by additional FSS efforts.

Conclusions are documented in the FSS Report.

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9.0 REPORT OF SURVEY FINDINGS

Survey procedures and results are documented in an FSS Report, following the general guidance for FSS evaluation reports in the MARSSIM. Information from the FSS Report is an integral part of an applicable Post Remedial Action Report (PRAR), or other similar document.

Documentation of the FSS should provide a complete and unambiguous record of the radiological status of the SU, relative to the established DCGLs. In addition, sufficient data and information should be provided to enable an independent re-creation and evaluation at some future time. To the extent practicable, the report will be a stand-alone document with minimum information incorporated by reference.

The FSS Report will, at a minimum, contain the following information:

- A facility map,
- Survey figures or maps that show scan locations and coverage, locations of elevated scan levels, and sample/fixed-point measurement locations from each SU,
- Tables of surface soil and surficial contamination survey results for each sample or static measurement in the SU,
- Tables of surface soil or surficial contamination survey results for each sample,
- Summary statistics for the systematic or random surface soil or static measurements from each SU,
- Results of the statistical test(s),
- Results of any EMC comparisons,
- Documentation of the overall scan and static MDCs for the FSS,
- Evidence that DQOs and the associated DQIs were met for the FSS,
- Indication that the survey design was appropriate, when reviewed retrospectively, and
- Conclusions of the FSS (i.e., that the SU meets or does not meet RGs).

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FIGURE

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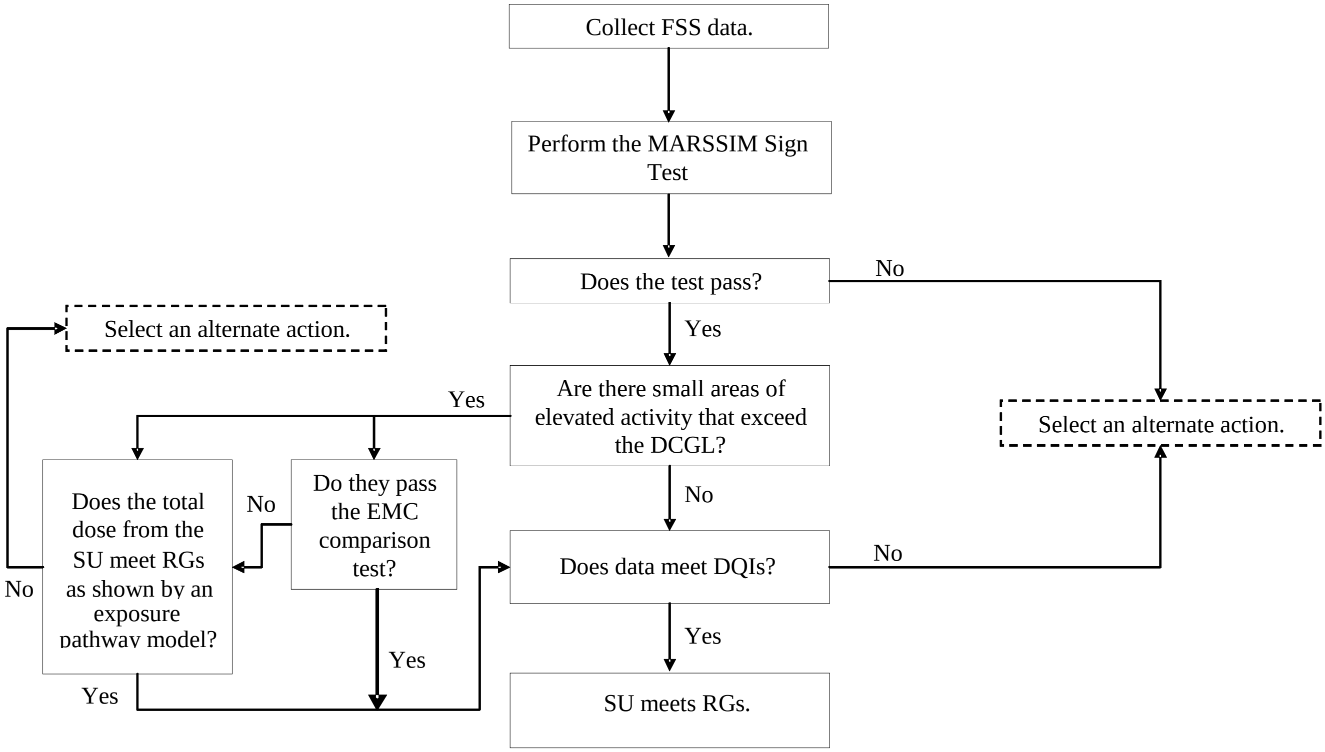

Figure 4-1. Final Status Survey Decision Tree.

APPENDIX A

2-INCH BY 2-INCH SODIUM IODIDE DETECTOR SCAN DETECTION OF DEPLETED URANIUM FRAGMENTS

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SODIUM IODIDE 2-INCH BY 2-INCH SCINTILLATION DETECTOR SCAN DETECTION OF DEPLETED URANIUM FRAGMENTS

NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1998), and NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, *Revision 1* (USEPA 2000b) provide examples of typical MDCs for various radionuclides using gamma scan detectors. These documents state that the MDCs provided are examples only and other scan MDC values may be equally justifiable depending on the values chosen for the various input parameters and site-specific conditions. The MDC value listed in NUREG 1507 for DU-contaminated soil is considered justifiable and sufficient. However, the use of this value is not appropriate for the detection of visible, solid DU fragments. Due to the specific activity of a DU fragment there is little doubt that the typical hotspot modeled in NUREG 1507 (0.25-cm radius) could be detected. The question is how small of a DU fragment can be detected with confidence.

The steps for calculating the size of a DU fragment that can be detected generally follow the approach detailed in NUREG 1507. The steps include:

1. Calculating the MDCR by selecting a given level of performance, scan speed, and background level of a 2-inch by 2-inch (or 2 inches × 2 inches) NaI detector,
2. Selecting a surveyor efficiency, and
3. Relating the minimum detectable count rate of the surveyor ($MDCR_{surveyor}$) to a given exposure rate.
4. Modeling the exposure rate of various size fragments.
5. Comparing the MDCR exposure rate to the modeled exposure rates.

The development of this relationship in item three requires two significant steps. In step one, the relationship between the detector's net counting rate to net exposure rate in counts per minute per microroentgen per hour (cpm/μR/hr) is established. In step two, the relationship between the specific activity of DU and exposure rate is determined. For particular gamma energies, the relationship of the 2-inch by 2-inch NaI detector's counting rate (in cpm) and exposure rate may be determined analytically. Once this relationship is known, the $MDCR_{surveyor}$ (in cpm) of the NaI detector can be related to the minimum detectable net exposure rate (MDER). This minimum rate is used to determine the minimum detectable DU fragment by modeling a specified postulated fragment.

For determining the MDCR, an average background for the 2-inch by 2-inch NaI detector of 10,000 cpm was selected. The observable background counts is the number of background counts observed within the observation interval. This is commonly referred to as *b'*. The equation used for calculating *b'* is as follows:

$$b' = (\text{background count rate}) \times (\text{observation interval}) \times (1\text{ minute}/60\text{ seconds}) = \text{counts/interval}$$

$$b' = (10{,}000\text{ cpm}) \times (1\text{ second}) \times (1\text{ minute}/60\text{ seconds}) = 166.67\text{ counts.}$$

The observational interval of 1 second is based on the selected instrument to be used during the GPS assisted gamma walkover. The detector/meter combination will produce a data point or estimated cpm reading every second during operation. This reading will be married to a specific X Y coordinate and recorded in the associated data logger.

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, *d'*, is the alpha/beta error acceptable for a given survey. Alpha and beta errors of

95 percent (true positive rate) and 60 percent (false positive rate), respectively, were selected to be consistent with NUREG 1507. Selection of a high beta error signifies that the surveyor will stop the scan at very small increases in detection signal "clicks" in order to conduct an intensified scan. This slows down the survey but provides a higher level of confidence in the results of the survey. The value of 1.38 was obtained from Table 6.1 in NUREG 1507 (Table 6.5 in MARSSIM).

MDCR = (d') × (square root of b') × (# of observation/minute) = cpm

MDCR = (1.38) × (square root 166.67) × (60 observations/minute) = 1069 cpm

The $MDCR_{surveyor}$ is defined as the increase above background during a survey that will be identified as an increase by the surveyor. Surveyor efficiency was selected to be 50 percent, consistent with NUREG 1507:

$MDCR_{surveyor}$ = (MDCR) / (square root of surveyor efficiency)

$MDCR_{surveyor}$ = (1069) / (square root of 0.5) = 1512 cpm.

An estimated exposure rate for various sizes of square DU fragments was obtained by modeling with Microshield Version 5.01. A rectangular volume of DU with various lengths and a constant width and thickness of 1.0 cm was selected. The modeled exposure rate was used to calculate the expected increase in count rate above background for the 2-inch by 2-inch NaI detector. Using the same parameters as above, the same sizes of DU fragments were modeled with 5 cm (approximately 2 inches) of soil cover material. The density of the soil was estimated at 1.6 grams (g) per cubic centimeter (cm^3). Table A-1 shows the size of the DU fragment, associated cpm increase for a 2-inch by 2-inch NaI detector modeled for a fragment located on the ground surface, and the associated cpm increase for a 2-inch by 2-inch NaI detector modeled for a fragment covered with 5 cm of soil.

Table A-1. Modeled Count Rate versus Depleted Uranium Fragment Size

DU Fragment Size (cm^3)	Net count rate with DU fragment on ground surface (cpm)[a]	Net count rate with DU fragment beneath 5 cm of soil (cpm)[a]
1.0	2,058	1,081
2.0	4,065	2,147
3.0	5,976	3,186
4.0	7,756	4,186
5.0	9,385	5,137
6.0	10,853	6,032
7.0	12,162	6,865
8.0	13,321	7,637
9.0	14,337	8,347
10.0	15,227	8,994

[a] Net count rate using a 2 inches x 2 inches NaI detector.

Since the $MDCR_{surveyor}$ = 1,512 cpm, one cm^3 DU fragment located on the surface of the survey area is capable of being detected. However, survey experience has shown that random background fluctuation interferes with recognizing a 1,500 cpm increase in count rates. An investigation level of 2,000 cpm above relevant background is typically established and used as a field screening value. Setting 2,000 cpm above background as the investigation level maintains the size of detectable DU fragments on the ground surface to 1.0 cm^3 when the detector is located directly above the fragment for one second. Maintaining the investigation level constant at 2,000 cpm above relevant background establishes that a 2 cm^3 DU fragment buried beneath 5 cm of soil can be detected when the detector is located directly above the fragment for one second. As shown in the table, in both cases, as the size of the fragment increases the modeled count rate increases. The larger the fragment size the easier it becomes to detect.

However, the detection of the above fragments is dependent on the detector being positioned directly above the fragment for the entire 1 second count interval. The typical scan rate employed during gamma walkovers is 0.5 m per second. This means that the detector will cover approximately 0.5 m^2 or 50 cm^2 in one second. Therefore, during a typical scan survey the detector would only be positioned above the fragment for a fraction of the 1 second count time.

To maintain the required confidence that the fragment would be detected during a normal scan survey the lowest count rate for a specific size DU fragment obtainable in the 1 second count rate window when normalized to cpm must be greater than 2,000 cpm. The lowest obtainable count rate within the 1 second count rate window when moving at 50 cm per second would occur 25 cm from the fragment.

An estimated exposure rate 25 cm from various sizes of square DU fragments was obtained by modeling with Microshield Version 5.01. A rectangular volume of DU with a various lengths and a constant width and thickness of 1.0 cm was selected. The modeled exposure rate was used to calculate the expected increase in count rate above background for the 2-inch by 2-inch NaI detector. Using the same parameters as above, the same sizes of DU fragments were modeled with 5 cm (2 inches) of soil cover material. The density of the soil was estimated at 1.6 g/cm^3. Table A-2 shows the size of the DU fragment, associated cpm increase for a 2-inch by 2-inch NaI detector modeled for a fragment located on the ground surface, and the associated cpm increase for a 2-inch by 2-inch NaI detector modeled for a fragment covered with 5 cm of soil.

Table A-2. Modeled Count Rate versus Depleted Uranium Fragment Size at 25 cm

DU Fragment Size (cm^3)	Net count rate at 25 cm with DU fragment on ground surface (cpm)[1]	Net count rate at 25 cm with DU fragment beneath 5 cm of soil (cpm)
5.0	1,717	1,113
6.0	2,047	1,326
7.0	2,370	1,534
8.0	2,684	1,736
9.0	2,990	1,932
10.0	3,286	2,121

Maintaining the investigation level constant at 2,000 cpm above relevant background establishes that a 6.0 cm^3 DU fragment on the surface of the survey area and that 10.0 cm^3 DU fragment buried beneath 5 cm of soil can be detected with confidence during a normal scan survey. Once again, the larger the fragment the higher the probability of detection.

In summary, the smallest fragment of DU located on the surface of the survey area that can be detected is approximately a 1.0 cm^3 fragment. The smallest fragment of DU that can be detected with confidence during a normal scan survey using conservative assumptions is a 6.0 cm^3 fragment. The smallest fragment of DU that is covered with 5 cm of soil that can be detected is approximately a 2.0 cm^3 fragment. The smallest fragment of DU that is covered with 5 cm of soil that can be detected with confidence during a normal scan survey using conservative assumptions is a 10 cm^3 fragment.

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APPENDIX B

GENERATING SIMPLE RANDOM SAMPLE LOCATIONS FROM THE TREATED SOIL PILES

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GENERATING SIMPLE RANDOM SAMPLE LOCATIONS FROM THE TREATED SOIL PILES

The number of samples to be obtained from a treated soil pile will be calculated using standard MARSSIM techniques as described in Section 5.6 of the FFSP.

Samples will be obtained from each treated soil pile using a simple random sampling strategy (unless USACE dictates that systematic sampling should be performed).

Where feasible, samples will be obtained during pile creation by sampling soil as it comes off out of the sorting machinery before it falls into the soil pile. Care should be taken to ensure that some samples are representative of the later portions of the material.

Sample locations for existing piles will be identified using three values: angle of rotation (a_r), height above ground level (h_s), and distance from the pile surface (d_s) in a horizontal direction, as depicted in Figure B-1.

0 degrees pile rotation will be established as true North.

Values for a_r, h_s, and d_s should be generated via random number generator, table, etc. (a Microsoft Excel worksheet is available that takes the pile height and radius, and generates random sample points that are restricted to the bounds of the physical pile).

A tabulation of random sample points, along with documentation of the method used to generate the sample points, should be retained in the planning package.

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APPENDIX B

FIGURE

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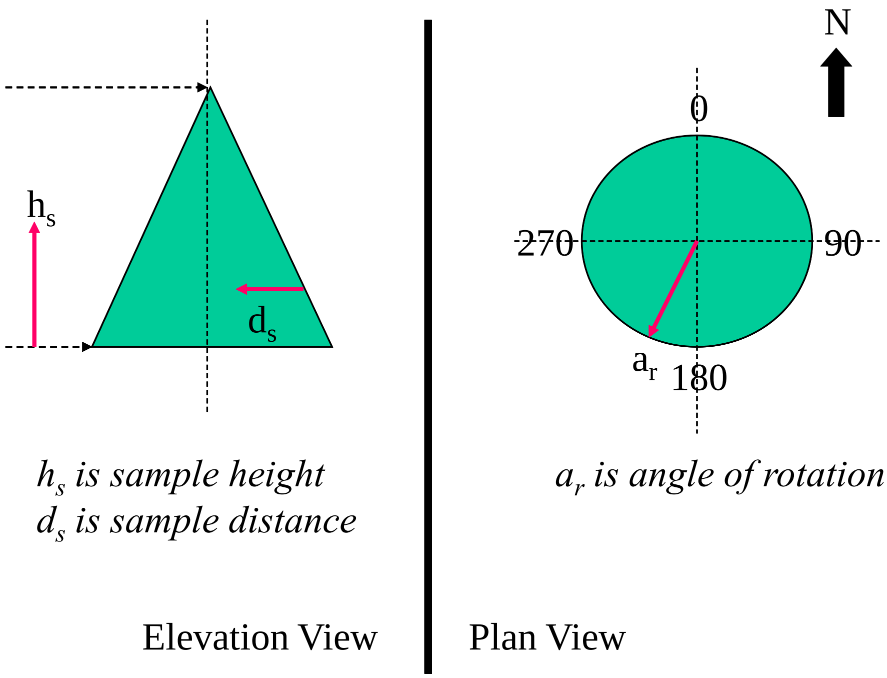

Figure B-1. Identifying a Pile Sample Location

APPENDIX C

TECHNICAL BASIS FOR SURVEY OF TREATED MATERIALS PILES

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TECHNICAL BASIS FOR SURVEY OF TREATED MATERIALS PILES

The scope of MARSSIM is limited to surface soils. Surveys are based on area units, and the scope of the survey evaluation is limited to the first 15 cm of soils. Because of these limitations, MARSSIM cannot be directly applied to volumes such as crushate or overburden piles.

However, with some modifications, MARSSIM statistical techniques can be applied to volume units.

LIMITATIONS OF THE MARSSIM TECHNIQUE

In attempting to apply the MARSSIM directly to a volume unit, one should consider the following limitations:

- MARSSIM relies on scanning to detect small areas of elevated activity. Scanning will not detect contaminants at a depth in excess of 6 inches (15 cm), therefore much of the volume will not be evaluated by scanning.
- Using MARSSIM to evaluate each 6-inch interval independently would result in a large number of samples that would need to be obtained and analyzed.
- Variations in the surface contour can make the assessment of individual 6-inch intervals difficult.
- The shape and contours of a crushate/overburden pile make gridding and the collection of accurate systematic samples difficult.

PARAMETRIC VERSUS NON-PARAMETRIC STATISTICS

MARSSIM uses non-parametric statistical techniques because:

- Contamination within an SU may not be normally distributed (i.e., contamination gradients and areas of elevated activity).
- SU data is obtained systematically vs. randomly.

Parametric techniques may be appropriate for crushate/overburden piles because:

- The excavation, movement, and stockpiling of materials will tend to distribute the contamination more normally.
- Simple random sampling is more readily achievable in a "pile" geometry.
- Parametric procedures perform well even when their underlying assumptions of the distribution of the data are not strictly true. This occurs with sample sizes in the range of 20 or greater.

The compositing of field samples is not performed for material piles. Compositing will "mechanically average" the individual sample result, and skew the 95 percent upper confidence limit (UCL_{95}) result.

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APPENDIX D

DERIVATION OF REMEDIATION GOALS

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INTRODUCTION

Human health RGs for the IAAAP FUSRAP areas are soil or structural surface concentrations developed for DU that, if allowed to remain, would not result in adverse human health or environmental impacts under the exposure scenarios evaluated in the baseline risk assessment (BRA). The DU RGs are risk- or ARAR-based concentrations that have been derived using computer models targeting a pre-determined risk level or dose limit derived from ARARs, and that incorporate exposure assumptions and the most updated toxicity values that were used in the BRA. Therefore, the RG for DU at the FUSRAP areas is the lower (most conservative) of the risk- and dose-based values. All exposure assumptions and toxicity criteria used to calculate the RG were presented in the BRA conducted as part of the FUSRAP remedial investigation (RI) Report (USACE 2008).

RISK AND DOSE BASIS FOR HUMAN HEALTH REMEDIATION GOALS FOR DEPLETED URANIUM

The development of human health RGs for soil and structural surfaces consider carcinogenic effects from exposures to DU. According to the NCP [40 *CFR* §300.430(e)(2)(i)(A)(2)], the acceptable human health exposure levels to known or suspected carcinogens are levels that represent an excess incremental lifetime cancer risk (CR) (i.e., above baseline) to an individual of between 1 in 1,000,000 (1.0E-6) and 1 in 10,000 (1.0E-4). The lower limit of the range (1.0E-6) is considered to be USEPA's point of departure CR from which all risk management decisions begin. Risk-based RGs may be revised upward within the target CR range based on a variety of site- or remedy-specific factors such as the reliability of data, quantification or detection limits, background considerations, or other considerations consistent with the remedy selection criteria defined in the NCP [40 *CFR* §300.430(f)(1)(i)]. Therefore, RGs for DU were initially established that equate to the health-conservative end of USEPA's target CR range, or 1.0E-6. To facilitate site-specific risk-management decision making, RGs have also been derived and are presented for DU that target CRs of 1.0E-5 and 1.0E-4. DU is the byproduct remaining after the extraction of U-235 from naturally occurring uranium. DU typically contains about 99.7990, 0.200, and 0.0010 percent by weight U-238, U-235, and U-234, respectively, with corresponding activity percentages of 90.14, 1.45, and 8.40. Natural uranium, by comparison, consists of about 99.284, 0.711 and 0.005 weight percent U-238, U-235, and U-234, respectively, with corresponding activity percentages of 48.6, 2.2, and 49.2 for the stated radioisotopes.

Based on ARAR analysis, 10 *CFR* 20.1403(b) and 20.1403(e) are relevant and appropriate to the derivation of remedial goals for restricted release. Because 90.14 percent of the activity of DU is attributable to U-238, a soil RG has been developed for U-238 in FSA soil. This approach uses U-238 as a surrogate for U-234 and facilitates comparisons with laboratory confirmation measurements.

The U-238 RG is health-protective of the cumulative effects from all three DU isotopes. This was done by targeting a TEDE of 22.5 mrem/yr (i.e., 90 percent of 25 mrem/yr). The laboratory-measured U-238 concentrations (attributable to DU) for soil (pCi/g) will be compared to the corresponding RG derived for U-238 to evaluate compliance with the RG. Because the TEDE of 22.5 mrem/yr considers contributions from all three uranium isotopes in DU, the RG is protective for exposure to U-234 and U-235, as well as to U-238.

Derivation of an RG for U-238 for Line 1 structural surfaces considers all three uranium isotopes at their activity percentages. This approach allows for direct comparisons with RG surface measurements to gross alpha and gross beta activity (in units of dpm/100 cm^2). Therefore, the structural RG is based on DCGLs derived for a cumulative dose of 25 mrem/yr.

DEVELOPMENT OF THE SOIL REMEDIATION GOAL FOR DEPLETED URANIUM

The following RG derivation is the same as was used to derive the RGs for the ROD.

Risk and Dose Assessment Model

RESRAD (RESidual RADioactive) is a computer code developed at Argonne National Laboratory (ANL) for the Department of Energy (DOE) to determine site-specific residual radiation guidelines and dose to an on-site receptor at sites that are contaminated with residual radioactive materials. RESRAD, version 6.4, was used to derive the DCGL for DU.

Source Term

Based on Table 2-1 of *Guide of Good Practices for Occupational Radiological Protection in Uranium Facilities* (DOE, 2000), DU is the sum of 99.8 percent of U-238, 0.0007 percent of U-234, and 0.2 percent of U-235 with respect to percentages by weight with corresponding activity percentages of 90.14, 1.45, and 8.40. Because U-238 accounts for over 90 percent of the DU activity, only U-238 DCGLs equivalent to the relative dose/risk limit were developed (i.e., the U-238 DCGLs will be based on relative dose/risk values that are less than the limit to account for dose/risk from U-234 and U-235) and will be protective considering associated U-234 and U-235. Therefore, soil analysis needs only account for U-238 to compare to the DCGL.

Receptor Scenarios

Based on the current and future land use, the site worker and construction worker receptors are modeled for this assessment.

Site Worker

The site worker scenario assumes that the critical receptor is a typical site worker who works 250 days per year for 25 years (USEPA, 1991). During a typical working day, the worker is assumed to spend 8 hours outdoors and will ingest 50 milligrams (mg) of soil. The site worker may be exposed to radioactive contamination through several exposure pathways relative to site soil. Members of the site worker critical group can incur a radiation dose via the following pathways:

- Direct radiation from radionuclides in the soil,
- Inhalation of re-suspended dust present on contaminated soil, and
- Direct ingestion of contaminated soil.

Construction Worker

The construction worker scenario assumes that the critical receptor is a typical construction worker who works 8 hours per day for 250 days. During a typical working day, the worker will ingest 480 mg of soil. A construction worker may be exposed to radioactive contamination through several exposure pathways relative to site soil. Members of the construction worker critical group can incur a radiation dose via the following pathways:

- Direct radiation from radionuclides in the soil,
- Inhalation of re-suspended dust present on contaminated soil, and
- Direct ingestion of contaminated soil.

Site Physical Parameters

For this evaluation, the RESRAD parameters selected are consistent with those used in the RI Report (USACE, 2008), as well as USEPA's (1997) *Exposure Factors Handbook*, USEPA's (2000c) *Soil Screening Guidance for Radionuclides*, and *Argonne National Laboratory's Data Collection Handbook to Support Modeling Impacts of Radioactive Material in Soil* (ANL 1993). Site-specific information is given the first preference for selection of site physical parameter values for RESRAD input parameters. The input parameters selected for the site worker and construction worker scenarios are the default RESRAD input parameters with the exception of inhalation and ingestion rate, exposure durations, and indoor/outdoor time fractions. The non-default RESRAD input parameters for the receptor scenarios are presented in Table D-1.

Table D-1. RESRAD Input Parameters for Risk and Dose Assessments

Category	Parameter	Values	
Physical Parameters	Area of contaminated zone (m^2)	FSs	354,695
	Thickness of the contaminated zone (m)	FSs	0.9
Exposure Parameters		***Site Worker***	***Construction Worker***
	Inhalation rate[a] (m^3 per year)	7,300	7,300
	Exposure duration (year)	25	1
	Indoor time fraction	0	0
	Outdoor time fraction[b]	0.2283	0.2283
	Soil ingestion (g per year)[c, d]	18.25	175.2

[a] Inhalation rate is based upon 20 m^3 per day * 365 days per year = 7,300 m^3 per year.
[b] Fraction of time outdoor per year = (8 hours per day x 250 days per year) / (24 hours per day x 365 days per year) = 0.2283.
[c] Site worker soil ingestion = 50 mg per day x 365 days per year x g/1,000 mg = 18.25 g per year.
[d] Construction worker soil ingestion = 480 mg per day x 365 days per year x g/1,000 mg = 175.2 g per year.

Development of a Soil Remediation Goal

Using the RESRAD Model, version 6.4, site-specific RGs (also known as DCGLs) for DU were developed for both receptor scenarios (site worker and construction worker) that were evaluated in the risk and dose assessment of the RI Report (USACE, 2008). These RGs, which are based on the known activity percentages of the uranium isotopes, are presented in Table D-2. Additionally, to comply with the CERCLA risk range of 1.0E-6 to 1.0E-4, RGs based on target CRs of 1.0E-6, 1.0E-5, and 1.0E-4 have also been calculated for soil and are presented in Table D-2. To be health-protective of U-234 and U-235, the risk-based soil DCGLs also consider the activity percent contribution of U-238.

Table D-3 presents the risk-based soil DCGL for U-238 that is protective of all DU constituents. Using RESRAD, risk-to-source ratios (RSRs) were developed for each radionuclide. A relative DU risk was then calculated by multiplying the RSR and the DU activity concentration. An equivalent risk was then calculated by dividing the isotopic relative DU risk by the sum of the isotopic DU risks and multiplying by the risk limit. (In Table D-3, the risk limit of 1.0E-4 was used. Other risk-based DCGLs provided in Table D-4 were calculated using the same methodology.) The U-238 DCGL (equivalent to 1.0E-4 DU risk) was calculated by dividing the isotopic equivalent risk by the associated RSR.

Table D-2. Dose- and Risk-Based Derived Concentration Guideline Levels for Consideration as Soil Remediation Goals

Scenario	TEDE = 22.5 mrem/yr (pCi/g)	TR = 1 x 10^{-6} (pCi/g)	TR = 1 x 10^{-5} (pCi/g)	TR = 1 x 10^{-4} (pCi/g)
Site Worker	575	2	15	150
Construction Worker	461	30	295	2,950

NOTE: Construction worker DCGLs were calculated in the same way as the site worker DCGLs.

Table D-3. IAAAP Risk-Based Derived Concentration Guideline Levels

Isotope	RSR Risk/pCi/g	DU Activity Concentration (%)	Relative DU Risk (Risk/pCi/g) (%)		1.00E-04 Isotopic Equivalent Risk	DCGL (pCi/g)
U-234	3.60E-08	0.084	3.02E-09	1	5.02E-07	
U-235	2.84E-06	0.0145	4.12E-08	7	6.84E-06	
U-238	6.19E-07	0.9014	5.58E-07	93	9.27E-05	**150**
		Total	6.03E-07			

The dose DCGL for U-238 is calculated the same as the risk DCGL. Table D-4 shows these calculations.

Table D-4. IAAAP Dose-Based Derived Concentration Guideline Levels

Isotope	Dose-to-Source Ratio (DSR) (mrem/yr/pCi/g)	DU Activity Concentration (%)	Relative DU Dose (mrem/yr/pCi/g) (%)		25-mrem/yr Isotopic Equivalent Dose	DCGL (pCi/g)
U-234	6.57E-03	0.084	5.52E-04	1	3.52E-01	
U-235	1.77E-01	0.0145	2.57E-03	7	1.64E+00	
U-238	4.00E-02	0.9014	3.61E-02	92	2.30E+01	**575**
		Total	3.92E-02			

Following a review of the soil DCGLs presented in Table D-2, the consideration of dose- and risk-based DCGLs was narrowed to include the site worker DCGLs of 575 and 150 pCi/g, respectively, for further evaluation to determine the selected soil RG for the following reasons: the site worker has been identified as the limiting receptor, and the target risk of 1.0E-4 is consistent with the current and expected future land of the IAAAP. Because the risk-based DCGL (150 pCi/g) is more restrictive (i.e., more health-conservative) than the dose-based DCGL (575 pCi/g), the risk-based DCGL of 150 pCi/g (U-238) has been selected as the DU RG for soil.

DEVELOPMENT OF THE REMEDIATION GOAL FOR DU ON STRUCTURES

Risk and Dose Assessment Model

RESRAD-BUILD, version 3.4, was used to derive the DCGL for DU. RESRAD-BUILD is a computer code developed at ANL for DOE to analyze the radiological doses and risks resulting from the remediation and occupancy of buildings contaminated with radioactive material (ANL 2003).

Source Term

DU is the sum of 99.8 percent of U-238, 0.0007 percent of U-234, and 0.2 percent of U-235 with respect to percentages by weight. Because structure survey instruments cannot differentiate between alpha/beta contamination from independent isotopes, the instrument sees decays from all three. Therefore, the DCGL is based on all three isotopes at their assumed activity percentages.

For this assessment, both receptors are assumed to work in the same facility where the entire floor (model default area = 100 m^2) and walls up to a height of 2 m (model default height) are uniformly contaminated with DU. The assumptions regarding room dimensions and contamination represent default model inputs per NUREGs 5512 and 6697 (PNNL, 1994; SNL, 1999; ANL, 2000). The default room size is being used because it represents a room size that is likely to be smaller than rooms typically found at a large production facility such as the IAAAP. Because in a smaller room, the distances between the walls and receptor located in the center of the room are less than those in a larger room in a production facility, it is assumed that the smaller room results in a higher delivery of radioactive dose to a receptor than a larger room of similar surface concentrations. Therefore, model inputs for the default room are likely to represent a health-conservative exposure scenario.

Receptor Scenarios

Based on the current and future land use, the site worker and construction worker receptors are modeled for this assessment.

Site Worker

The site worker scenario assumes that the critical receptor is a typical site worker who works 250 days per year for 25 years (USEPA, 1991). The individual works in the building structure that is contaminated with surficial radioactive material. The radioactive material can be released into the indoor air by mechanisms such as mechanical removal (decontamination activities) or erosion (removal of surface contamination). The applicable pathways for the site worker include the following:

- External exposure to penetrating radiation from surfaces,
- Inhalation of airborne radioactive particulates, and
- Direct ingestion of surface contamination.

Construction Worker

The construction worker scenario assumes that the critical receptor is a typical construction worker who works 8 hours per day and 250 days per year for 1 year. The individual works in the building structure that is contaminated with surficial radioactive material. The radioactive material can be released into the indoor air by mechanisms such as mechanical removal (decontamination activities) or erosion (removal of surface contamination). The applicable pathways for the construction worker include the following:

- External exposure to penetrating radiation from surfaces,
- Inhalation of airborne radioactive particulates, and
- Secondary ingestion of surface contamination.

NOTE: Because the only difference between the site worker and the construction worker receptors is the number of years each is exposed on-site (i.e., 1 year versus 25 years), both receptors will have the same dose; however, the site worker receptor will be more limiting for risk because risk is additive over the exposure period whereas the dose limit is an annual limit.

The RESRAD-BUILD parameters for both scenarios are listed in Table D-5.

Table D-5. Parameters for RESRAD-BUILD Building Occupancy Scenario (Site Worker/Construction Worker)

Parameter	Description	Value	Justification
Time Parameters			
Exposure Duration	Amount of time that exposure occurs	365 days	NUREG/CR-5512, Volume 1, Section 3.2.1
Indoor Fraction	Fraction of the exposure duration that is spent inside the building	0.23	8 hours per day; 250 days per year
Evaluation Time	Times at which doses are calculated	0 year	RESRAD-BUILD Default
Building Parameters			
Number of Rooms	Number of compartments in the building	1	RESRAD-BUILD Default
Deposition Velocity	Velocity at which airborne particles are deposited onto the floor surfaces	0.01 m per second	RESRAD-BUILD Default (A sensitivity test resulted in no significant difference between the default value and the minimum and maximum values listed in NUREG/CR-6697)
Re-suspension Rate	Rate at which deposited material is re-suspended into the air	5.0 E-07 second^{-1}	RESRAD-BUILD Default (approximate midpoint between NUREG/CR-6697 minimum and maximum values)
Building Exchange Rate	Total volume of air going out of the building per unit time divided by the total volume of the building	0.8 hour^{-1}	RESRAD-BUILD Default Consistent with value of 0.75 hour^{-1} for conditioned spaces (cited by American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.)
Room Area	Floor area of the room	100 m^2	NUREG/CR-5512, Volume 1, Section 6.2.1
Room Height	Height of the room	2.5 m	RESRAD-BUILD Default Consistent with NUREG/CR-6697 most likely value of 2.4 m
Room Exchange Rate	Total volume of air going out of the room per unit time divided by the total volume of the room	0.8 hour^{-1}	RESRAD-BUILD Default Same as building exchange rate due to single room
In/Out Flow Rate	Flow rates of air into and out of the room	200 m^3 per hour	Room volume (250 m^3) * Room exchange rate (0.8 hour^{-1})
Receptor Parameters			
Number of Receptors		1	RESRAD-BUILD Default
Room # Location	Room in which the receptor is located	1	RESRAD-BUILD Default
Time Fraction	Fraction of time within the building that the exposed individual spends at his receptor location	1	RESRAD-BUILD Default
Breathing Rate	Inhalation rate of airborne material at this location	33.6 m^3 per day	NUREG/CR-6697 most likely value (Breathing rate = 1.4 m^3 per hour)
Ingestion Rate	Ingestion rate of deposited dust for this location	1 E-04 m^2 per hour	RESRAD-BUILD Default (approximate midpoint between NUREG/CR-6697 minimum and maximum values)
Receptor Location	Coordinates of the receptor	5 m, 5 m, 1 m	Located in center of room at height of 1m

Table D-5. Parameters for RESRAD-BUILD Building Occupancy Scenario (Site Worker/Construction Worker) (Continued)

Parameter	Description	Value	Justification
Shielding Parameters			
Thickness	Thickness of the shielding between the contamination source and the receptor location	0	RESRAD-BUILD Default
Density	Density of the shielding material	Not applicable	
Material	Identification of the shielding material	Not applicable	
Source Parameters			
Number of Sources		5	Floor and four walls
Room # location	All sources are located in Room # 1	1	
Source Type		Area	Surface contamination only; volume source is not likely due to historical assessment of the IAAAP buildings. (No processing of materials or activation of building materials)
Direction	Axis perpendicular to the exposed area	Floor (z), Ceiling (z), 4 walls (x,y,x,y)	NUREG/CR-5512, Volume 1, Section 6.2.1
Location	Center point of the source in the x, y, z direction	Floor: 5 m, 5 m, 0 m Walls: 10 m, 5 m, 1 m 5 m, 10 m, 1 m 0 m, 5 m, 1 m 5 m, 0 m, 1 m	Entire floor and bottom 2 m of each wall are uniformly contaminated
Geometry: Area	Area of the exposed surface over which the contamination is evenly distributed	100, 20, 20, 20, 20 m^2	
Air Release Fraction	Fraction of the eroded material that is released into the air	0.07	Most likely value. NUREG/CR-6697
Direct Ingestion	Direct ingestion rate of the source by any receptor in the room	0 per hour	RESRAD-BUILD Default
Removable Fraction	Fraction of the source that can be linearly removed between t =0 and lifetime	0.2	Most likely value NUREG/CR-6697
Lifetime	Amount of time in which all of the removable fraction of the source is linearly eroded	10,000 days	Most likely value NUREG/CR-6697
Radionuclides Concentration	Unit concentration is initially run; results are normalized to 25 mrem/yr and 1E-4 risk to determine each isotopic DCGL	1 picocurie per square meter (pCi/m^2)	

NOTE: The construction worker is exposed for only a single year whereas the site worker is exposed for 25 years.

Development of Derived Concentration Guideline Levels for Structures

DCGLs applicable to structures contaminated by DU have been developed to address the associated contamination.

To derive the surficial contamination DCGL value that would be equivalent to the dose limit of 25 mrem/yr, the IAAAP DU COCs (U-238, U-235 and U-234) were entered into the RESRAD-BUILD code (version 3.4) using a source concentration term of 1 picocurie per square meter (pCi/m^2) to determine a dose-to-source ratio (DSR) and RSR for each of the five surficial exposure sources (i.e., four walls and the floor) assumed for a room in the contaminated structure. The DSR is a derived value based upon the RESRAD-BUILD modeling output that can be used to convert the dose limit to units of surficial contamination (in pCi/m^2). Likewise, the RSR is a derived value based upon the RESRAD-BUILD modeling output that can be used to convert a target CR to units of surficial contamination (in pCi/m^2). The total room DSR and RSR for DU was then calculated by summing the individual surface DSRs and the individual RSRs, respectively. Table D-6 shows the DSR for DU from all five (four walls and the floor) sources that was based on results obtained from RESRAD-BUILD.

Table D-6. Dose-to-Source Ratio Values

Source	DSR (mrem/yr/pCi/m^2)					
	1	2	3	4	5	Total
U-238	1.00E-05	1.97E-06	1.97E-06	1.97E-06	1.97E-06	1.79E-05
U-235	1.17E-05	2.13E-06	2.13E-06	2.13E-06	2.13E-06	2.02E-05
U-234	1.09E-05	2.18E-06	2.18E-06	2.18E-06	2.18E-06	1.96E-05

To determine a DU DCGL, a relative DU dose must first be established by multiplying the DSR by the corresponding DU activity concentration percent. Dividing each relative DU dose by the sum of the relative DU doses results in a percent of DU dose. Multiplying the percent of DU dose by 25 mrem/yr results in a dose value for each isotope that, when divided by the DSR and multiplied by a conversion factor, yields the isotope-specific DCGL. The sum of the isotope-specific DCGLs yields a DU DCGL equivalent to 25 mrem/yr. Table D-7 shows these calculations. The DU DCGL for dose (25 millirem [mrem]) is 30,700 dpm/100 cm^2.

Table D-7. Derived Concentration Guideline Level Calculations (Dose-Based)

Isotope	DSR (mrem/yr pCi/m^2)	DU Activity Concentration (%)	Relative DU Dose	% DU Dose	Equivalent Dose (mrem/yr)	DCGL (dpm/100 cm^2)
U-238	1.79E-05	0.9014	1.61E-05	89%	22.3	27,703
U-235	2.02E-05	0.0145	2.93E-07	2%	0.406	446
U-234	1.96E-05	0.084	1.65E-06	9%	2.28	2,582
		Total	1.81E-05		**Total**	**30,731**

Isotopic DCGLs = (Equivalent Dose/DSR) * (2.22 dpm/[picocurie] pCi) * (m^2/100 cm^2).

Table D-8 shows the RSR for DU from all five sources based on results obtained from RESRAD-BUILD.

Table D-8. Risk-to-Source Ratio Values

Source	Single-Year RSR (risk/pCi/m^2)					
	1	2	3	4	5	Total
U-238	2.18E-12	4.06E-13	4.06E-13	4.06E-13	4.06E-13	3.80E-12
U-235	3.18E-12	4.85E-13	4.85E-13	4.85E-13	4.85E-13	5.12E-12
U-234	2.31E-12	4.60E-13	4.60E-13	4.60E-13	4.60E-13	4.15E-12

The risk DU DCGL is calculated in the same way as the dose DU DCGL with the exception that it is divided by a factor of 25 to account for the 25-year CERCLA risk limit versus the single-year RSR. Table D-9 shows these calculations. The DCGL value is 23,000 dpm/100 cm^2 for DU at 1.0E-4 risk.

Table D-9. Derived Concentration Guideline Level Calculations (Risk-Based)

Isotope	RSR (risk/year pCi/m^2)	DU Activity Concentration (%)	Relative DU Dose	% DU Risk	Equivalent Risk	DCGL (dpm/100 cm^2)
U-238	3.8E-12	0.9014	3.20E-13	90%	9.00E-05	21,009
U-235	5.1E-12	0.0145	7.42E-14	2%	1.80E-06	311
U-234	4.2E-12	0.084	3.74E-12	8%	8.00E-06	1712
		Total	4.13E-12		**Total**	**23,033**

Isotopic DCGLs = ((Equivalent Dose/RSR)/25 year) * (2.22 dpm/pCi) * (m^2/100 cm^2).

The risk DCGL value (23,000 dpm/100 cm^2) is more restrictive and has been selected as the DCGL for structural surfaces at Line 1.

SUMMARY OF REMEDIATION GOALS AND HEALTH PROTECTIVENESS

Table D-10 summarizes all soil and structures DU RGs derived for protection of human health at the FUSRAP areas.

Table D-10. Soil and Structural Remediation Goals for the Formerly Utilized Sites Remedial Action Program Areas

COC	Soil RG (pCi/g)	Structures RG (dpm/100 cm^2)
DU	150	23,000

It should be noted that derivation of the human health RGs ensures that the CR from exposures to DU in soil and structures does not exceed the upper end of USEPA's target CR range. Additionally, the RGs derived for DU ensure that the TEDE resulting from exposures to contaminated soil and structures does not exceed 25 mrem/yr. Table 3 illustrates the health protectiveness of the selected RGs by presenting the corresponding radiological doses and CRs that would result from exposures to residual concentrations of DU equivalent to the respective human health RGs. Table D-11 also shows that the total radiological dose and CR corresponding to exposures to soil concentrations of DU equivalent to the RG are 8 mrem/yr and 1.0E-4, respectively.

Table D-11. Human Health Protectiveness of Formerly Utilized Sites Remedial Action Program Area Remediation Goals

Human Health COC	Medium	RG	RG Basis	Corresponding Radiological Dose (mrem/yr)	Corresponding CR (unitless)
DU	Soil	150 pCi/g	CR-based DCGL for U-238 in soil	8[a]	1.0E-4
DU	Structural Surface	23,000 dpm/100 cm^2	Risk-based structural DCGL for all three DU isotopes (cumulatively) converted to gross surface activity	18.7	1.0E-4

[a] 25 mrem/yr is the total radiological dose targeted for DU assuming the combined activity percentages of 90.14%, 1.48%, and 8.48% for the respective DU isotopes (U-238, U-235, and U-234).

Table D-11 also shows that the total dose and CR corresponding to exposures to gross radioactivity from a DU concentration on structural surfaces equivalent to the RG of 23,000 dpm/100 cm^2 are 18.7 mrem/yr and a CR of 1.0E-4, respectively. Therefore, the RG selected for structural surfaces meets the dose- and risk-based health protectiveness benchmarks of 25 mrem/yr and 1.0E-4, respectively.

Cumulative radiological dose and CRs from DU in both soil and structures combined, do not need to be determined because site worker exposures are likely to occur to either surface or soil contamination but not to both surface and soil contamination. Site workers who could be exposed to structural contamination in the buildings are mainly indoor workers and are not likely to be exposed to soil while carrying out their job responsibilities.

Therefore, in summary, the soil and structural RGs determined for DU in the FUSRAP areas are both individually and cumulatively protective of the total dose limit of 25 mrem/yr and the CR of 1.0E-4.

FINAL

SOIL SORTING PILOT STUDY TEST REPORT IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8, DEPLETED URANIUM CONTAMINATED SOIL AND STRUCTURE REMEDIATION

Middletown, Iowa

October 2014

U.S. Army Corps of Engineers
St. Louis District Office
Formerly Utilized Sites Remedial Action Program

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Middletown, Iowa

October 2014

Prepared by:

U.S. Army Corps of Engineers, St. Louis District Office,
Formerly Utilized Sites Remedial Action Program

With technical assistance from:

North Wind Solutions, LLC
Under Contract No. W912P9-13-D-0515
AMEC Environmental & Infrastructure Inc.
Under NWS Subcontract No. 50006S.01

EXECUTIVE SUMMARY

AMEC Environment & Infrastructure (AMEC) and North Wind Services, LLC (North Wind) developed and implemented a Soil Sorting Pilot Study of AMEC's Orion *ScanSort*^{SM} radioactive soil sorting system. The pilot study was performed for the United States Army Corps of Engineers (USACE) at the Iowa Army Ammunition Plant (IAAAP), Firing Site 12 (FS-12), Operable Unit 8 (OU-8) near Middletown in southeast Iowa. AMEC conducted the pilot study to evaluate and demonstrate the effectiveness of utilizing full-scale radiological sorting equipment and systems in support of the planned Remedial Action (RA) associated with the cleanup of depleted uranium (DU) contaminated soils located at the IAAAP site.

Summary of Objectives

The purpose of the IAAAP Pilot Study project was to determine if the *ScanSort*^{SM} system (a conveyor-assisted, automated soil surveying and sorting system) could effectively detect and isolate DU fragments from bulk soil while confidently satisfying the remediation goals (RGs). An additional overarching objective was to determine the full-scale operational process throughput rate that could reasonably be achieved and to gauge the soil waste volume reduction that might be expected when operating in a full-scale RA mode in support of the RA stipulated in the Record of Decision (USACE, 2011).

The key objectives, as defined in the Pilot Study Test Plan, are as follows:

1) *Evaluate and demonstrate the ability to process and sort site-specific soils and materials (i.e. clay content, moisture, grasses, materials sizes, etc.) using the ScanSort*^{SM} *system.*
2) *Setup and calibrate the ScanSort*^{SM} *system to support characterization and release of materials below the RGs processed through the ScanSort*^{SM} *system during full-scale RA operations. The data generated during soil sorting operations should support a final status survey (FSS) process and evaluation based on Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) guidance (EPA, 2000) for open land areas.*
3) *Demonstrate that the ScanSort*^{SM} *system can be an effective tool for separating DU contaminated soils having a variety of deposition characteristics and properties from across the site to ensure the soils meet the RGs for the site.*
4) *Evaluate the expected overall contaminated soil volume reduction that may be achieved from soils obtained from different areas across the site, representing different levels and deposition densities of DU contamination.*
5) *Determine the cost effectiveness of using the soil sorting system during full-scale soil remediation activities.*

6) *Determine the full-scale operational process feed rate, or planned throughput rate, that would be applicable to various soil types that will be encountered during full-scale RA.*

7) *Determine if additional operational controls and or components will be needed for the sorting system to properly implement sorting during full-scale remedial activities. Items evaluated will include the possible need for additional pre-processing equipment or procedures needed to meet the 4- to 6-inch inlet sizing requirement and/or the need for additional environmental protection components and controls (i.e., enclosure or containment systems).*

8) *Determine the amount of contaminated soil separated from clean soils based on radiological measurements obtained by the ScanSort^{SM} system. These quantities will then be evaluated to ensure that DU concentrations in segregated contaminated soil can meet the applicable waste acceptance criteria of the selected disposal facility.*

Results

Soil was excavated from a variety of selected locations and depths at the site and processed through the *ScanSort*^{SM} system in a number of varying configurations along with discrete DU sources of known radioactivity and mass to optimize the operational characteristics of the system. Critical variables evaluated during the pilot study included angular response (i.e., response of the detector in relation to the lateral position of the source), residence time (i.e., speed of the conveyor), and radiation attenuation (i.e., thickness of soil placed on top of the source). Following the evaluation of critical variables, which indicated that the system can be an effective tool to accomplish the RGs for the site, the system was operated in a mock production mode to identify potential issues regarding communications, logistics, maintenance, etc.

Conclusions

This report presents data generated during the Pilot Study and details the implementation of the test, the radiological capabilities of the system, and the overall volume reduction estimates that might reasonably be anticipated based on a spectrum of full-scale operational process throughput rates.

The pilot study/demonstration project showed that the AMEC's ScanSortSM system has the ability to consistently detect and isolate discrete, singular DU fragments with activities greater than 2.25 µCi U-238 (which is equivalent to a fragment that is approximately 6.5g) in producing "below criteria" soil with an average bulk concentration significantly less than the soil RG (150pCi/g U 238 as DU). During the full-scale demonstration runs, processing speeds ranged between 20 and 50 tons per hour. At these process speeds, the system was able to divert less than 100 lbs. (~50 kg) of soil per single DU fragment diversion. Based on the site-specific soils tested during the pilot study, the ScanSortSM system is estimated to produce a contaminated soil volume reduction of greater than 90%.

The suggested operational parameters will allow for an estimated average daily processing rate of approximately 200 tons of soil per day during an 8-hour shift.

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ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
AC	alternating current
AMEC	AMEC Environment & Infrastructure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm^2	square centimeters
cm^3	cubic centimeters
cm/s	centimeters per second
cps	counts per second
Cs-137	cesium 137
DCGL	Derived Concentration Guideline Level
DCS	diversion control setpoint
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
dpm	disintegrations per minute
DU	depleted uranium
FS	Firing Site
FSS	final status survey
FSSP	Final Status Survey Plan
ft^2	square feet
FUSRAP	Formerly Utilized Sites Remedial Action Program
g	gram
g/cm^3	grams per cubic centimeter
IAAAP	Iowa Army Ammunition Plant
in.	inch
K-40	potassium-40
keV	kiloelectron volt
kg	kilogram
m	meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
μCi	microcurie

NaI(Tl)	thallium doped sodium iodide
NMG	nuclear measurement gauge
North Wind	North Wind Services, LLC
OSS	Orion software system
OU	operable unit
Pa-234	protactinium 234
pCi/g	picocuries per gram
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	Remedial Action
RAWP	Remedial Action Work Plan
RG	remediation goal
ROC	radionuclides of concern
ROD	Record of Decision
ROI	region of interest
STL	survey team leader
Th-234	thorium 234
U-234	uranium 234
U-235	uranium 235
U-238	uranium 238
USACE	United States Army Corps of Engineers
UXO	unexploded ordinance
WAC	waste acceptance criteria
yd^3	cubic yards

1.0 INTRODUCTION

AMEC Environment & Infrastructure (AMEC) and North Wind Services, LLC (North Wind) developed and implemented a Pilot Study Test at the Iowa Army Ammunition Plant's (IAAAP), Firing Site 12 (FS-12), near Middletown in southeast Iowa for the United States Army Corps of Engineers (USACE). AMEC conducted the pilot test in accordance with the processes and objectives outlined in the Pilot Study Test Plan (USACE, 2013a). The pilot study was designed to evaluate the effectiveness of utilizing AMEC's radiological sorting system (Orion *ScanSort*^{SM}) in support of the planned Remedial Action (RA) associated with the cleanup of depleted uranium (DU) contaminated soils located at the Operable Unit (OU)-8 IAAAP site. AMEC and North Wind prepared a Pilot Study Test Plan, as identified in the OU-8 RA Work Plan (USACE, 2013a), that describes the RAs to take place as part of the *ScanSort*^{SM} Sorting System Pilot Study Test.

1.1 Site Description and Historical Summary

The IAAAP site, managed by the U.S. Army Joint Munitions Command, produces and delivers component assembly and medium and large caliber ammunition items in support of worldwide Department of Defense (DoD) operations. The site was established in 1940 as the Iowa Ordinance Plant. Portions of the site were managed by the U.S. Atomic Energy Commission (AEC) from 1947 through 1975. During management under the AEC, production of materials and components for atomic weapons and final assembly of atomic weapons was performed. In 1975, control of the entire site reverted back to the U.S. Army.

In 1989, the IAAAP was placed under the DoD Installation Restoration Program, which manages Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA) activities. Additionally, portions of the site contain contamination resulting from activities that supported the early atomic weapons and energy programs, qualifying those areas as eligible for activities under the Formerly Utilized Sites Remedial Action Program (FUSRAP). Currently, the Army and the USACE are performing remedial activities at the IAAAP; the Army under the Defense Environmental Restoration Program (DERP), the USACE under FUSRAP, and the DERP Record of Decision (ROD) for Line 1 and West Burn Pad Area South of the Road. This Pilot Study was conducted for the USACE as a component of the FUSRAP remedial activities of OU-8.

The IAAAP site encompasses more than 19,000 acres (approximately 30 square miles) in Des Moines County near Middletown in southeast Iowa (Figure 1). Approximately one-third of the IAAAP is involved in loading, assembling, and packing ammunition items (including projectiles, mortar rounds, warheads, and other munitions). The remaining two-thirds of the site is either forested or agriculture space.

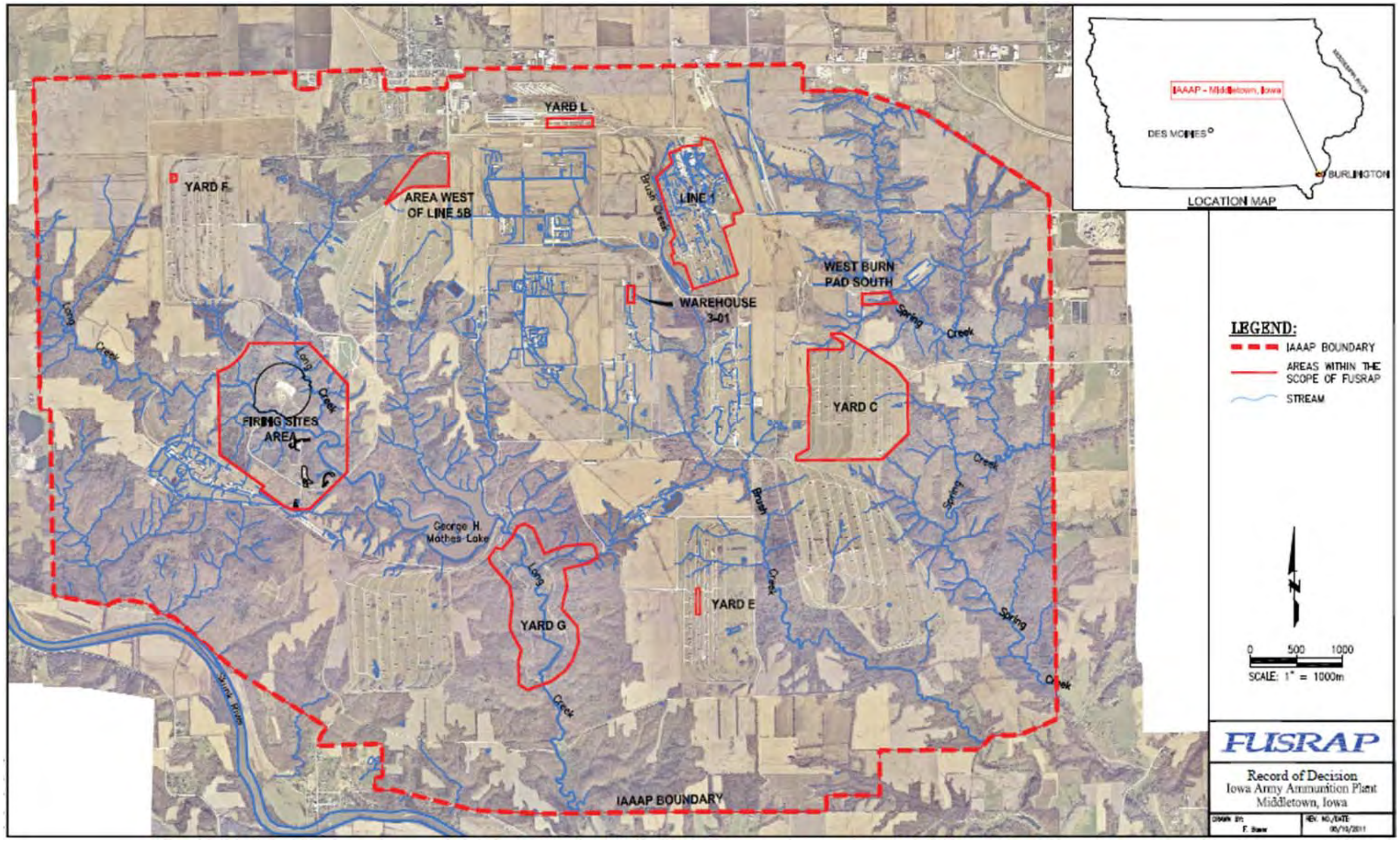

Figure 1. IAAAP Site, Middletown, Iowa

1.1.1 Contaminants of Concern

Based on review of data contained in the FUSRAP ROD (USACE, 2011), the potential radionuclides of concern (ROCs) applicable to the OU-8 RA are primarily those associated with DU contamination, including:

- U-238,
- U-235, and
- U-234.

The main components of the RAs include excavation of DU-contaminated soil within OU-8 followed by radioactive assay and sorting of the soil to segregate materials that exceed the established remediation goal (RG) for subsequent off-site disposal. Soils that are shown to meet the RG will be returned to the OU for reuse and placeback.

1.1.2 Remediation Goals

The criteria, in this case, are identified as the industrial soil RGs, as defined in Section 2.8.3 of the ROD (USACE, 2011). The RGs are listed in Table 1.

Table 1. Soil and Structural Remediation Goals

COC	Soil RG (pCi/g)	Structures RG (dpm/100 cm^2)
DU	150	23,000

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2.0 MATERIAL SORTING PILOT TEST OBJECTIVES

2.1 Objectives

The purpose of the IAAAP Pilot Study project was to determine if the *ScanSort*^{SM} system (a conveyor-assisted, automated soil surveying and sorting system) could effectively detect and isolate DU fragments from bulk soil while confidently satisfying the RGs. An additional overarching objective was to determine the full-scale operational process throughput rate that could reasonably be achieved, and to gauge the soil waste volume reduction that might be expected when operating in a full-scale RA mode in support of the RA stipulated in the ROD (USACE, 2011).

The key objectives, as defined in the Pilot Study Test Plan and discussed further in Section 5.0, are as follows:

1. Evaluate and demonstrate the ability to process and sort site-specific soils and materials (i.e., clay content, moisture, grasses, materials sizes, etc.) using the *ScanSort*^{SM} system.
2. Setup and calibrate the *ScanSort*^{SM} system to support characterization and release of materials below the RGs processed through the *ScanSort*^{SM} system during full-scale RA operations. The data generated during soil sorting operations should support a final status survey (FSS) process and evaluation based on Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) guidance (EPA, 2000) for open land areas.
3. Demonstrate that the *ScanSort*^{SM} system can be an effective tool for separating DU contaminated soils having a variety of deposition characteristics and properties from across the site to ensure the soils meet the RGs for the site.
4. Evaluate the expected overall contaminated soil volume reduction that may be achieved from soils obtained from different areas across the site, representing different levels and deposition densities of DU contamination.
5. Determine the cost effectiveness of using the soil sorting system during full-scale soil remediation activities.
6. Determine the full-scale operational process feed rate, or planned throughput rate, that would be applicable to various soil types that will be encountered during full-scale RA.
7. Determine if additional operational controls and or components will be needed for the sorting system to properly implement sorting during full-scale remedial activities. Items evaluated will include the possible need for additional pre-processing equipment or procedures needed in order to meet the 4- to 6-inch inlet sizing requirement and/or the need for additional environmental protection components and controls (i.e., enclosure or containment systems).

8. Determine the amount of contaminated soil separated from clean soils based on radiological measurements obtained by the *ScanSort*^{SM} system. These quantities will then be evaluated to ensure that DU concentrations in segregated contaminated soil can meet the applicable waste acceptance criteria (WAC) of the selected disposal facility.

2.2 Pilot Test Scope of Work

The scope of work for the pilot study test was to deliver, assemble, configure, calibrate, test, operate, and evaluate AMEC's Orion *ScanSort*^{SM} screening and sorting system for its ability to detect and isolate fragments of DU distributed in bulk soils within OU-8. As such, soil passing through the system as "clean" would have a maximum equivalent diffuse U-238 activity concentration of less than 150 picocuries per gram (pCi/g) averaged over a conservative mass of no more than 500 tons (soil survey unit associated mass). The purpose of the pilot test was to design and implement a pilot and demonstration test that would ascertain whether such a system has the necessary sensitivity to screen out DU fragments from surrounding soils with economic feasibility, while at the same time meeting or exceeding the soil RG. The DU material is dominated by the radioactivity associated with U 238 (one of the three radionuclides specifically identified in the ROD) and as such, the measurements and references to the radiation levels used in the sorting system operations are expressed as an activity concentration of U 238 in units of pCi/g. The soil RG as addressed in the text of this report will use the RG of 150 pCi/g U 238 and is derived as an activity concentration.

Supplemental tasks integral to meeting the objectives outlined in the Pilot Test Work Plan included:

- Testing the variability in detection sensitivity with DU fragments at different soil depths, belt lateral locations, and belt speed;
- Evaluating/calibrating/optimizing system parameters for maximizing system production efficiency; and
- Conducting a short-duration production run using soils from the designated pilot test dig areas to estimate volume reduction and production rates.

2.3 Project Organization

Pilot test activities were managed and performed by a team composed of qualified personnel from North Wind, AMEC, Envirocon, and other subcontractor personnel, as shown in Figure 2.

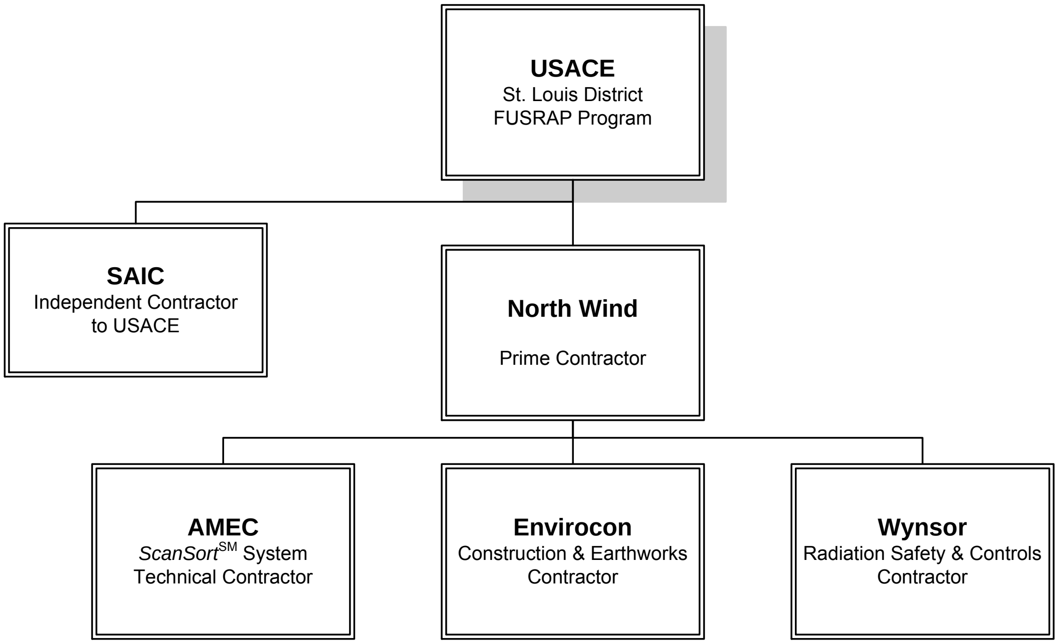

Figure 2. Pilot Study Project Organization Chart

2.3.1 North Wind

As the prime contractor to the USACE, North Wind was responsible for the oversight and project management of the pilot study project. North Wind coordinated the operation and activities of each subcontractor in support of the AMEC survey team leader (STL) in order to accomplish the goals and objectives of the pilot study project. North Wind provided project support staff, including a Safety and Health Officer, Quality Assurance/Quality Control (QA/QC) Supervisor, and Radiation Safety Officer.

2.3.2 AMEC

AMEC was responsible for supplying the specialized equipment and materials directly related to and unique to the Orion *ScanSort*^{SM} system. These included the mobile command center and all related computers and control systems, *ScanSort*^{SM} survey and sorting conveyors, sensors and detectors, electro-mechanical control systems, electrical distribution system, stacking conveyors necessary to move materials into manageable piles, soil feed control, and final stage pre-conditioning of soils fed directly to the *ScanSort*^{SM} system. AMEC also provided the necessary personnel to oversee the assembly of the system on site, to operate the system, to calibrate the system, and to perform the various tasks of the pilot study. The AMEC project team was comprised of a project manager, *ScanSort*^{SM} system engineer, *ScanSort*^{SM} STL, and Health Physicist. Field work involving the *ScanSort*^{SM} system was performed under the supervision of the AMEC STL. The AMEC team reported to the North Wind Field Project Engineer and Project Manager.

2.3.3 Envirocon

Envirocon performed the construction and earthworks tasks required to implement this project. They supplied the heavy equipment and operators used to help assemble the *ScanSort*^{SM} system on site, excavate and stockpile soils, feed the *ScanSort*^{SM} system, and move materials that had been processed through the system.

2.3.4 Wynsor

Wynsor provided radiological safety and controls personnel and equipment for the project under the direction of North Wind. They assisted in performance of radiological surveys to locate and isolate discrete DU fragments that were flagged by the *ScanSort*^{SM} system during the pilot study project.

2.4 Pilot Test Schedule

Mobilization of the *ScanSort*^{SM} system and equipment to the site occurred from May 17-20, 2013. Upon arrival of personnel to the IAAAP site on May 20, 2013, equipment and personnel were not permitted to access the pre-designated *ScanSort*^{SM} staging area due to the discovery of potential unexploded ordinance (UXO) issues at the operations dig site. *ScanSort*^{SM} equipment was offloaded from the transportation vehicles for temporary storage at the IAAAP "M yard" until the UXO issues were resolved.

Access was again permitted to the project site on June 19, 2013 after the UXO issues were resolved. *ScanSort*^{SM} equipment was moved from the IAAAP "M yard" and transported to the designated setup location at FS-12. The equipment was then offloaded and configured for pilot study testing and operations.

The pilot test activities (following mobilization and setup at the site) were estimated to take approximately 4 calendar weeks. The actual duration of the pilot test was 4 weeks, beginning June 19, 2013 and ending July 19, 2013.

3.0 PILOT TEST IMPLEMENTATION

The pilot study was conducted at the IAAAP, FS-12 site using the full-size, production-ready, Orion *ScanSort*^{SM} soil-screening and sorting system. DU contaminated soils at the FS-12 site were used as the testing medium. Prior to AMEC mobilization, North Wind mobilized personnel and equipment to prepare the system laydown areas. The *ScanSort*^{SM} system and associated support equipment were then mobilized to the site and set up for processing soils in support of the pilot study objectives. Site soils were excavated from designated areas within the site, stockpiled, and then processed through the system in a number of varying configurations, allowing system operational variables to be tested.

3.1 Project Laydown and Staging Areas

North Wind performed site preparation activities, in accordance with the Pilot Study Test Plan, to ready the system laydown and soil stockpile area(s). Activities included grading, installation of work surfaces, signage, and access controls.

3.2 Excavation and Soil Pre-Treatment

3.2.1 Pilot Study Dig Areas

Soil material was obtained from different areas of the site for the pilot study. The soil was excavated from the pilot study dig areas (Figure 3), identified, and selected using previously gathered site characterization data showing the surface radioactivity levels and observed location density of higher radiological surface measurements for each of the areas. In support of the pilot study objectives, three levels of soil were identified and selected. These were excavated using conventional earth moving equipment and stockpiled for use in the Pilot Study:

1. High DU surface fragment density area,
2. Intermediate DU surface fragment density area, and
3. Low DU surface fragment desnity area.

The areas were excavated in nominal 8- to 10-inch lifts, as shown in Table 2. Materials and soil excavated from each of the areas and each lift were kept segregated prior to and during the pilot study operations.

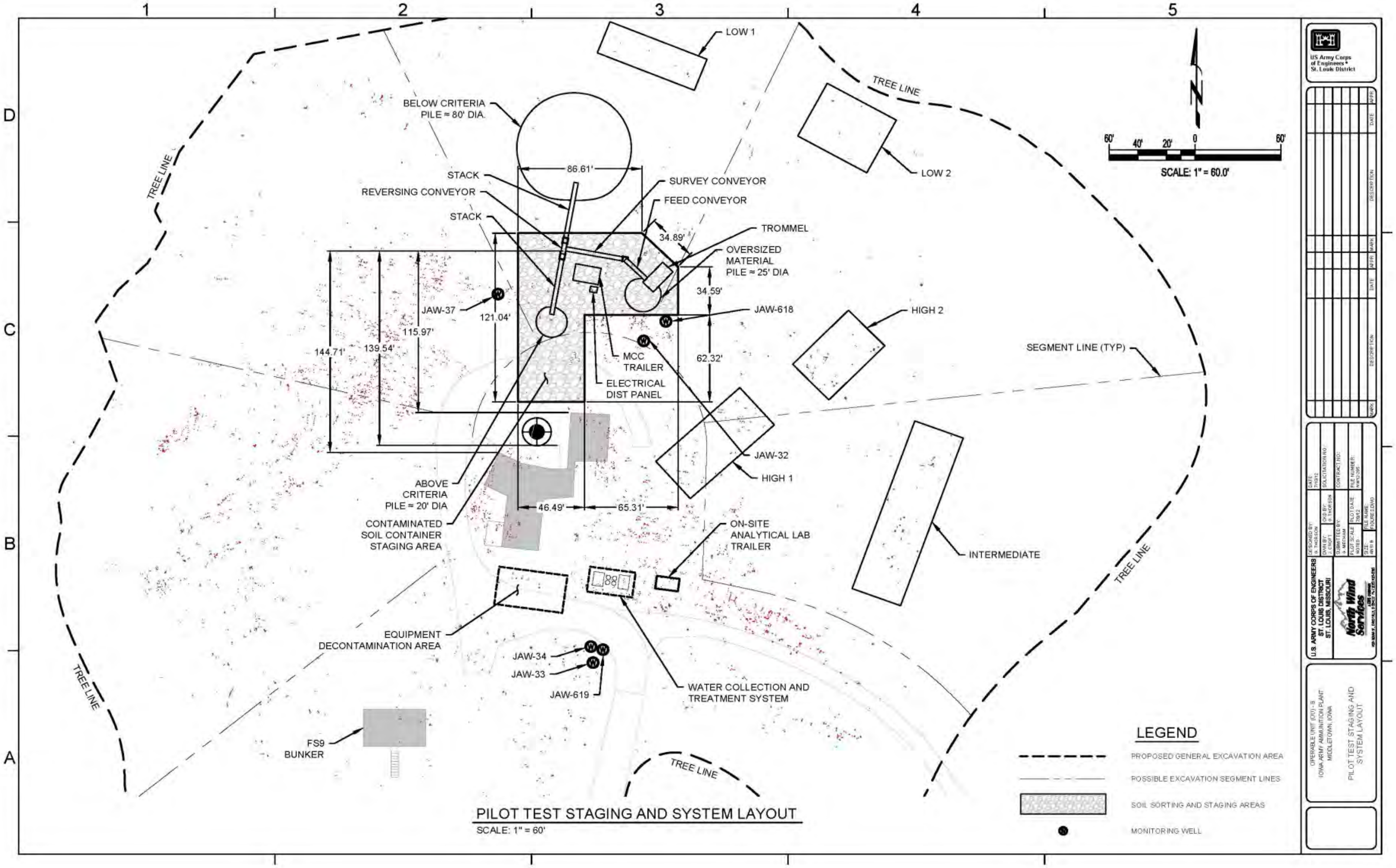

Figure 3. Pilot Study Project Staging and ScanSort[SM] Layout

Table 2. FS-12 Soils Used for the Pilot Study

Area Decsription *(DUFragment Density)*	**Area** *(ft^2)*	**Lifts**	**Approximate Volume** *(yd^3)*
Low Area	2,326	2	131
Intermediate Area	4,652	2	300
High Area 1	2,880	1	312
High Area 2	1,994	2	

3.2.2 Material Pre-Treatment

Soil material was excavated from the identified areas and was delivered to the *ScanSort*^{SM} system sorting area. Immediately prior to processing by the *ScanSort*^{SM} system, the soil was pre-conditioned using a motorized mechanical-screening plant to break up soil clumps and remove rock and other large debris (including DU fragments estimated at 2.7×10^8 pCi or greater) with dimensions larger than 2.5 inches. The conditioned soil was then discharged directly into the *ScanSort*^{SM} system's survey conveyor hopper for assay by the system. The large debris was discharged from the screening plant and stockpiled for future disposal.

3.2.3 Support Utilities

The *ScanSort*^{SM} system required 3-phase, 480-volt, alternating current (AC) electrical power. Electrical power was obtained from a portable diesel generator provided by North Wind. Standard single-phase, 120-volt, AC electrical power was obtained from the *ScanSort*^{SM} Power Distribution Skid, which transformed the 3-phase, 480-volt input.

3.3 Setup/Configuration of *ScanSort*^{SM} and Equipment

Components of the *ScanSort*^{SM}, including a survey conveyor, sorting conveyor, control and operation station (e.g., mobile command center trailer), power distribution panels, and system electronic panels, were provided by AMEC. Associated conveyor and support equipment, including a mechanical material screener, feed conveyor, below criteria soil staking conveyor, and above criteria soil stacking conveyor, were provided by a specialty equipment vendor (Figure 4).

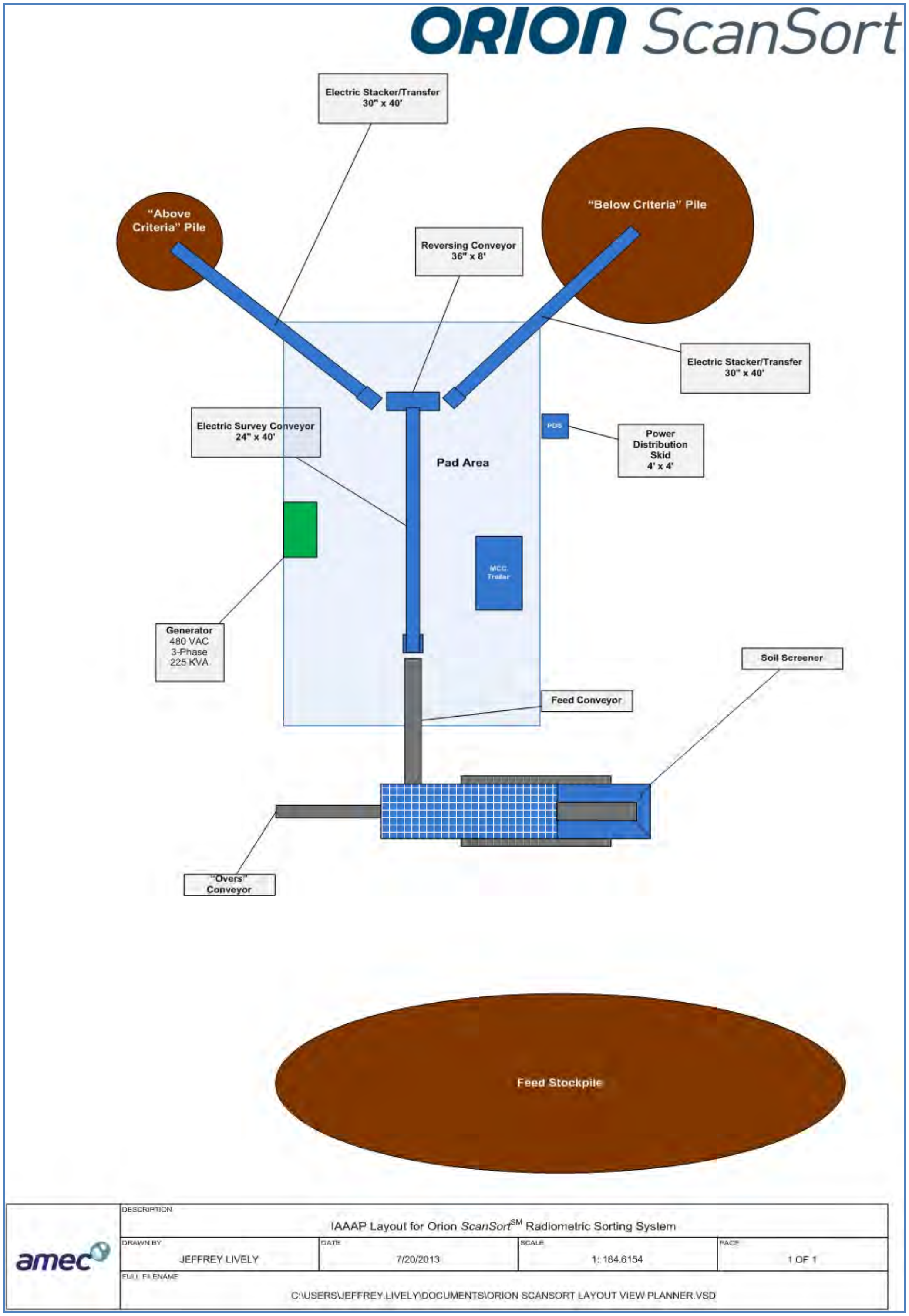

Figure 4. ScanSort℠ System Equipment and Material Layout

Following connection to utilities, a variety of general adjustments to the conveyors and monitoring equipment were made, including, but not limited to, fine-tuning of the speeds to match throughput for individual components, spacing and timing for the monitoring equipment and the reversing conveyor, adjustment of speed and level sensors, positioning of detectors and shielding, and adjustment of the soil leveler gate.

3.4 Flow of Soil Through the *ScanSort*SM System

The flow of the soil material through the material screener and *ScanSort*SM system proceeded as follows:

- Beginning at the trommel drum style material screener, soil is loaded into a large hopper by a front-end loader and conveyed into a rotating trommel drum.
    - The trommel drum is equipped with a 2.5-inch wire screen designed to break up soil clumps and remove large debris,
    - The trommel produces material that is mechanically screened to 2.5-inch-minus size gradation, and
    - Larger soil clumps and debris that do not pass through the screen are sent out of the system into a discharge pile to be reprocessed or otherwise dispositioned.
- Soil passing through the trommel screen is fed onto the feed conveyor and then into the Orion *ScanSort*SM survey conveyor's feed hopper.
- The Orion *ScanSort*SM survey conveyor's feed hopper is equipped with an adjustable soil leveler gate that controls the flow of soil into the survey conveyor, which is set to regulate the depth of soil on the survey belt.
- The mass of soil on the survey belt is measured with the *ScanSort*SM system's nuclear measurement gauge.
    - The soil is then passed under the *ScanSort*SM system's DU radiation detector array for radiometric assay, which utilized two large volume, 2-liter (2 inch × 4 inch × 16 inch) thallium doped sodium iodide [NaI(Tl)] detectors.
    - The detector array was suspended roughly 2 to 4 inches above the soil, depending on the soil thickness being tested.

- Parameters of the soil measured are fed to the *ScanSort*^{SM} system's operating software and compared to established diversion control setpoints (DCSs) to determine which one of two bins a given element of soil under evaluation should be discharged into[1].
  - An element of soil that is judged to exceed a DCS is diverted to the "above criteria" bin, and
  - An element of soil that is judged to satisfy each DCS is diverted to the "below criteria" bin.
- As an element of soil that is judged to exceed a DCS approaches the end of the survey conveyor belt, the software reverses the sorting conveyor to divert the offending soil.
- A set of two stacking conveyors are positioned at the two discharge points of the sorting conveyor to capture the soils that are diverted into either of the two pathways.
  - The stacking conveyors rapidly move the segregated material from the discharge of the sorting conveyor to form two stockpiles of material (one that is "above criteria" and another that is "below criteria") for subsequent management and disposition.

3.5 System Calibration

The calibration of the Orion *ScanSort*^{SM} system involves calibration of the sensors that feed data to the decision logic in the Orion software system (OSS). Each major element of the system calibration is described in the subsections that follow.

3.5.1 *ScanSort*^{SM} System Sensor Array and Alignment

The first alignment consideration is related to the desired size of a single element of soil to be evaluated. Several considerations are taken into account, including the survey/sorting objectives, the anticipated operational belt speed, the anticipated operation soil thickness on the survey belt, and the physical limitations and constraints of the equipment itself. Since it is known that the sorting objective is to detect and divert soils that contain discrete DU fragments above some activity threshold, the decision was made to set the length of a single element of soil equal to 0.5 meters. This is ideal for diverting smaller volumes of soil when a fragment is detected. AMEC's proprietary Orion operating system software (OSS) records spectral data for each soil element in unique "acquisitions," which it then uses to process and analyze the data set and make diversion decisions. An acquisition

[1] The selection of the project specific element size is discussed in Section 3.5.1. The selection of the project specific diversion control setpoints is discussed in Section 4.0.

length of 0.5 meters is the smallest practical acquisition length that can be implemented when singular, discrete, point sources (i.e., with DU fragments) are potentially present in the soil and must be assayed as such. This limitation is due to the large physical size of the spectrometers that *ScanSort*^{SM} uses, which are themselves nearly 0.5 meters long.

Having set the desired acquisition length to 0.5 meters, the AMEC team positioned and aligned the various detectors and sensors of *ScanSort*^{SM} system on the survey conveyor. All positions are identified relative to the end of the survey belt (Figure 5).

After physical placement of the sensors, tests were performed to verify the alignment of the system relative to the alignment settings programmed into the OSS. This alignment test ensures that an acquisition identified as having an elevated signal above a pre-determined alarm point was appropriately timed to be diverted to the "above criteria" bin when a divert signal was initiated by the software. The alignment tests performed confirmed that the *ScanSort*^{SM} system consistently diverted flagged acquisitions accurately. To ensure that an offending acquisition is completely diverted to the above criteria bin and stockpile, a small amount of additional (collateral) soil is also diverted into the "above criteria" pile.

3.5.1.1 DU Region of Interest (Spectral)

The *ScanSort*^{SM} system is a fully functional and integrated scanning spectroscopy system capable of measuring and distinguishing between a wide range of gamma-emitting isotopes. The operating software makes use of the ability to set regions of interest (ROIs) within the gamma spectrum to derive meaningful and quantitative information related to the identity and radioactivity of radionuclides of concern. DU is dominated by the radioactivity associated with U-238 (one of the three radionuclides specifically identified in the ROD) and as such, the soil RG specified in the ROD is expressed as an activity concentration of U-238 in units of pCi/g. The soil RG is stated as 150 pCi/g U-238 and is derived as an activity concentration limit permissible in a mass of soil associated with a single survey unit of 300 cubic meters (m^3) of soil (conservatively about 500 tons).

The relative signal-to-noise ratios of a number of potential spectral regions (various positions and channel widths) were evaluated in efforts to determine the appropriate ROI to be used for identifying and quantifying the radiation signal emitted from DU. Given the natural background levels (signal not attributable to radiation emission from DU) observed while measuring a variety of soils from the site, AMEC identified and selected a number of channels within a ROI that yielded the greatest signal-to-noise ratio for the detection and quantization of DU under a conservatively assumed set of operating and measurement conditions likely to be encountered. The gamma radiation emissions from DU are primarily those associated with U-238 and associated daughter products that can achieve equilibrium with U-238 during the time period since the DU was processed.

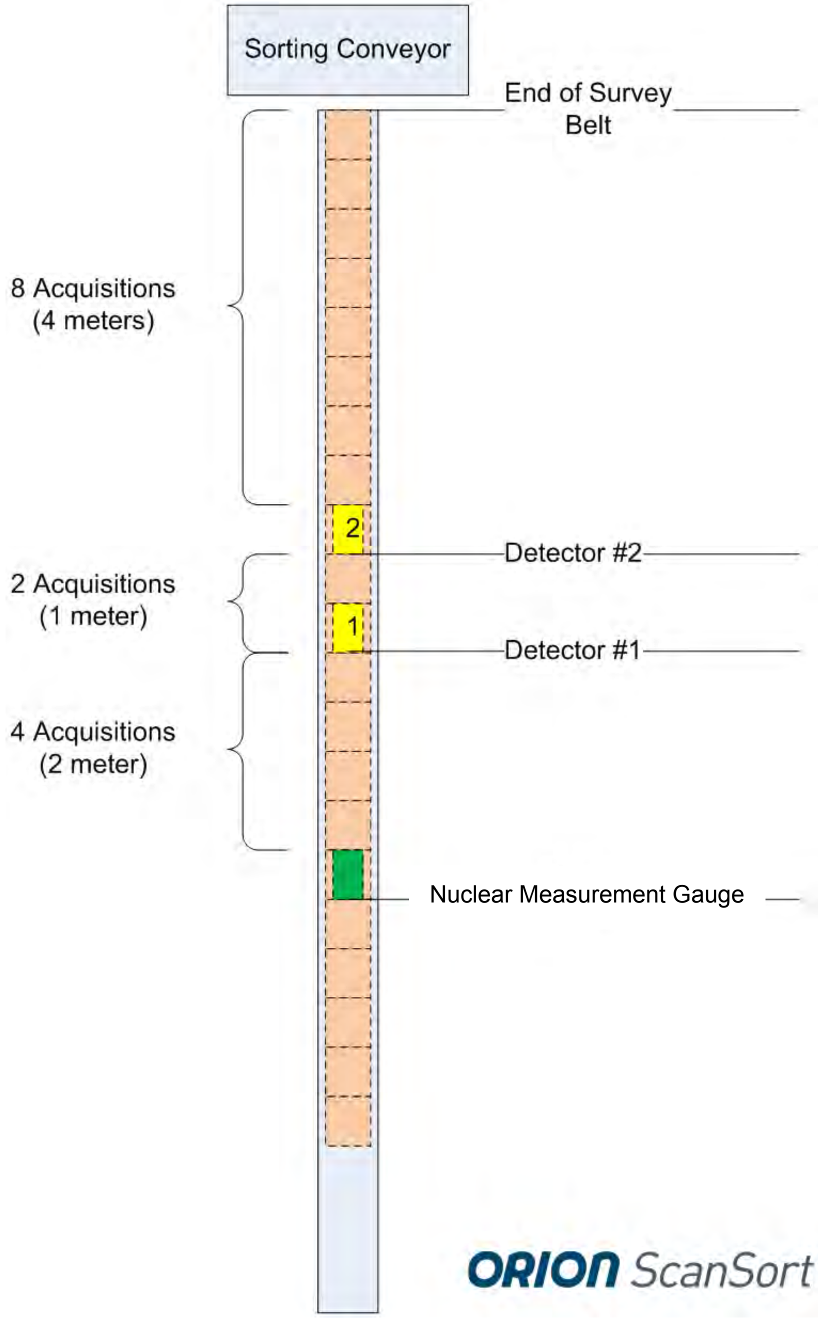

Figure 5. ScanSort^{SM} System Sensor Array & Alignment

These daughter products include thorium (Th)-234, protactinium (Pa)-234m, and Pa-234. While there are a number of gamma emissions at various energies that could be utililized for quantification of U-238, there are interferences from other naturally occurring radionuclides in soil (e.g., uranium, thorium, and potassium). The selected DU ROI provides a range that includes primary gamma lines (63 kiloelectron volt [keV] Th-234, 226/227 keV Pa-234, 258 keV Pa-234m, 293 keV Pa-234, 351 keV Pa-234, and 369 keV Pa-234), uranium K x-rays, and compton scatter generated by the DU gammas as they interact with the surrounding soil. Therefore, the ROI selected is 30 keV to 409 keV.

3.5.1.2 Bulk Soil Efficiency Calibration

To calibrate the *ScanSort*SM system for bulk soil efficiency, a multi-point volumetric calibration method using large volume site soils as "standards" was used. The bulk soil efficiency calibration is necessary to quantify the volumetric soil concentration of U-238 as DU and attribute it in units of pCi/g. It is not required to detect and remove discrete DU fragments from the soil; however, it is required to measure and report soil activities in units that the RG is stated in (pCi/g, U-238). The product of this calibration is an efficiency curve that relates the response of the *ScanSort*SM system in counts per second (cps) within the selected DU ROI to the radioactivity of U-238 in bulk soil in units of pCi/g. The objective of the multi-point volumetric calibration method is to isolate and blend two to four volumes of soil taken from the site and having a range of activities spanning the activities of interest for the project. It is desireable to have one volume with a very low bulk soil activity concentration (i.e., near background), one at or near the decision threshold (i.e., 150 pCi/g U-238), and one somewhat above the decision threshold (e.g., 200-300 pCi/g U-238). A portion of soil from each of the four soil test areas identified by North Wind for the pilot study project was evaluated for its potential use as a reference calibration standard (Table 2, Figure 3).

To prepare the soils for use as bulk soil reference calibration standards, each of the four soil batches were processed through the *ScanSort*SM system to remove discrete DU fragments. The soil was then assayed with the *ScanSort*SM system to yield a measure of the count rate in the DU ROI in cps. This process was repeated for each of the four candidate soil batches. After each batch was assayed by the *ScanSort*SM system, a set of five soil samples was collected from each batch and tested at the the USACE St. Louis District FUSRAP Laboratory in St. Louis, Missouri for U-238 activity.

Likely due to the nature of the contaminant distribution in soil at the FS-12 site, only one of the four candidate soil batches (High Area-1, Lift 1) yielded a mean volumetric U-238 activity that was markedly elevated (18.63 pCi/g, U-238) relative to the existing background levels of U-238 after having removed the measureable DU fragments. One other batch (Low Area, Lift 1) yielded a small U-238 activity concentration (2.48 pCi/g, U-238) that was measureable, statistically distinguishable from background soils, and at a relatively low activity concentration and was therefore useful to establish a calibration response curve for bulk soil quantitation. The other batches were not discernable from background. Therefore, two known datapoint pairs were used to establish the bulk soil response curve.

The response of the *ScanSort*^SM system within the DU ROI compared to the reported mean activity from soil samples collected from the same soil and measured at the USACE St. Louis District FUSRAP Laboratory provides the necessary relationship to establish the calibration curve and its associated calibration constant in units of cps per pCi/g (Figure 6).

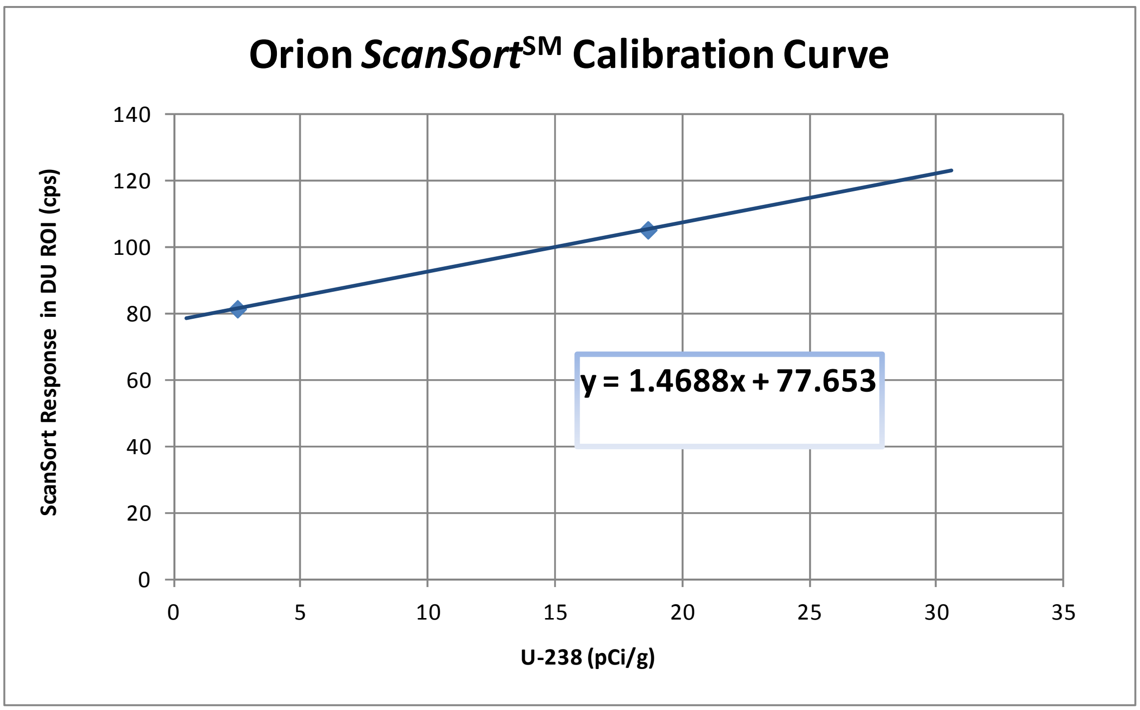

Figure 6. Bulk Soil Efficiency Calibration Curve[2]

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[2] A two-point calibration such as that used to calibrate the ScanSort system yields a known slope factor(calibration) that does not rely on the assumptions that the curve passes through zero as most calibrations do. In the relatively narrow range of activity concentrations between the two calibration data points used, there is no reasonable expectation that the response curve would be other than linear (e.g., due to dead time or other measurement phenomenon). Furthermore, the two point calibration brackets spans the range of expected mean volumetric activity in the soil at the IAAAP site. Thus, the two-point calibration used to establish the slope (cal factor) is appropriate for this application and exceeds the requirements and practices of generally accepted approaches.

The slope of the response curve, which correlates the *ScanSort*^{SM} system's response in the DU ROI to soil sample results collected from the same soil, is the bulk soil efficiency calibration constant. It is used to establish the basis for reporting DU radioactivity in units of pCi/g.

The calibration response curve derived for the DU ROI is 1.5 cps per pCi/g U-238 (as DU).

3.5.1.3 Nuclear Measurement Gauge Calibration

The nuclear measurement gauge (NMG) on the *ScanSort*^{SM} system measures the attenuation of a baseline radiation signal caused by the amount of soil mass on the survey conveyor belt. The degree of attenuation measured is sensitive to the variances in the bulk soil density (including the soil moisture content) and the thickness of the soil on the survey belt. The primary function of this gauge is to:

- Provide continuous measurement of the mass of soil that is surveyed by the *ScanSort*^{SM} system.
- Provide correction factors that normalize the *ScanSort*^{SM} system's primary radiometric sensors to their "belt-full" geometry response established at the time of their calibration. In this way, variability in bulk soil density, moisture content, and survey belt fill height are automatically and continuously compensated.

The NMG uses a radiation source (Cs-137) mounted beneath the survey belt to generate a signal that passes through the survey belt (as well as any material present at that point) and interacts with a detector mounted above the survey belt. The radiation signal is generated by a radioactive source in a collimating housing positioned beneath the survey belt. A collimated radiation gamma detector (designed and built by AMEC) is positioned above the survey belt in such a way that the alignment of the source and detector are optimized.

The OSS is configured to determine the apparent density of the material on the belt during processing via the response from the NMG detector. The apparent density of the material represents the actual density of the material being processed. For instance, if material with a true density of 1.1 grams per cubic centimeter (g/cm^3) was placed on the belt and had a complete fill height of 6 inches, the OSS would measure an apparent density of x. If that same material (1.1 g/cm^3) was placed on the belt but actually only had a thickness of 3 inches, the OSS would adjust the density value based on NMG measurements and use an apparent density of y, where y is roughly one-half of x.

The NMG detector response is inversely correlated to the amount (mass) of soil material present on the survey belt at that point due to the attenuation of the radiological signal. Baseline measurements were made with the survey belt empty (i.e., devoid of soil) to produce an unattenuated "empty belt" benchmark with an apparent density of 0. The calibration standards from High Area-1, Lift 1 and Low Area, Lift 1 were each repeatedly processed through the *ScanSort*[SM] system at varying material fill heights, and several series of attenuated measurements were collected. Based on these measurements the apparent density value is calculated for the processed soils.

The apparent density of the processed materials also effects the measurements obtained from the primary detectors. The average primary detector's response in the DU ROI for each calibration run was evaluated based on the apparent density of the calibration runs. The primary detector's responses were normalized to account for the differing radiological characteristics of the calibration standards. The normalized average primary detector response was then plotted against the apparent density for each calibration run. These results were used to derive the site-specific NMG calibration correction curve (Figure 7). The OSS automatically applies the NMG correction curve (in real time) to the primary detector response to accurately and continuously account for variability in bulk soil density, moisture content, and survey belt fill height.

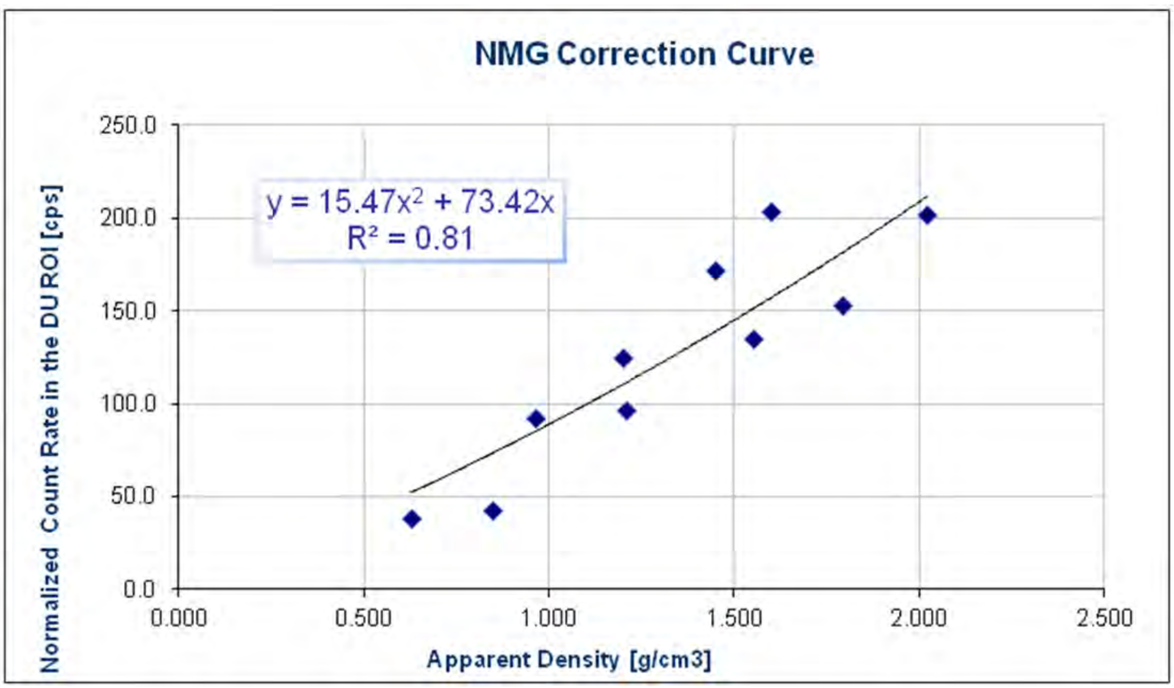

Figure 7. NMG Calibration Curve

To determine the density of actual FS-12 soils (as measured on the survey conveyor during the pilot test), several samples were collected from the conveyor. During processing, the system was paused and a 0.5-meter length on the survey conveyor belt was marked (one acquisition) and isolated. This acquisition of soil was collected from the belt into a container, weighed, and the volume measured. This process was performed using 3-, 4-, and 6-inch fill heights. The results are summarized in Table 3.

Table 3. FS-12 Measured Soil Density

Fill Height (in.)	Mass (g)	Volume (cm^3)	Density (g/cm^3)
3	11,300	9,850	1.15
3	14,650	12,770	1.15
4	12,340	11,680	1.06
4	13,400	11,310	1.18
6	26,800	25,550	1.05
		Average	**1.12**

3.5.1.4 Survey Belt Speed-Distance Calibration

The travel distance of the survey belt is an important parameter used in a number of calculations performed by the *ScanSort*^{SM} system's operating and control software. A high resolution, digital encoder device is used to continuously sense the change in position of the survey belt in real time. That signal is fed to the *ScanSort*^{SM} system's digital input/output controller, where it is synthesized with timing circuits and other parameters to initiate control functions (i.e., data-logging and sorting conveyor reversing) and record important operational data for reporting.

The calibration uses a sequence of trials in which the survey belt is moved a known distance (e.g., one complete revolution of the belt). The number of pulses produced by the digital encoder is measured over each trial and a simple ratio of pulses for distance travel is calculated. The average ratio observed over a series of trials is established as the calibration constant for the survey belt speed-distance sensor. The calibration constant is 3,144 pulses/meter. This value is entered and set into the *ScanSort*^{SM} system's operating software and provides a precise measure of survey belt travel distance, position of acquisition on the conveyor belt, and belt speed.

3.5.2 Empirical Point Source Efficiency Phase

One important objective performed as part of the pilot study's point source efficiency phase was to characterize the system for its response to a discrete (i.e., singular) point source of DU in a variety of configurations that could be anticipated during operations. Several critical variables were tested, including:

- Angular response (lateral [side-to-side]) position of the DU source in relation to the position of the detector),
- Residence time (speed of the survey conveyor),
- Attenuation (thickness of soil covering the source), and
- Activity of the DU fragment.

3.5.2.1 Identifying and Retrieving DU Fragments

Before the empirical point source efficiency for a DU fragment could be established, it was necessary to acquire a suite of DU fragments (point sources) of varying size (mass) and activity to be used in the tests. To accomplish this, impacted soils from the site were processed thru the *ScanSort*^{SM} system. Alarms were established in the operating software that would make the system highly sensitive to discrete fragments of depleted uranium. When an alarm signal was generated, indicating the presence of a DU fragment, the survey belt was stopped to identify and retrieve it. A hand-held 2-inch × 2-inch NaI(Tl) detector was used to survey the volume of soil until the DU fragment was identified and retrieved. A total of 13 DU fragments were collected in this manner, eight of which were selected for use during the engineered test runs (Table 4).

Table 4. DU Fragments Retrieved for Use in Engineered Test Runs

Assigned Fragment ID	Mass (g)	U-238 Activity (µCi)	Total DU Activity (uCi)
1	186.0	62.56	66.96
2	22.2	7.47	7.99
3	10.5	3.53	3.78
4	8.0	2.69	2.88
5	2.0	0.67	0.72
6	0.9	0.30	0.32
7	0.7	0.24	0.25
8	0.4	0.13	0.14

The collected fragments had a wide range of sizes and conditions. Many were solid in form, had metallic appearances, low amounts of oxidation, and could be cleaned of excess soil or debris. Some fragments had considerable oxidation and some of the recovered fragments had no solid structure that could be differentiated from the surrounding soil (likely small fragments that had materially decayed from decades of oxidation) and could not be used for point source quantization.

The solid, metallic fragments selected for use during the engineered test runs were individually weighed on a small digital scale. The DU fragment activities reported in Table 4 were calculated by multiplying the mass of the fragment by the specific activity of U-238 as DU metal (336,351 pCi/g). Although the fragments were cleaned of most visible dirt or debris, they may not have been chemically pure uranium. This leads to a conservative assumption that all measured mass of the fragments were grams of pure DU. In addition, the total radioactivity of DU was calculated by multiplying the mass of the fragment by the specific activity of DU (360,000 pCi/g), as provided in 10 Code of Federal Regulations (CFR) 20, Appendix B (Footnote 3 of Tables 1, 2, and 3). The fragments were sealed in thin plastic bags and attached to high visibility ribbons. Each fragment was uniquely numbered to maintain positive control over their identity during subsequent testing in the engineered test runs.

3.5.3 Engineered Test Runs

The eight DU fragments selected (Table 4) were then used to characterize the system's response to fragments in different system configurations. The fragments were manually inserted into clean material being processed by the *ScanSort*^{SM} system. Material was processed at different fill heights (2, 3, 4, 5, and 6 inches) by adjusting the soil leveler gate position on the outlet of the survey conveyor's feed hopper. For each fill height tested, the system was operated at 30, 50, and 70 centimeters per second (cm/s). For each combination of fill height and speed, the identified fragments were inserted into the process material at a variety of locations (i.e., the top of material in the center of the survey belt, the bottom center, and the edge of material). These locations are illustrated in Figure 8.

At each location, the fragments were processed in ascending identification order (fragment 1, 2, 3, etc.) with sufficient physical space between each insertion so that the measured radiation signal from one fragment did not overlap with a subsequent fragment's signal. At each fill height, speed, and location, the eight fragments were processed a total of five times each.

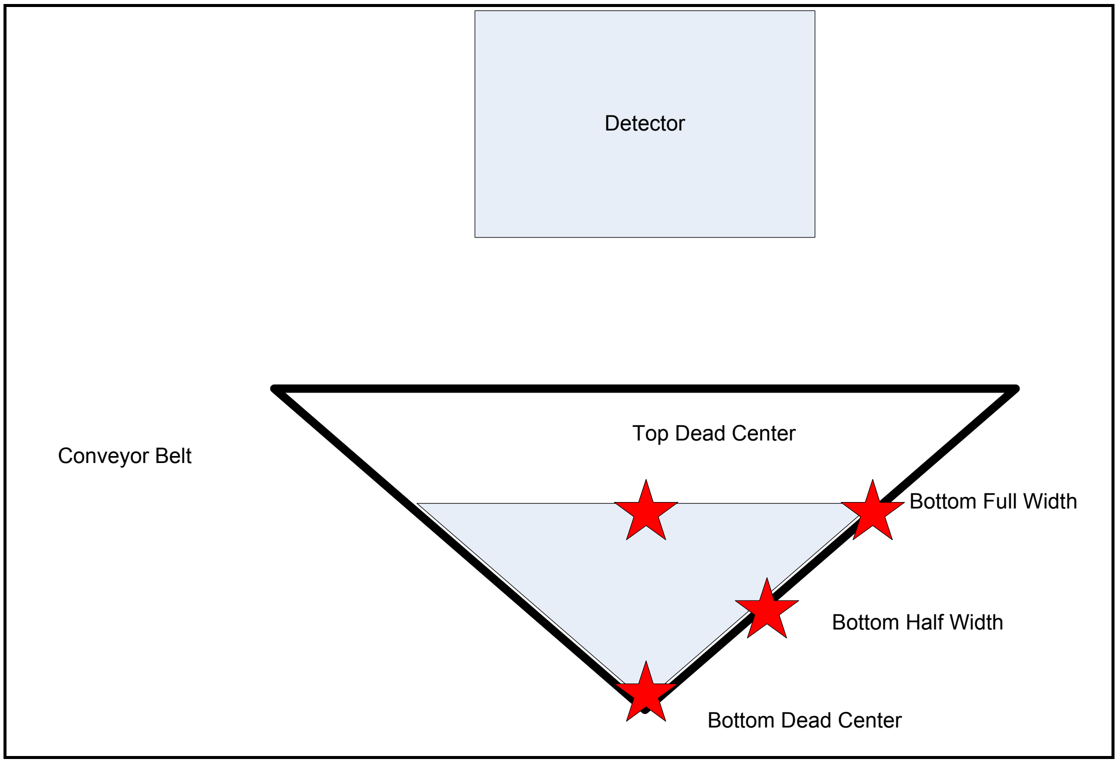

Figure 8. Source Location on Conveyor Belt

3.5.3.1 Engineered Test Results

Because no discrete activity remediation guidance existed, the results were examined to qualitatively establish a discrete DU fragment activity that the system could confidently detect under a varity of variable conditions. The data from each of the five engineered test runs for each fragment insertion at each fill height, speed, and location were then analyzed to assess the probability that the *ScanSort*^{SM} system would detect and alarm on the DU fragment as it passed beneath the detector array. The engineering test runs generated a series of datasets that were used to calculate and project the DU fragment detection probabilities over the range of values tested for each variable. A series of graphs visually relate the multi-variate relationships in the engineered test run datasets that yield the projected detection probability (i.e., estimated true positive response rate). These detection probabilities were established by utilizing alarm thresholds that delivered <2% false positive alarm rates.

As expected, the analysis of the engineered test runs shows that the thinner the soil layer thickness used, the higher the likelihood that a DU fragment of diminishing activity would be identified and diverted. While the 2-inch thickness would offer better detection probabilities at very low DU fragment activities, it was confirmed during the pilot study testing that the material flow characteristics of the soil begin to suffer appreciably when the soil thickness was reduced to less than 3 inches. This is related to the 2.5-inch screen size used in the mechanical screen plant used to precondition the soil and the cross-sectional profile of the survey belt constrained by the soil lever gate.

Likewise, it was observed that using thicker fill heights (i.e., 4-, 5-, and 6-inches) produced geometries that made detection of lower activity DU fragments progressively more difficult when they were inserted in the “bottom dead center” of the belt location (compare Figure 9 with Figure 10). While a 2-inch fill height is slightly more sensitive to very small DU fragments, a 3-inch fill height still offers very sensitive response to quite small DU fragments with activities well below any relevent risk-based benchmark. Therefore, AMEC concludes that the 3-inch fill height is the optimum fill height thickness for this project, as it offers the best combination of fragment sensitivity and sustainable soil measurement geometry with reasonable material handling characteristics.

It is important to consider that Figure 9 depicts the “worst case” detection probability scenario for a DU fragment under 3 inches of soil. The reality is that the likelihood that a DU fragment will reside in this “worst case” position on the belt is relatively small compared with all of the positions that it might reside within the cross section of soil. Indeed, the probability of detection for a given size or activity of DU fragment continuously improves as the fragment resides closer to the soil surface. It is informative to consider the “best case” scenario detection probability scenario alongside the “worst case” detection probability scenario for a given activity of DU fragment (compare Figure 9 with Figure 11). Such a comparison reveals that there is a range of detection probabilities for a given activity of DU fragment dependent upon its position in the soil column and the speed at which the survey belt is operated. When the data are composited to account for the random nature of the position of a fragment within the soil column on the survey belt, the overall projected detection probability is derived for the 3-inch fill height case (Figure 12).

3-inch Fill Height - Bottom Dead Center Position						
Source			Speed (cm/second)			
No.:	Mass (g)	U-238 Activity (µCi)	70	50	30	
1	186.0	62.6	100%	100%	100%	CONFIDENCE
2	22.2	7.5	100%	100%	100%	
3	10.5	3.5	100%	100%	100%	
4	8.0	2.7	100%	100%	100%	
5	2.0	0.7	80%	100%	100%	
6	0.9	0.3	60%	80%	80%	
7	0.7	0.2	40%	50%	60%	
8	0.4	0.1	20%	30%	40%	

Figure 9. Projected Detection Confidence, 3-inch Fill Height, Bottom Dead Center

4-inch Fill Height - Bottom Dead Center Position						
Source			Speed (cm/second)			
No.:	Mass (g)	U-238 Activity (µCi)	70	50	30	
1	186.0	62.6	100%	100%	100%	CONFIDENCE
2	22.2	7.5	100%	100%	100%	
3	10.5	3.5	100%	100%	100%	
4	8.0	2.7	100%	100%	100%	
5	2.0	0.7	80%	90%	100%	
6	0.9	0.3	40%	50%	60%	
7	0.7	0.2	0%	25%	30%	
8	0.4	0.1	0%	0%	0%	

Figure 10. Projected Detection Confidence, 4-inch Fill Height, Bottom Dead Center

3-inch Fill Height - Top Dead Center Position						
Source			Speed (cm/second)			
No.:	Mass (g)	U-238 Activity (µCi)	70	50	30	
1	186.0	62.6	100%	100%	100%	CONFIDENCE
2	22.2	7.5	100%	100%	100%	
3	10.5	3.5	100%	100%	100%	
4	8.0	2.7	100%	100%	100%	
5	2.0	0.7	100%	100%	100%	
6	0.9	0.3	100%	100%	100%	
7	0.7	0.2	80%	100%	100%	
8	0.4	0.1	60%	70%	80%	

Figure 11. Projected Detection Confidence, 3-inch Fill Height, Top Dead Center

3-inch Fill Height - Random Position						
Source			Speed (cm/second)			
No.:	Mass (g)	U-238 Activity (µCi)	70	50	30	
1	186.0	62.6	100%	100%	100%	CONFIDENCE
2	22.2	7.5	100%	100%	100%	
3	10.5	3.5	100%	100%	100%	
4	8.0	2.7	100%	100%	100%	
5	2.0	0.7	83%	92%	93%	
6	0.9	0.3	67%	77%	80%	
7	0.7	0.2	47%	60%	67%	
8	0.4	0.1	27%	40%	50%	

Figure 12. Projected Detection Confidence, 3-inch Fill Height, Random Position

Key conclusions derived from the engineered test runs include:

- The ideal fill height thickness for processing soil and detecting small DU fragments is 3 inches.
- As the fill height increases, the probability of detecting increasingly smaller DU fragments goes down.
- As the survey belt speed goes up, the probability of detecting a DU fragment of a given size and activity, assuming a constant false positive rate, goes down.
- DU fragment detection probability is more sensitive to its random position within the soil column than it is to belt speed variance.
- DU fragment detection probability is more sensitive to soil thickness than is it is to belt speed variance.
- Over the range of survey belt speeds tested (30 to 70 cm/sec), the *ScanSort*^{SM} system detected the 2.69 µCi U-238 (8g) DU fragment 100% of the time when placed in the worse case lateral and depth positions in 2-, 3-, and 4-inch fill heights.
- Over the range of survey belt speeds tested (30 to 70 cm/sec) and using 3-inch fill height, the *ScanSort*^{SM} system detected the 0.67 µCi U-238 (2g) DU fragment between ~80 and 100% of the time depending upon its lateral and depth position within the soil column.
- At a survey belt speed of 30 cm/s, and a fill height of 3 inches, the *ScanSort*^{SM} system can be expected to remove a 2.69 µCi (8g) DU fragment ~100% of the time, a 0.67 µCi (2g) DU fragment ~93% of the time, a 0.30 µCi (0.9g) DU fragment ~80% of the time, a 0.24 µCi (0.7g) DU fragment ~67% of the time, and a 0.13 µCi (0.4g) DU fragment ~50% of the time.

The mass of a single measurement acquisition of the ScanSortSM system, as configured for the IAAAP project, is ~15 kg (assuming a 3-inch fill height, 0.5 m acquisition length, and site-specific soil density of approximately 1.1 g/cm3, as provided in Section 3.5.1.3). If a single (15 kg) measurement acquisition was homogenously contaminated at the approved Derived Concentration Guideline Level (DCGL)W activity concentration of 150 pCi/g, the total U 238 activity present would be 2.25 µCi. Logically, one can conclude that if 150 pCi/g U 238 distributed in 15 kg of soil meets the RG and corresponds to a total activity of 2.25 µCi, then a single DU fragment with an activity equal to 2.25 µCi should also be acceptable. Additional evaluation addressing the use of this value to meet the RG criteria in included in section 4.2.2.

Based on this data and assessment, AMEC is confident that the system can support a diversion control setpoint that identifies and segregates soil that contains a single discrete DU fragment with a U-238 activity of 2.25 µCi (~6.5g) with at least 95% confidence and/or a DU fragment with a U-238 activity of 0.7 µCi (~2g) with at least 80% confidence. A DU fragment with a U-238 activity of 2.25 µCi is a quantitative value of significance, as discussed in Section 4.

3.5.4 Mock Production Runs

Following the engineered test runs, mock production runs were performed to assess the system's performance in a production environment and to estimate the soil separation efficiency of processing site soils through the *ScanSort*SM system. The *ScanSort*SM system was configured to process soils using the proposed operating conditions based on preliminary pilot study data prior to the mock production runs (Table 5).

Table 5. ScanSortSM System Settings during Mock Production Testing

Parameter	Value
Fill Height	3 inches
Belt Speed	50 cm/s
Diversion Control Set Point	2.25 µCi

Soils were processed in batches corresponding to the areas from which they were excavated. Acquisitions of soil that generated a signal above the DCS were diverted as "above criteria" material. The total volume of diverted material for each batch was then compared to the total volume of soil that was not diverted during that mock production run. Soils from Intermediate Area, Lift-1; Intermediate Area-1, Lift-2; and High Area-1, Lift-2 were processed in this manner. The data from previous testing for Low Area, Lift-1 and High Area-1, Lift-1 were analyzed to determine the volume of soil that would have been diverted at the proposed operational set points. The percentage of material diverted from each batch is presented in Table 6.

Table 6. Material Diverted in Mock Production Testing

Batch ID	Proportion of Material Diverted
Low Area, Lift 1 Low Area, Lift-2	2.0%
Intermediate Area, Lift-1	5.3%
Intermediate Area, Lift-2	1.2%
High Area-1, Lift-1	3.1%
High Area-1, Lift 2	3.0%

3.5.5 Reprocessing Run

The soil material from High Area-1, Lift-2 was reprocessed by the *ScanSort*^{SM} system (using the same operational parameters) to verify the system's ability to identify and segregate discreet DU fragments with a U-238 activity of greater than 2.25 µCi. It is important to realize that the DCS was conservatively set such that a discreet DU fragment of soil with a U-238 activity of 2.25 µCi or greater, in the *least* favorable location in the soil column (Bottom Dead Center), would be identified and segregated with ~100% probability. As a consequence of this conservatism, discreet DU fragments with activity of *less* than 2.25 µCi have the potential to generate a signal above the DCS in the *ScanSort*^{SM} system if encountered in more favorable locations in the soil column.

During the reprocessing of the High Area-1, Lift-2 material, the *ScanSort*^{SM} system diverted a small volume of soil due to more favorable positions of discreet DU fragments (relative to the initial run), as anticipated. Twenty-eight acquisitions generated a signal above the DCS and were diverted by the *ScanSort*^{SM} system on the second pass of the same material. Of those 28 diversions, 13 were selected, collected in isolation, and reserved for manual assessment to determine if significant, measureable DU fragments could be found (Table 7).

Table 7. Diversions Initiated in Materials Processed Twice

Run	Number of Diversions Initiated by *ScanSort*^{SM}	Individually Assessed Diversions
1	74	N/A
2	28	13

Following collection and isolation, each of the individually assessed diversions were spread into thin (approximately 1-inch to 3-inch) lifts. Radiation Control Technicians performed gamma surveys with a hand-held 2-inch × 2-inch NaI(Tl) detector in an attempt to identify and quantify any DU fragments therein. No discernible fragments could be discretely isolated or found in 11 of the 13 volumes diverted by the *ScanSort*^{SM} system. A single discernible DU fragment was found in the other two diversions. The identified DU fragments were isolated and removed from the surrounding soils and assayed to determine their mass derived activities. One had an activity of 0.91 µCi; the other had an activity of 1.78 µCi.

This reprocessing test affirms the *ScanSort*^{SM} system's ability to identify and segregate discreet DU fragments with activity greater than the DCS programmed in the software (2.25 µCi).

3.5.6 Demonstration Test Verification

At the completion of the successful demonstration test, verification that the *ScanSort*^{SM} correctly separated contaminated soils above the RG from soils below the RG was required. Verification samples were collected from both soil streams after the soil was processed through the system. Three grab samples were collected from each soil pile and sent offsite to the USACE St. Louis District FUSRAP Laboratory for gamma and alpha spectroscopy analysis. Results of the verification samples show the *ScanSort*^{SM} system separated soils correctly and that material separated into the "below criteria" pile was, on average, below the soil RG for DU in soils. The laboratory results are included in appendix A.

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4.0 WASTE VOLUME REDUCTION AS A FUNCTION OF DCS SET POINT

The implementation of the soil sorting element of the RA phase of the IAAAP project at OU-8 requires that appropriate DCSs be established for operation of the *ScanSort*^{SM} system in order to achieve the desired goals for the RA. To assess what DCSs might be appropriate for the project, AMEC evaluated the test data collected during the pilot / demonstration phase of the project in the light of the RGs defined in the ROD, the Remedial Action Work Plan (RAWP), and the observed capabilities of the Orion *ScanSort*^{SM} system.

The radiological RA objectives for the site include assaying and segregating soils impacted with DU fragments created from firing tests conducted at the site in the past such that:

- Significant, measureable fragments of DU are effectively removed from the soils that are shown to meet the RG; and
- Soils that meet the RG, as stated in the ROD, can be placed back in excavations onsite as acceptably clean.

To accomplish these objectives, the *ScanSort*^{SM} system must be configured with diversion control set points that result in segregation operations that ensure that:

- The large volume activity limit (RG), as stated in the ROD, is met with acceptable confidence; and
- Significant, measureable fragments of DU are removed from the soils that are intended to be retained onsite.

The sections below address the appropriate DCSs that are needed to satisfy each of these two goals.

4.1 DCS for Segregating Soils to Meet the Large Volume Activity Limit RG

The ROD (USACE, 2011) establishes a volumetric activity limit consistent with the assumptions and bases used in the risk model. The single radiological RG (defined in the ROD for soils from OU-8) is 150 pCi/g U-238. The basis for the RG includes the assumptions that (1) U-238 occurs as DU and (2) that the activity concentration limit applies as an average over a single class 1 survey unit, as described in MARSSIM (2,000 m^2 by 0.15 m thick [300 m^3]). Based on typical in-place soil densities, 300 bank m^3 of soil will have a mass of approximately 500 U.S. tons.

Two elements of the soil that are being assayed must be measured in order to demonstrate compliance—(1) activity concentration (pCi/g) and (2) average mass (tons). While compliance could rightly be addressed by averaging the activity concentration over a mass as large as 500 tons, it is not practical to make sorting and segregation decisions on volumes of soil so large. The measurement sensitivity of the *ScanSort*^{SM} system for assaying DU is sufficiently capable to allow sorting decisions to be made on a much smaller averaging mass (tons). In the interest of practicality and conservatism in applying the soil RG criteria to the sorting decision, AMEC proposes and recommends that a single DCS designed to meet the soil RG criteria for volumetric soils should be established.

DCS: *If the DU activity in a single measurement acquisition would cause the average activity concentration (averaged over 1 ton of soil in neighboring volumes) to exceed the activity concentration limit, as specified in the RG (150 pCi/g [U-238 as DU]), then divert that single acquisition to the above criteria stockpile.*

Applying the DCS (as stated) would be conservatively protective of the large volume activity limit RG for soil, as approved.

4.2 DCS for Segregating Soils Containing DU Fragments

USACE has identified, as a secondary objective, the desire to remove "significant, measureable fragments of DU" from the site soils that otherwise meet or comply with the ROD. The ROD does not establish an RG or a criterion basis for defining a "significant, measureable fragment of DU". Consequently, the USACE may establish the criterion and definition as a best management practice decision consistent with its vision for the "as left" post-remedial condition of the site.

4.2.1 "Measureable" Activity of a DU Fragment

The engineered point source data described in Section 3.5.3 demonstrates that the *ScanSort*^{SM} system can confidently measure and segregate soils having singular discrete DU fragments with activities greater than 2.25 µCi[3] (approximately 6.5g) under an assumed set of processing conditions. Thus, AMEC concludes that it is reasonable to declare that a 2.25 µCi DU fragment is "measureable."

[3] Section 3.5.3 of this report details the performance and results of the series of engineered test runs that were performed to assess the response characteristics and sorting capabilities of the *ScanSort*^{SM} system when challenged with singular, discrete point sources of DU fragments distributed in soil on the survey belt. Those results show that there is essentially 100% detection probability for a DU fragment of 2.67 µCi but that the detection probability for a 0.7µCi DU fragment begins to fall off when the fragment is not positioned in the "best case" measurement geometry. The selection of 2.25 µCi as the size of DU fragment that is confidently measureable is based on projected confidence in detection capability in the light of the results of the engineered test runs and the alignment of that DU fragment activity with other recognized, applicable, and approved benchmarks that relate to the "significance" of DU radioactivity in the environment.

4.2.2 "Significant" Activity of a DU Fragment

The ROD establishes a RG for DU contaminated soils in units of pCi/g, which is applicable to large volumes of soils. Following the MARSSIM approach, the RG was derived using the RESRAD computer code, which utilizes soil concentrations of radionuclides over the entire site. However, it does not establish an RG or criterion to define the basis for removal of a discrete fragment of DU. This section provides a framework for comparing the relative "significance" of the radioactivity associated with a single DU fragment with the permissible or stated radioactivity in a variety of soil volumes. To establish the comparative basis, AMEC calculated the total amount of radioactivity that would be present in the mass of soil from a single measurement acquisition of the *ScanSort*^{SM} system (~15 kg), assuming that the activity concentration was equal to the permissible mean activity concentration stated in the ROD (150 pCi/g U-238 as DU). In accordance with MARSSIM for radionuclides, non-parametric statistical evaluations are performed during the decision making process which compares the data to the RG, using the central tendency (median) as the primary criterion

As stated in section 3.5.3.1, the mass of a single measurement acquisition of the *ScanSort*^{SM} system, as configured for the IAAAP project, is ~15 kg (assuming a 3-inch fill height, 0.5 m acquisition length, and site-specific soil density of approximately 1.1 g/cm^3, as provided in Section 3.5.1.3). If a single (15 kg) measurement acquisition was homogenously contaminated at the approved Derived Concentration Guideline Level $(DCGL)_W$ activity concentration of 150 pCi/g, the total U-238 activity present would be 2.25 µCi. Logically, one can conclude that if 150 pCi/g U-238 distributed in 15 kg of soil meets the RG and corresponds to a total activity of 2.25 µCi, then a single DU fragment with an activity equal to 2.25 µCi should also be acceptable. This is not the only comparison that can be made. In fact, the volume of 15 kg used in this comparison is entirely an artifact of the setup of the *ScanSort*^{SM} system for the IAAAP project. A series of like comparisons are drawn below using activities and volumes that are recognized, applicable, and approved in existing RA documents used for the project. These serve as benchmarks for comparison with the a 2.25 µCi DU fragment. These benchmarks can be used to understand the relative difference in the amount of DU radioactivity involved in one or more of the measures used to assess the RA at FS-12. They help put into context the amount of radioactivity in a DU fragment with the amount of radioactivity accepted in other contexts.

AMEC identified nine stated and measureable benchmarks from existing project documents that can serve as benchmarks for considering the significance of a 2.25 µCi DU fragment. Each of these is described below.

Benchmark #1

The Final Status Survey Plan (FSSP) identifies a $DCGL_{EMC}$ value of 2,300 pCi/g U-238 averaged over a soil mass of 240 kg. The total U-238 activity permissible under this benchmark is 552 µCi (1,625g), which is ~250 times more radioactive than a 2.25 µCi DU fragment.

Benchmark #2

The mass of a single measurement acquisition of the *ScanSort*^{SM} system, as configured for the IAAAP project, is ~15 kg (more than an order of magnitude smaller than the approved $DCGL_{EMC}$ volumetric criterion of 240 kg). If a single (15 kg) measurement acquisition was homogenously contaminated at the approved $DCGL_{EMC}$ activity concentration of 2,300 pCi/g, the total U-238 activity present would be ~35 µCi (101g), which is ~15 times more radioactive than a 2.25 µCi DU fragment.

Benchmark #3

In the FSSP, the FSS contractor states that the "conservative" (worst case) detection limit for a DU fragment lying 5 cm beneath the surface is 64.2 µCi [185g] (~29 times more radioactive than a 2.25 µCi DU fragment).

Benchmark #4

In the FSSP (USACE, 2013b), the FSS contractor states that the "conservative" (i.e., worst case) detection limit for a DU fragment lying on the surface is 38.5 µCi (111g), which is ~17 times more radioactive than a 2.25 µCi DU fragment.

Benchmark #5

In the FSSP, the FSS contractor states that the "optimal" (i.e., best case) detection limit for a DU fragment lying 5 cm beneath the surface is 12.8 µCi (37g), which is ~6 times more radioactive than a 2.25 µCi DU fragment.

Benchmark #6

In the FSSP, the FSS contractor states that the "optimal" (i.e., best case) detection limit for a DU fragment lying on the surface is 6.4 µCi (18g), which is ~3 times more radioactive than a 2.25 µCi DU fragment.

Benchmark #7

NUREG 1507 establishes accepted industry standard methods for calculating the minimum detectable concentrations that can be relied upon to detect locally elevated radioactivity in soil for typical instruments under various field conditions. The NUREG 1507 method standardizes on an area and thickness (volume) equal to 60 kg assuming typical soil density. If a 60 kg mass of soil were uniformly contaminated with DU at the RG activity concentration limit of 150 pCi/g, the total U-238 activity permissible under this benchmark is 9 µCi (26g), which is 4 times more radioactive than a 2.25 µCi DU fragment.

Benchmark #8

In the FSSP, the FSS contractor, using the NUREG 1507 methodology described above, states that the scan minimum detection concentration for distributed DU in surface soil (as measured with a hand held 2-inch × 2-inch NaI detector) is 56 pCi/g (homogeneously distributed over 60 kg). The total U-238 activity permissible under this benchmark is 3.4 µCi (10g), which is ~1.5 times more radioactive than a 2.25 µCi DU fragment.

Benchmark #9

The mass of a single measurement acquisition of the *ScanSort*^{SM} system, as configured for the IAAAP project, is ~15 kg. If a single (15 kg) measurement acquisition was homogenously contaminated (hypothetical) at the approved $DCGL_W$ activity concentration of 150 pCi/g, the total U-238 activity present would be 2.25 µCi (6.5g), which is equal to the radioactivity of a single 2.25 µCi DU fragment.

A graphic comparison of these benchmarks, each of which represents a "measureable" quantity, a "significant" quantity, or both, provides insight into the appropriateness of the selection of a criterion for defining a "significant, measureable fragment of DU" (Figure 13). From the caparisons presented, it is clear that a DCS designed to remove DU fragments having activities greater than 2.25 µCi (6.5g) is conservative in every case.

In addition to the relative significance of the amount of radioactivity associated with a DU fragment, the DCS should be selected in recognition of the waste volume that will be generated at a given DCS. Again, data collected during the pilot/demonstration study and identified as "mock production runs" (described in Section 3.5.4) provide a basis for assessing projected waste volumes that might be expected relative to the magnitude of activity in a DU fragment that is designed to be removed. The "mock production run" data was used to create a composite, projected waste volume estimate (as a percentage of volume processed) curve plotted against potential diversion control set points that might be used to remove DU fragments (Figure 14).

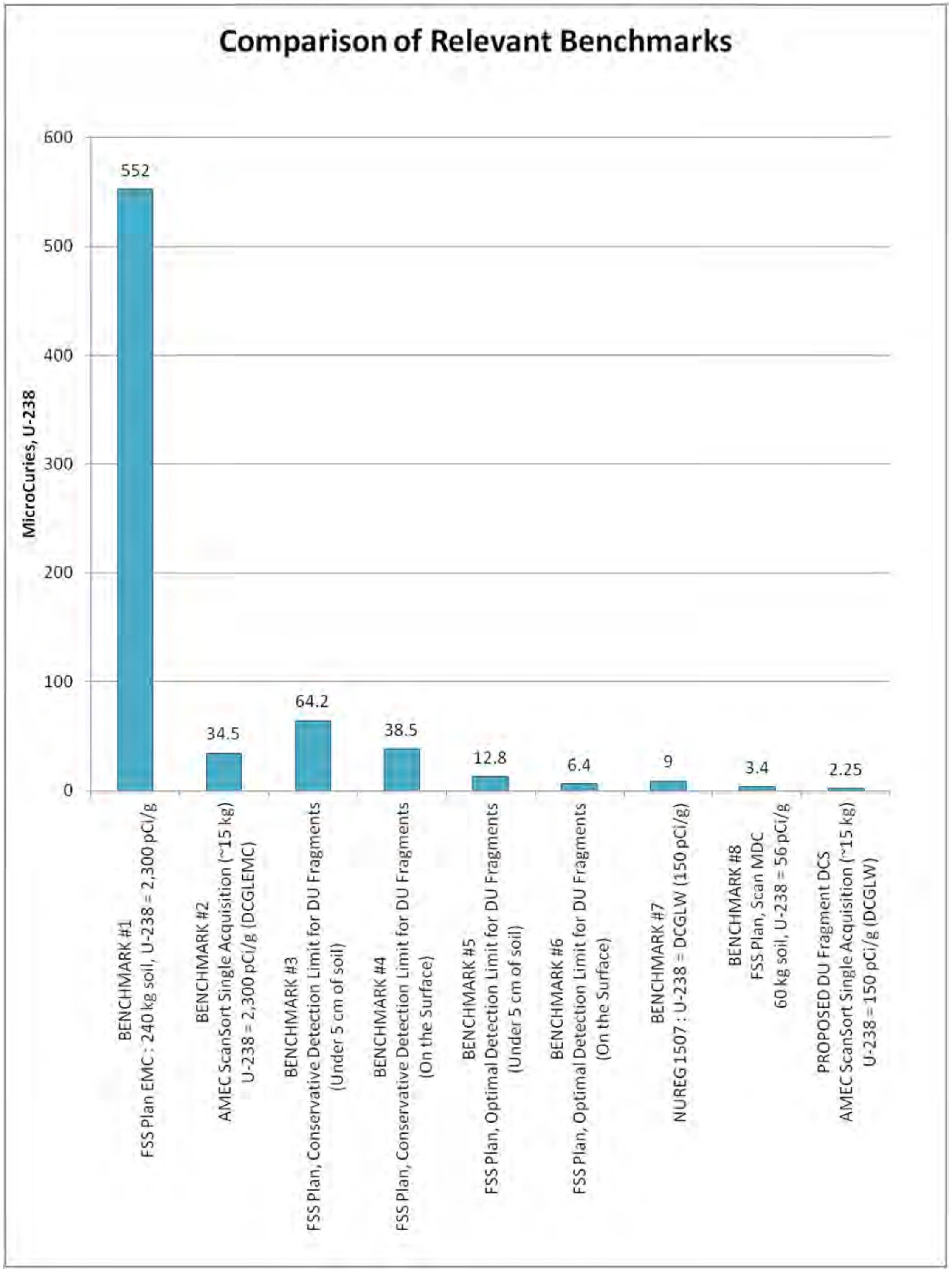

Figure 13. Comparison of Relevant Benchmarks

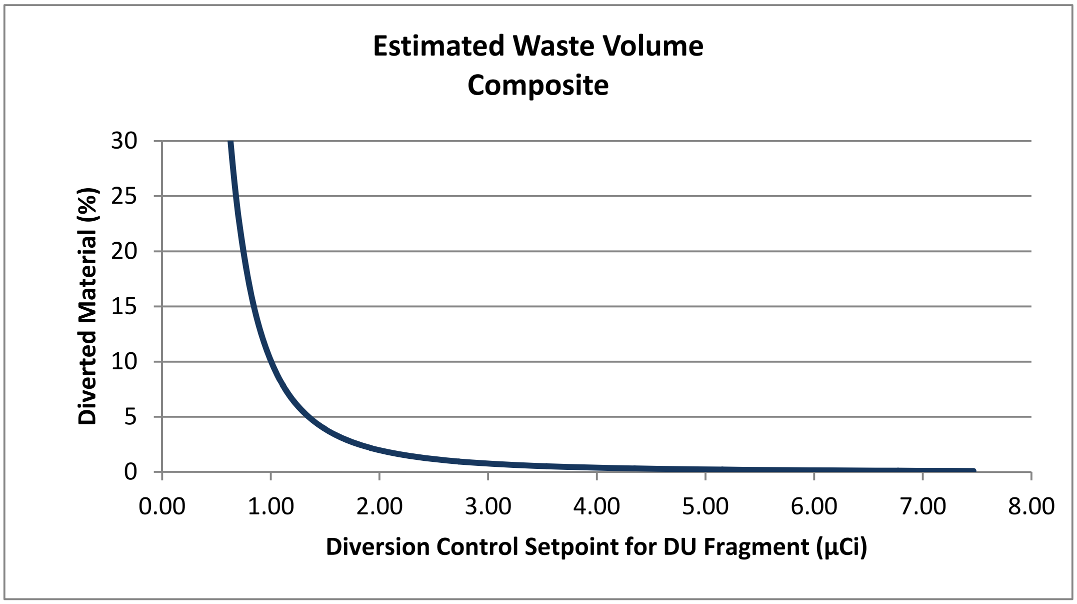

Figure 14. Waste Volume vs. DU Fragment DCS

This curve predicts that waste volumes (as a percent of total volume assayed) will likely be relatively low (given the DU fragment activities and spatial densities in soils tested during the pilot / demonstration study), likely less than 5% if the criterion for a "significant, measureable fragment of DU" is defined as 2.25 µCi or more. However, it is noteworthy to consider that the inflection point of this composite, projected waste volume estimate curve occurs between 1 and 2 µCi. Thus, two cost consequences will occur if the criterion for a "significant, measureable fragment of DU" is defined as less than ~2.25 µCi.

First, the volume of soil that will be diverted to the above criteria stockpile, which would require disposal off site as radioactive waste begins to increase exponentially. The waste transportation and disposal costs will follow the waste volume roughly proportionally.

Second, the processing rate required to confidently detect and segregate DU fragments smaller than ~2 µCi will go down, resulting in a longer timeframe required to assay the impacted soil volumes identified; however, this would result in more, and smaller, fragments being removed from the processed soils. The RA soil separation costs will be directly associated with the schedule duration and increase proportionally.

It is recommended that the USACE consider establishing 2.25 µCi as the criterion for a "significant, measureable fragment of DU" to be removed from soils assayed with the Orion *ScanSort*^{SM} system at the IAAAP, OU-8 site.

DCS: *If the DU activity in a single measurement acquisition indicates the likely presence of a DU fragment with an activity exceeding* 2.25 µCi *(U-238 as DU), then divert that single acquisition to the above criteria stockpile.*

Such a limit is reasonable and appropriate in a number of important ways:

1. It is supportive of the stated soil RG in the approved ROD.
2. It achieves the USACE's objective to remove significant DU fragments from the soil.
3. It has the added benefit of being equivalent to the activity concentration of the $DCGL_W$ (150 pCi/g [U-238 as DU]) when distributed homogeneously over a single 15 kg measurement acquisition.
4. It is conservative relative to the already approved and accepted benchmarks that were considered as benchmarks for this decision.
5. The Pilot/Demonstration Study established that the *ScanSort*^{SM} system can confidently measure and segregate soils having a single 2.25 µCi DU fragment in the least favorable measurement geometry and at reasonable and achievable target production rates that will support the existing schedule and RA plan.
6. The waste volume reduction that is anticipated at this limit is substantial, defensible, and cost efficient.

5.0 ASSESSMENT OF PROJECT OBJECTIVES AND LESSONS LEARNED

5.1 Assessment of Objectives

The purpose of the IAAAP Pilot Study project was to determine if the *ScanSort*^{SM} system could effectively detect and isolate DU fragments from bulk soil while confidently satisfying the RGs. An additional overarching objective was to determine the full-scale operational process throughput rate that could reasonably be achieved and to gauge the soil waste volume reduction that might be expected when operating in a full-scale RA mode in support of the RA stipulated in the ROD (USACE, 2011).

The key objectives as defined in the Pilot Study Test Plan are as follows:

5.1.1 Objective 1

> *Evaluate and demonstrate the ability to process and sort site-specific soils and materials (i.e., clay content, moisture, grasses, materials sizes, etc.) using the ScanSort*^{SM} *system.*

The *ScanSort*^{SM} system was shown to effectively and efficiently process and sort site-specific soils with the system configured as in the pilot study. The soils with low moisture and clay content in the soil did not significantly impact the material handling characteristics of the soil in the conveyor based system. Soils with a high moisture content did limit the rate in which the soil could be pushed through the level gate. The Screenmachine 612T trommel, with a 2.5-inch screen, proved effective at pre-conditioning the soils before feeding to the *ScanSort*^{SM} system. The feed flow onto the *ScanSort*^{SM} system's survey conveyor was smooth and efficient when the soil leveler gate on the feed hopper was set to deliver soil at a fill height of 3 inches or greater. Root masses from vegetation in near surface soils were effectively managed by tilling the surface before feeding that material.

5.1.2 Objective 2

> *Setup and calibrate the ScanSort*^{SM} *system to support characterization and release of materials below the RGs processed through the ScanSort*^{SM} *system during full-scale RA operations. The data generated during soil sorting operations should support a FSS process and evaluation based on MARSSIM guidance (EPA, 2000) for open land areas.*

The *ScanSort*^{SM} system was setup and calibrated to deliver data to support characterization and FSS release of materials processed to the "below criteria" stockpile. The calibration demonstrates that the system is adequately sensitive with respect to the RG for DU in soils to confidently demonstrate that the soil in the below criteria piles meets or exceeds the RG.

5.1.3 Objective 3

> *Demonstrate that the ScanSort^{SM} system can be an effective tool for separating DU contaminated soils having a variety of deposition characteristics and properties from across the site to ensure the soils meet the RGs for the site.*

The *ScanSort*^{SM} system was engaged in tests during the pilot study using a variety of soils selected from within the FS-12 site, which were selected to represent the expected range of deposition characteristics and properties likely to be encountered during the RA. The setpoints programmed into the *ScanSort*^{SM} system's OSS were designed to address these variables. The *ScanSort*^{SM} system proved to be effective in isolating and separating soils having measuremable and significant DU fragments, as well as diffuse radioactivity in excess of the RG from soils from surrounding soils that meet the RG.

5.1.4 Objective 4

> *Evaluate the expected overall contaminated soil volume reduction that may be achieved from soils obtained from different areas across the site, representing different levels and deposition densities of DU contamination.*

The pilot study was successful in generating data that can be used to estimate and project the magnitude of waste soil volume reduction that could be expected to be achieved. The degree of waste volume reduction is a function of the magnitude of DU fragment activity that is desirable to remove. This study shows that significant numbers of DU fragments with relatively low activity can be removed from the site's soil while reducing waste volumes to 10% or less.

5.1.5 Objective 5

> *Determine the cost effectiveness of using the soil sorting system during full-scale soil remediation activities.*

Engineering estimates provided by others indicate that soil sorting is a cost-effective alternative to the traditional "dig-and-haul" approach when it results in waste volume reductions of greater than approximately 50%. Given the waste volume reduction factors observed during the pilot study, it is clear that the *ScanSort*^{SM} system is a cost-effective tool for implementing full-scale remediation activities.

5.1.6 Objective 6

> *Determine the full-scale operational process feed rate, or planned throughput rate, that would be applicable to various soil types that will be encountered during full-scale RA.*

To achieve the best possible detection probability for a DU fragment of any activity, the system would operate with a thin soil fill height and a slow belt speed. Many options were tested during the pilot study. As stated earlier in this report, the thinnest soil fill height that does not significantly impact material handling properties is 3 inches. Belt speeds between 30 and 70 cm/s were evaluated. The process rates under these conditions range from ~40 tons per hour at 30 cm/s to ~80 tons per hour at 70 cm/s. Of course, these rates are ideal and do not take into account production efficiencies common to RAs such as this. If production efficiencies are taken into account, it can be assumed that mean production rates would range from ~200 to 400 tons per day (assuming an 8-hour work day).

5.1.7 Objective 7

> *Determine if additional operational controls and or components will be needed for the sorting system to properly implement sorting during full-scale remedial activities. Items evaluated will include the possible need for additional pre-processing equipment or procedures needed to meet the 4- to 6-inch inlet sizing requirement and/or the need for additional environmental protection components and controls (i.e., enclosure or containment systems).*

Some additional controls and safety measures for the Screenmachine 612T trommel screen plant have already been implemented. These include a “bang board” barrier to extend the height of the feed hopper, a mirror to allow the loader operator to see into the feed hopper while loading, and a new remote control operating pendant that disables the track system when the feed belt is stopped.

For extended operations, it would be advantageous to erect a sprung tent structure over the *ScanSort*^{SM} system to improve working conditions, protect the equipment from the elements, and attenuate wind-blown dust at the operator’s work stations.

Surface soils should be thoroughly tilled prior to excavation in order to break up root masses and improve material flow. Stockpiles should be covered when rain or snow is forecast to help control the moisture content of feed soils.

5.1.8 Objective 8

> *Determine the amount of contaminated soil separated from clean soils based on radiological measurements obtained by the ScanSort*^{SM} *system. These quantities will then be evaluated to ensure that DU concentrations in segregated contaminated soil can meet the applicable WAC of the selected disposal facility.*

Based on the soils that were processed in the pilot study, the mean activity concentration observed in the “above criteria” pile was consistently well below the applicable waste acceptance criteria for the designated disposal facility. In any case, the *ScanSort*^{SM} system produces a report that documents the measured mean, median, minimum, and maximum DU activity for each batch of “above criteria” produced. These values can be readily compared with the WAC to assure compliance.

5.2 Lessons Learned During Pilot Study

5.2.1 Screening Plant Maintenance

Much of the site material processed during the pilot study contained very low moisture content. This caused the soil structure to rapidly break down into relatively fine particles during pre-conditioning with the motorized mechanical-screening plant. This is desirable, as it allows the soil to better flow through the *ScanSort*^{SM} system; however, a small amount of this relatively fine material was able to collect underneath the screening plant. Over time, this material accumulated enough to impact the operability of the screening plant, and was therefore removed at that time.

To effectively remove the accumulated material, the screening plant was tracked (i.e., moved) a safe distance away to allow a front-end loader access the area. Moving the screening plant required that the plant be configured for travel prior to movement and reconfigured for operations following clean up.

A significant level of difficulty was encountered during the removal of the deposited material. The screening plant could not be tracked from its operational position due to the excessive amount of soil beneath it. Much of the soil had to be removed from beneath the plant manually before it could be moved. These difficulties would be mitigated by the inclusion of a clean out of the screening plant in the weekly maintenance of the *ScanSort*^{SM} system and supporting equipment. It is recommended that 2 to 3 hours per week be allocated to this process.

5.2.2 Soil Management Practices

The efficiency and value of this RA cannot be optimized without utilizing effective soil management practices to track, excavate, deliver (to the *ScanSort*^{SM} area), process, and remove (from the *ScanSort*^{SM} area) a given volume of flowable soil.

5.2.3 Soil Tracking

Although it is not required, there is value in correlating the *ScanSort*^{SM} system's response to a given volume of soil with the location from which that soil was excavated. Typically, soil from a known area and depth will be delivered to the *ScanSort*^{SM} system and processed (i.e., sorted) as a batch. The results of each batch (collection of measurements) can then be compared to one another in meaningful manners.

At FS-12, soil tracking could be achieved by simply assigning a two-dimensional grid system to the area to be remediated. Each grid square would then be excavated in incremental vertical lifts, resulting in a three-dimensional representative space.

5.2.3.1 DU Fragment Concentration Map

One advantage of effectively tracking batches of soil material from excavation through processing is that it allows for the production of a geospatial map representative of the concentration of discreet DU fragments in each grid volume. This allows for potential patterns to be discerned and a more complete understanding of the amount and distribution of the DU fragments at FS-12.

5.2.3.2 Determine Areal and Vertical Extent of DU Contamination

A second advantage of effectively tracking batches of soil from excavation through processing is that the resulting data can be utilized as a tool to help determine, and quite possibly predict, the areal and vertical extent of DU contamination at the site. This information would be useful to consider when planning any further RA at FS-12.

5.2.4 Discharge Point Maintenance

To optimize throughput during full *ScanSort*^{SM} operations, the soil discharge points will need to be effectively maintained. The "below criteria" discharge point will require significant effort, as 95% of the material is expected to be discharged to this side.

The radial "below criteria" stacking conveyor can be rotated along an arc, which allows for the production of two or more discharge piles. This feature provides the opportunity for simultaneous soil processing along with the removal of discharged material from the inactive region of the discharge arc. It is recommended that the "below criteria" stacking conveyor be rotated on a daily basis, and that discharged material from the previous processing shift be removed from the inactive region. This allows for the conveyor to then be returned to the original position prior to the next processing shift. Another advantage to this methodology is that the movement of the stacking conveyor can be performed simultaneously with shift startup or shutdown, again minimizing the time necessary to manage the effluent soils.

5.2.5 Moisture Control

Most of the soils processed during the pilot study had low moisture content and proved highly flowable through the *ScanSort*^{SM} system. This allowed for a uniform fill height of the survey conveyor belt. The maintenance of a uniform material fill height on the survey conveyor belt is desirable as it maximizes throughput and increases certainty in the radiological measurements.

In contrast, soils from Low Area 2, Lift 1 and High Area 2, Lift 1 with high moisture content were processed at the beginning of the pilot study. Maintaining a uniform material fill height proved challenging with these soils, as they tended to clump together and block the travel pathway out of the survey conveyor hopper. The moisture content did not affect any other process or function of the sorting system. This significantly reduced throughput, as the material had to be continually cleared from the exit point of the survey conveyor hopper.

It is recognized that soils with high moisture content have a negative impact on production rates; therefore, the soil moisture content should be minimized. This can be achieved by ensuring that excavated soils are not left exposed, particularly if precipitation is expected. It is recommended that unprocessed, excavated material be covered with plastic sheeting or tarpaulins when precipitation is forecast.

6.0 QUALTIY ASSURANCE AND CONTROL

The OU-8 RA, including this pilot study/demonstration, was performed in accordance with the approved OU-8 Work Plan (USACE, 2013a), supporting documents, associated procedures and guidance documents, and the project Quality Assurance Project Plan (QAPP). The QAPP complies with key elements of the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006). The QAPP provides specific guidance and QA/QC requirements and evaluation criteria that result in generation of environmental data that have known quality and can be used to make site-specific decisions related to the OU-8 RA.

6.1 *ScanSort*^{SM} QA/QC Measures

The soil-screening and sorting system was subject to a variety of routine QA/QC measures throughout the testing. Variables continuously monitored and recorded included the conveyor speed, soil fill height, and soil density. Source response checks on the two 2-liter NaI(Tl) detectors (2-inch × 4-inch × 16-inch) housed in the detector carrier array were performed at the beginning and end of each shift. Source response checks were performed using a 1 µCi Cs-137 source to evaluate detector efficiency and resolution. Additional spectral alignment was analyzed using both the Cs-137 peak (662 keV) and the ^{40}K peak (1,460 keV). The alignment was adjusted, as needed, after each source response check. The detector response remained extremely stable throughout the campaign.

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7.0 CONCLUSION

The pilot study/demonstration project proved to be very successful. AMEC's *ScanSort*^{SM} system demonstrated the ability to consistently detect and isolate discrete, singular DU fragments with activities greater than 2.25 µCi U-238 (which is equivalent to a fragment that is approximately 6.5g) in producing "below criteria" soil with an average bulk concentration significantly less than the soil RG (150pCi/g U-238 as DU). There is not a single lateral point in the designed measurement geometry of the system that will limit the capabilities of DU fragment detection beyond that for which it has been calibrated. During a full-scale demonstration run, processing speeds of nearly 50 tons per hour were achieved. At this process speed, the system was able to divert less than 100 lbs. (~50 kg) of soil per single DU fragment diversion. Based on the site-specific soils tested during the pilot study, the *ScanSort*^{SM} system is estimated to produce a contaminated soil volume reduction of greater than 90%.

While lower activity (i.e., smaller) DU fragments can be detected and isolated, the level of confidenence that all smaller fragments will be removed decreases as the associated radioactivity levels decrease and approach the natural background levels of the soils. In addition, the overall processing rates would increase and the resulting contaminated soil volume reduction would decrease exponentially, as indicated in Figure 14.

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8.0 REFERENCES

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Appendix A

IAAAP Pilot Test Laboratory Results for Uranium Isotopes

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Sample	Analyte	Result (pCi/g)	Method
IAAP154740 Low Area 1-001	U-234	1.16	AS
	U-234*	1.52	AS
	U-235	-0.7 U	GS
	U-235*	0.14 U	AS
	U-235	0.06 U	AS
	U-238	1.89	AS
	U-238*	3.31	AS
	U-238	3.67	GS
IAAP154741 High Area1-001	U-234	217.5	AS
	U-235	20.59	GS
	U-235	75.51	AS
	U-238	1460.00	GS
	U-238	2248	AS
IAAP154742 High Area2-001	U-234	5.51	AS
	U-235	0.36 U	GS
	U-235	0.84	AS
	U-238	26.94	GS
	U-238	23.19	AS
IAAP155853 Borrow Material Clean Soils-004	U-234	1.33	AS
	U-235	0.12 U	GS
	U-235	0.06	AS
	U-238	1.52	GS
	U-238	1.74	AS
IAAP155854 Borrow Material Clean Soils-005	U-234	1.87	AS
	U-235	0.00 U	GS
	U-235*	0.03 U	GS
	U-235	0.07	AS
	U-238*	1.55	GS
	U-238	1.05	GS
	U-238	2.2	AS
IAAP154743 Intermediate-001	U-234*	2.32	AS
	U-234	1.35	AS
	U-235	0.17 U	GS
	U-235*	0.27 U	AS
	U-235	0.06 U	AS
	U-238	15.68	GS
	U-238*	6.50	AS
	U-238	5.17	AS

Sample	Analyte	Result (pCi/g)	Method
IAAP155820 Hi-Clean-001	U-234	2.62	AS
	U-235	0.59 U	GS
	U-235	0.14 U	AS
	U-238	18.61	GS
	U-238	14.37	AS
IAAP155821 Hi-Clean-002	U-234	2.80	AS
	U-235	0.45	GS
	U-235	0.48	AS
	U-238	27.54	GS
	U-238	13.21	AS
IAAP155822 Med-Clean-001	U-234	1.72	AS
	U-235	0.02 U	GS
	U-235	0.16 U	AS
	U-238	4.02	GS
	U-238	3.88	AS
IAAP155823- Med-Clean-002	U-234	1.88	AS
	U-235	0.00 U	GS
	U-235*	0.20 U	GS
	U-235	0.17 U	AS
	U-238	3.46	GS
	U-238*	3.67	GS
	U-238	3.74	AS
IAAP155824 Dirty-High-1 Lift 122-002	U-234	1.89	AS
	U-235	0.05 U	GS
	U-235	0.23 U	AS
	U-238	7.55	GS
	U-238	7.20	AS
IAAP155825 Dirty-High-1 Lift 122-001	U-234	1.68	AS
	U-235	0.19 U	GS
	U-235	0.15 U	AS
	U-238	5.78	GS
	U-238	7.49	AS
IAAP155826 Dirty- Intermediate Lift 2-001	U-234	1.69	AS
	U-235	0.22 U	GS
	U-235	0.08 U	AS
	U-238	6.47	GS
	U-238	4.63	AS

Sample	Analyte	Result (pCi/g)	Method
IAAP155827 Dirty- Intermediate Lift 2-002	U-234	1.26	AS
	U-235	0.01 U	GS
	U-235	0.09 U	AS
	U-238	6.31	GS
	U-238	4.99	AS
IAAP155828 Clean-High Lift 122-001	U-234	2.43	AS
	U-235	0.31 U	GS
	U-235	0.51	AS
	U-238	16.00	GS
	U-238	11.19	AS
IAAP155829 Clean-High Lift 122-02	U-234	3.57	AS
	U-235	0.18 U	GS
	U-235	0.23 U	AS
	U-238	11.86	GS
	U-238	13.55	AS
IAAP155830 Clean-Intermediate Lift 122-01	U-234	1.48	AS
	U-235	0.01 U	GS
	U-235	0.18 U	AS
	U-238	3.33	GS
	U-238	4.38	AS
IAAP155831 Clean-Intermediate Lift 2-002	U-234	1.08	AS
	U-235	0.10 U	GS
	U-235*	0.07 U	GS
	U-235	0.17 U	AS
	U-238	3.12	GS
	U-238*	2.97	GS
	U-238	4.12	AS
IAAP155840 High -001	U-234*	2.44	AS
	U-234	2.16	AS
	U-235	0.20 U	GS
	U-235*	0.23	AS
	U-235	0.52	AS
	U-238	16.59	GS
	U-238*	14.49	AS
	U-238	10.98	AS

Sample	Analyte	Result (pCi/g)	Method
IAAP155841 High-002	U-234	2.42	AS
	U-235	0.36	GS
	U-235	-0.02 U	AS
	U-238	19.20	GS
	U-238	13.55	AS
IAAP155842 High-003	U-234	3.57	AS
	U-235	0.43	GS
	U-235	0.54	AS
	U-238	29.29	GS
	U-238	24.87	AS
IAAP155843 High-004	U-234	1.20	AS
	U-235	0.19 U	GS
	U-235	0.47	AS
	U-238	13.76	GS
	U-238	14.44	AS
IAAP155844 High-005	U-234	2.91	AS
	U-235	0.30	GS
	U-235	0.23 U	AS
	U-238	14.32	GS
	U-238	17.65	AS
IAAP155845 Low2-001	U-234	1.82	AS
	U-235	0.17 U	GS
	U-235	0.28	AS
	U-238	2.81	GS
	U-238	2.15	AS
IAAP155846 Low2-002	U-234	1.36	AS
	U-235	0.05 U	GS
	U-235	0.13 U	AS
	U-238	2.65	GS
	U-238	2.09	AS
IAAP155847 Low2-003	U-234	0.97	SA
	U-235	0.06 U	GS
	U-235	0.11 U	AS
	U-238	2.39	GS
	U-238	2.43	AS

Sample	Analyte	Result (pCi/g)	Method
IAAP155848 Low2-004	U-234	1.39	AS
	U-235	0.07 U	GS
	U-235	0.06 U	AS
	U-238	1.89	GS
	U-238	3.32	AS
IAAP155849 Low2-005	U-234	0.89	AS
	U-235	0.03 U	GS
	U-235	0.00 U	AS
	U-238	2.67	GS
	U-238	2.08	AS
IAAP155850 Borrow Material Clean Soil-001	U-234	1.03	AS
	U-235	0.17 U	GS
	U-235	-0.01 U	AS
	U-238	1.20	GS
	U-238	1.38	AS
IAAP155851 Borrow Material Clean Soil-002	U-234	0.99	AS
	U-235	0.10 U	GS
	U-235	0.08 U	AS
	U-238	1.11	GS
	U-238	1.41	AS
IAAP155852 Borrow Material Clean Soil-003	U-234	1.07	AS
	U-235*	0.14 U	GS
	U-235	0.09 U	GS
	U-235	0.03	AS
	U-238*	1.27	GS
	U-238	1.17	GS
	U-238	1.10	AS
AS: Alpha Spec GS: Gamma Spec * Laboratory Duplicate			

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Appendix B

USACE RESPONSES TO EPA COMMENTS on the SOIL SORTING PILOT STUDY TEST REPORT

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USACE response to EPA comments on the document "Operable Unit 8 (OU-8) Draft Soil Sorting Pilot Study Test Report", Dated January 21, 2014".

Item No.	Page/ Section	Comment	Response	Initials
1.	Executive Summary	The conclusions section of the Executive Summary describes what the report presents, but does not state the conclusions that were made after completion of the pilot study (in relation to the stated objectives). Please include the report conclusions in this section of the Executive Summary.	The conclusions have been added to the summary.	USACE
2.	3-1, Section 3.2.1	Four different areas of the site were described as being the source of samples used for the pilot study. How were the "high", "intermediate" and "low" DU soil areas defined (i.e. what were the activity level breaks used for categorization)?	The areas were identified through previously conducted site walkover surveys. An explanation has been included in Section 3.5.2.1.	USACE
3.	3-9, Section 3.5.1.2	Please describe how the background activity of 1.21 pCi/g U-238 was determined.	For the pilot test, the U-238 background activity was obtained from alpha and gamma spectroscopy analysis of representative soil obtained from a nearby burrow area. The laboratory data is included in the data tables that were added as appendix A. The actual value for the background activity has been removed from the text, so that it would not be confused with the official background activity that is listed in the ROD.	USACE
4.	3-10, Figure 6	Please explain the validity of a two-point calibration curve.	Most radiological instruments receive a single point calibration. A two-point calibration such as that used to calibrate the ScanSort system yields a known slope factor(calibration) that does not rely on the assumptions that the curve passes through zero as most calibrations do. In the relatively narrow range of activity concentrations between the two calibration data points	USACE

USACE response to EPA comments on the document "Operable Unit 8 (OU-8) Draft Soil Sorting Pilot Study Test Report", Dated January 21, 2014".

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			used, there is no reasonable expectation that the response curve would be other than linear (e.g., due to dead time or other measurement phenomenon). Furthermore, the two point calibration brackets spans the range of expected mean volumetric activity in the soil at the IAAAP site. Thus, the two-point calibration used to establish the slope (cal factor) is appropriate for this application and exceeds the requirements and practices of generally accepted approaches. Footnote has been added to this figure.	
5.	3-14, Table 4	Table 4 lists the U-238 activity and DU activity in uCi for U-238 activity (listed as uCi for Total DU activity) It is unclear at this point in the text how this relates to the remediation goal of 150 pCi/g. In the final paragraph of Section 3.5.3, the U-238 activity is listed as 2.25 uCi, implying that this is the cleanup criterion for the DU fragments. Please move (or copy) the explanation of the relationship between the U-238 activity and the remediation goal, provided in the second paragraph under Section 4.2.2 on Page 4-3, to page 3-14.	The explanation from Section 4.2.2 has been moved to section 3.5.3	USACE
6.	3-23, Section 3.5.6	What is meant by the phrase "on average" in the last sentence of Section 3.5.6? Include (or reference if already included elsewhere in the document) a table that shows results of the verification samples for each soil pile sampled.	A table displaying the concentrations of U isotopes after processing through the ScanSort has been included in Appendix A.	USACE
7.	4-2, Section 4.2.1	It is not clear why 6.5 grams of DU fragments correlates with an activity of 2.25 uCi. Please provide an explanation in the text.	Converted utilizing specific activity as described in Section 3.5.2.1.	USACE
8.	4-3, Section 4.2.2	It is not clear why the RG for DU contaminated soils is applicable to large	Following MARSSIM, the RG was derived using the RESRAD computer code, which utilizes soil	USACE

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		volumes of soils. Isn't it also applicable to small volumes of soils? Please explain or revise accordingly.	concentrations of radionuclides over the entire site. Elevated Measurement Comparison values (EMC) can be calculated by reducing the area as provided in Benchmark #1 in Section 4.2.2. Text has been changed to include this explanation.	
9.	4-3, Section 4.2.2	The second paragraph implies that a mean value can be used as a remediation goal. Please provide an explanation why a mean values could be used as a remediation goal.	Following MARSSIM for radionuclides, non-parametric statistical evaluations are performed in the decision making process with comparison of the data to the RG, with the central tendency (median) as the primary criterion. Text has been changed to include this explanation.	USACE
10.	4-5, Benchmark #9	Please discuss the validity of the apparent assumption that the soil is homogenously contaminated.	This benchmark provides a comparison to the total radioactivity that would be present in soil if it were homogenously contaminated (hypothetical).	USACE
11.	All	There appears to be an inconsistency in the production rate claims throughout the document. The Executive Summary indicates approximately 200 tons/day during an 8-hour shift; Section 5.1.6 indicates approximately 200 to 400 tons/day; and, the Conclusion indicates approximately 50 ton/hour or 400 ton/day. Review for consistency.	The text will be revised to include the ranges that were tested during the PT (200-400 tons/day)	USACE
12.	5-1, Section 5.1.1	Section indicates moisture and clay content in the soil did not significantly impact the material handling characteristics of the soil in the conveyor based system. Section 5.2.5 indicates maintaining a uniform material fill height proved challenging with high moisture soils as they clump together and block the travel pathway. Material had to be cleared from the exit point of the hopper. While the covering of excavated material may reduce soil moisture content during rain events, in-situ impacted soils may become saturated	The text has been clarified to state that soils with low moisture content had little impact during material handling, while soils with higher moisture content did limit the throughput speed. Management of soils will alleviate this concern, as material is excavated and stockpiled it is allowed to dry out.	USACE

USACE response to EPA comments on the document "Operable Unit 8 (OU-8) Draft Soil Sorting Pilot Study Test Report", Dated January 21, 2014".

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		considerably limiting progress and reduce processing speeds. Review and revise these apparent discrepancies.		
13.	3-11, Section 3.5.1.3	Section indicates that the nuclear measurement gauge is sensitive to variances in bulk soil density which includes moisture content. Based on the concerns noted in Section 5.2.5, this will limit the effectiveness of the NMG on the OSS. Indicate how the NMG operated with the high moisture content soil from Low Area 2, Lift 1 and High Area 2 and Lift 1.	NMG addresses the difference in moisture and allows the system to function properly, soil management/processing issue only as described above. Text was added to section 5.2.5 that states that the moisture content only impacted the ability for the soil to come out smoothly from the survey conveyor hopper and that it did not affect any other process or function of the sorting system.	USACE
14.	vii, Acronyms and Abbreviations	Please add ^{40}K (potassium-40) to acronyms and abbreviations. Cesium- 137 is abbreviated as Cs-137 in part of the text and ^{137}Cs in Section 6.1. The uranium isotopes are listed as U-234, U-235, and U-238. Please either use the superscripted atomic mass or list it in the "hyphen" form as the uranium isotopes are listed, for each of the isotopes mentioned in the report.	All isotopes have been put into the "hyphen" format.	USACE
15.	1-1, Section 1.0	The site is listed as being in "southeast" Iowa and in Section 1.1 on the same page, it is listed as "Southeast" Iowa. Please use one form or the other for the sake of consistency.	The location has been corrected to southeast.	USACE
16.	Section 1.1	In the first paragraph, the abbreviation listed for the Department of Defense is listed as "DOD". The normal form of the abbreviation is "DoD'. Please change the text accordingly.	All "DOD" references have been corrected to "DoD"	USACE
17.	3-5, Section 3.4 4th bullet point	The term NaI(TI) is used, but not defined (other than in the Abbreviations section). Please add the definition of this tem where it first appears in the text.	The definition has been added.	USACE

USACE response to EPA comments on the document “Operable Unit 8 (OU-8) Draft Soil Sorting Pilot Study Test Report”, Dated January 21, 2014”.

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18.	3-8. Figure 5	Please define the term “NMG” on Figure 5	The definition of NMG has been added.	USACE
19.	3-9, Section 3.5.1.1	Please define the terms Th-234, Pa-234m, Pa-234 and keV in the first paragraph..	These terms have been defined.	USACE
20.	4-4, Benchmark #3	Please define “FSS Plan” along with the reference under “Benchmark #3”.	FSS has been defined and the reference has been added.	USACE

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Appendix C

USACE RESPONSES TO IOWA DEPARTMENT OF NATURAL RESOURCES (IDNR) COMMENTS
on the
SOIL SORTING PILOT STUDY TEST REPORT

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USACE response to IDNR comments on the document “Operable Unit 8 (OU-8) Draft Soil Sorting Pilot Study Test Report”, Dated January 21, 2014”.

Item No.	Page/ Section	Comment	Response	Initials
1.	1--3/ Section 1.1.2 first paragraph	The criteria, in this case, are identified as the industrial soil RGs, as defined in Section 2.8.3 of the ROD (USACE, 2011). Table 1 of the above referenced pilot study specifies the COC as "U-238 (as DU)" and the soil RG at 150 pCi/g. However, the ROD does not list the COC as "U-238 (as DU)", instead it is noted as "DU". In the ROD, Section 2.8.3, Derivation of Remediation Goals, it is stated both the risk and dose based values were derived based on the known activity percentage of the uranium isotopes in DU (U-234, U-235 and U-238). The ROD does not state radionuclide activity of DU as only U-238; instead it should be the total activity of U-234, U-235 and U-238.	The text has been changed to accurately reflect the RG of 15- pCi/g of DU, including all of the applicable uranium isotopes (U-234, U-235, U-238). The total concentration of the three uranium isotopes was taken in consideration when evaluating the soil during the Pilot Test and Remedial Action.	USACE
2.	3-23/ Section 3.5.6 first paragrpah	Three grab samples were collected from each soil pile and sent offsite to the USACE St. Louis FUSRAP Laboratory for gamma spectroscopy analysis. In this section it was noted gamma spectroscopy was used to verify the ScanSortSM system was correctly sorting soil. In the ROD, Section 2.8.3, it states confirmation samples will be processed by alpha spectroscopy to determine the isotope concentrations of all three uranium isotopes present in DU (U-238, U-235, U-238). It is unclear if alpha or gamma spectroscopy was	Both gamma and alpha spectroscopy analysis were completed on all samples sent to the FUSRAP lab. The text has been changed to include alpha spectroscopy.	USACE

USACE response to IDNR comments on the document “Operable Unit 8 (OU-8) Draft Soil Sorting Pilot Study Test Report”, Dated January 21, 2014”.

Item No.	Page/ Section	Comment	Response	Initials
		used to determine compliance with the ROD.		
3.	3-23/Section 3.5.6 first paragraph	Results of the verification samples show the ScanSortSM system separated soils correctly and that material separated into the "below criteria" pile was, on average, below the soil RG for DU in soils. No information was supplied in the pilot strudy to support the given statement. IDNR requested and received laboratory results but the results did not include data documenting sample location, collection method, laboratory information and/or the breakdown and comparision of the laboratory data to the RG. Additional data is needed to document the claim that the remedial goals have been achieve during pilot study.	Results from the Pilot Test have been provided in Appendix A that detail gamma and alpha results from the various soil calibration piles before they were put through the ScanSortSm system and after.	USACE