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DOE/NV--1560

Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 413: Clean Slate II Plutonium Dispersion (TTR) Tonopah Test Range, Nevada

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Environmental Management Nevada Program

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CORRECTIVE ACTION DECISION DOCUMENT/ CORRECTIVE ACTION PLAN FOR CORRECTIVE ACTION UNIT 413: CLEAN SLATE II PLUTONIUM DISPERSION (TTR) TONOPAH TEST RANGE, NEVADA

U.S. Department of Energy,
Environmental Management Nevada Program
Las Vegas, Nevada

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CORRECTIVE ACTION DECISION DOCUMENT/CORRECTIVE ACTION PLAN FOR CORRECTIVE ACTION UNIT 413: CLEAN SLATE II PLUTONIUM DISPERSION (TTR) TONOPAH TEST RANGE, NEVADA

Approved by: /s/ Tiffany A. Lantow Date: 05/18/2017

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List of Acronyms and Abbreviations

General Acronyms and Abbreviations

ALARA	As low as reasonably achievable
ASTM	ASTM International
bgs	Below ground surface
BMP	Best management practice
CA	Contamination area
CAA	Corrective action alternative
CADD	Corrective action decision document
CAI	Corrective action investigation
CAIP	Corrective action investigation plan
CAP	Corrective action plan
CAS	Corrective action site
CAU	Corrective action unit
CD	Certificate of disposal
cm	Centimeter
COC	Contaminant of concern
COPC	Contaminant of potential concern
cpm	Counts per minute
CR	Closure report
CSI	Clean Slate I
CSII	Clean Slate II
CSIII	Clean Slate III
CSM	Conceptual site model
CW	Construction Worker
day/yr	Days per year

List of Acronyms and Abbreviations *(Continued)*

DoD	U.S. Department of Defense
DOE	U.S. 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
EM	Environmental Management
EPA	U.S. Environmental Protection Agency
FADL	Field activity daily log
FAL	Final action level
FD	Field duplicate
FFACO	*Federal Facility Agreement and Consent Order*
FIDLER	Field instrument for the detection of low-energy radiation
FSL	Field-screening level
FSR	Field-screening result
ft	Foot
gal	Gallon
GPS	Global Positioning System
GZ	Ground zero
HCA	High contamination area
hr/day	Hours per day
hr/yr	Hours per year
IA	Industrial Area
in.	Inch
LLW	Low-level waste

List of Acronyms and Abbreviations *(Continued)*

m	Meter
m^2	Square meter
m^3	Cubic meter
MDC	Minimum detectable concentration
M&O	Management and operating
MOB	Multiples of background
mrem	Millirem
mrem/CW-yr	Millirem per Construction Worker year
mrem/IA-yr	Millirem per Industrial Area year
mrem/yr	Millirem per year
mV	Millivolt
N/A	Not applicable
NAC	*Nevada Administrative Code*
NAD	North American Datum
NDEP	Nevada Division of Environmental Protection
NEPA	*National Environmental Policy Act*
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NNSSWAC	*Nevada National Security Site Waste Acceptance Criteria*
PAL	Preliminary action level
PCB	Polychlorinated biphenyl
pCi/g	Picocuries per gram
PPE	Personal protective equipment
PSM	Potential source material
QA	Quality assurance

List of Acronyms and Abbreviations *(Continued)*

QAP	Quality Assurance Plan
QC	Quality control
r^2	Coefficient of determination
RBCA	Risk-based corrective action
RCRA	*Resource Conservation and Recovery Act*
RMA	Radioactive material area
ROM	Rough order of magnitude
RRMG	Residual radioactive material guideline
RWMC	Radioactive waste management complex
SCL	Sample collection log
SG	Study group
TED	Total effective dose
TLD	Thermoluminescent dosimeter
TTR	Tonopah Test Range
UCL	Upper confidence limit
UR	Use restriction
USAF	U.S. Air Force
UTM	Universal Transverse Mercator
yd^3	Cubic yard
µm	Micrometer

List of Acronyms and Abbreviations *(Continued)*

Symbols for Elements and Compounds

Ag	Silver
Al	Aluminum
Am	Americium
Cm	Curium
Co	Cobalt
Cs	Cesium
Eu	Europium
Nb	Niobium
Np	Neptunium
Pu	Plutonium
Sr	Strontium
Tc	Technetium
Th	Thorium
U	Uranium

Executive Summary

This Corrective Action Decision Document/Corrective Action Plan provides the rationale and supporting information for the selection and implementation of corrective actions at Corrective Action Unit (CAU) 413, Clean Slate II Plutonium Dispersion (TTR). This document has been developed in accordance with the *Federal Facility Agreement and Consent Order*. CAU 413 is located on the Tonopah Test Range and includes one corrective action site, TA-23-02CS.

CAU 413 consists of the release of radionuclides to the surface and shallow subsurface from the Clean Slate II (CSII) storage–transportation test conducted on May 31, 1963. The CSII test was a non-nuclear detonation of a nuclear device located inside a concrete bunker covered with 2 feet of soil. To facilitate site investigation and the evaluation of data quality objectives decisions, the releases at CAU 413 were divided into seven study groups, as shown in Table ES-1.

Table ES-1
CAU 413 Study Groups

SG Number	SG Name
1	Undisturbed Areas
2	Disturbed Areas
3	Sedimentation Areas
4	Former Staging Area
5	Buried Debris
6	Potential Source Material
7	Soil Mounds

SG = Study Group

Corrective action investigation (CAI) activities, as set forth in the CAU 413 Corrective Action Investigation Plan, were performed from June 2015 through May 2016. Radionuclides detected in samples collected during the CAI were used to estimate total effective dose using the Construction Worker exposure scenario. Corrective action was required for areas where total effective dose exceeded, or was assumed to exceed, the radiological final action level (FAL) of 25 millirem per year.

The results of the CAI and the assumptions made in the data quality objectives resulted in the following conclusions:

- The FAL is exceeded in surface soil in SG1, Undisturbed Areas.
- The FAL is assumed to be exceeded in SG5, Buried Debris, where contaminated debris and soil were buried after the CSII test.
- The FAL is not exceeded at SG2, SG3, SG4, SG6, or SG7.

Because the FAL is exceeded at CAU 413, corrective action is required and corrective action alternatives (CAAs) must be evaluated. For CAU 413, three CAAs were evaluated: no further action, clean closure, and closure in place. The CAAs were evaluated on technical merit focusing on performance, reliability, feasibility, safety, and cost. Based on the evaluation of analytical data from the CAI, review of future and current operations at CAU 413, and the detailed and comparative analysis of CAAs, clean closure was selected as the preferred CAA for CAU 413 by the U.S. Air Force, Nevada Division of Environmental Protection, and U.S. Department of Energy at the CAA meeting held on August 24, 2016.

1.0 Introduction

This Corrective Action Decision Document (CADD)/Corrective Action Plan (CAP) provides the rationale and supporting information for the selection and implementation of corrective actions at Corrective Action Unit (CAU) 413, Clean Slate II Plutonium Dispersion (TTR). This document has been developed in accordance with the *Federal Facility Agreement and Consent Order* (FFACO) (1996, as amended) that was agreed to by the State of Nevada; U.S. Department of Energy (DOE), Environmental Management; U.S. Department of Defense; and DOE, Legacy Management. CAU 413 includes one corrective action site (CAS), TA-23-02CS.

CAU 413 is located on the Tonopah Test Range (TTR), which is approximately 130 miles northwest of Las Vegas, Nevada, and approximately 40 miles southeast of Tonopah, Nevada (Figure 1-1). CAU 413 consists of the release of radionuclides to the surface and shallow subsurface from the conduct of the Clean Slate II (CSII) storage–transportation test conducted on May 31, 1963. The CSII test was a non-nuclear detonation of a nuclear device located inside a concrete bunker covered with 2 feet (ft) of soil. After the test, metal and concrete debris was scraped from the ground surface and mounded/buried at ground zero (GZ). A 1.2-acre area around GZ consisting of contaminated soil, concrete, and metal was then fenced to prevent access (Burnett et al., 1964). This fence surrounded contamination with a mass concentration of 1,000 micrograms per square meter total transuranics (NNSA/NSO, 2004) and was posted with “Alpha Contamination” signs.

In 1963, the burial area at GZ was excavated to recover pieces of buried metal debris for further study (DASA, 1963; Johnson, 1963). This activity involved the removal of the earth cover and extraction of the debris using heavy equipment and hand tools, where necessary. The historical account of this activity does not include a discussion of site restoration after excavation.

In 1973, the outermost fence at the CSII site was constructed to encompass approximately 120 acres, including the area previously fenced around GZ. This outer fence was established at a surface activity level of 40 picocuries per gram (pCi/g) total transuranics (NNSA/NSO, 2004) and is currently posted with contamination area (CA) signs. This outermost fence is referred to as the “CA fence” throughout this document. Between 1969 and 1973, an additional inner fence was established; however, the radiological criteria for this fence are unknown. Figure 1-2 shows the two inner fences and the outer

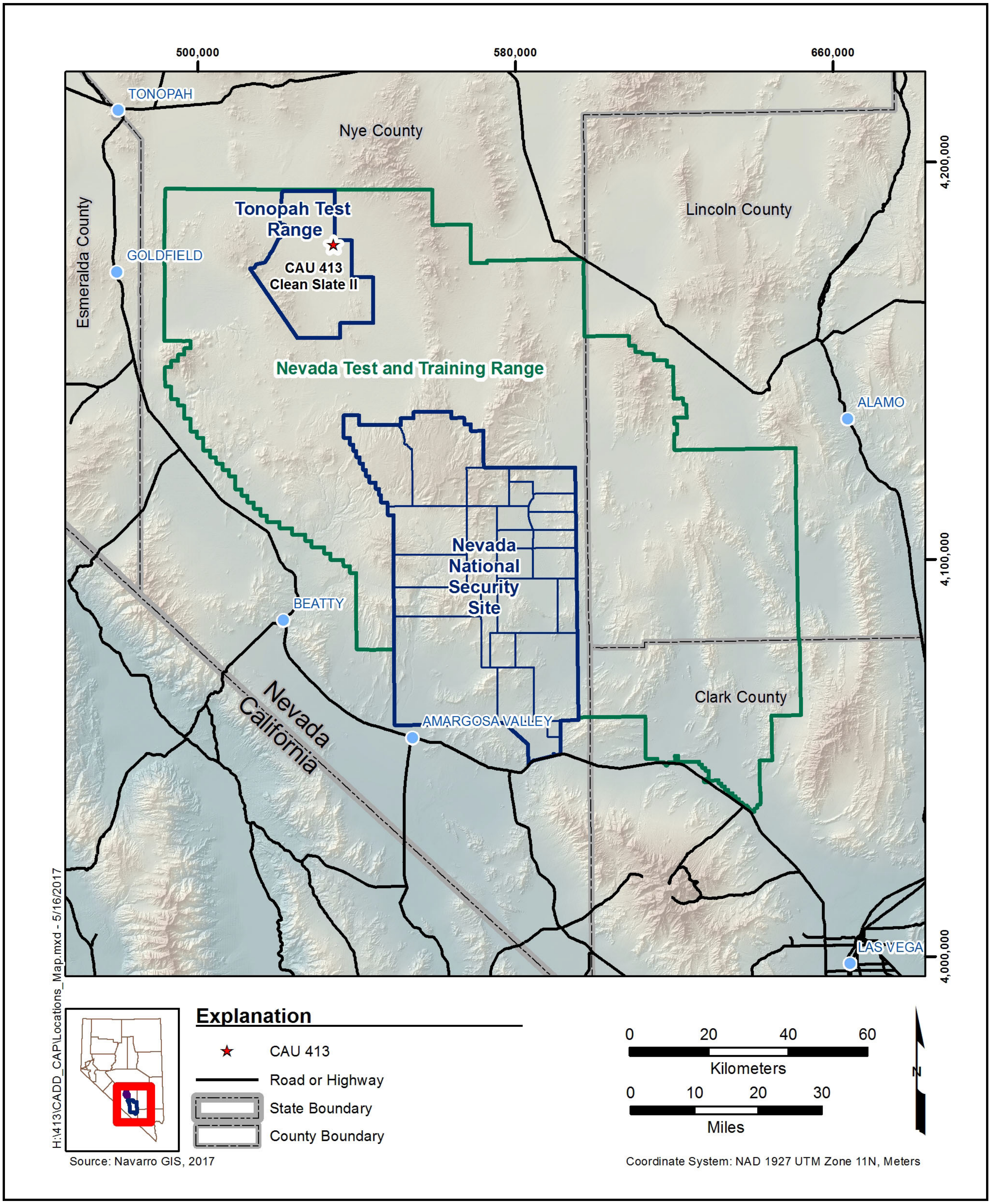

Figure 1-1
CAU 413 Location Map

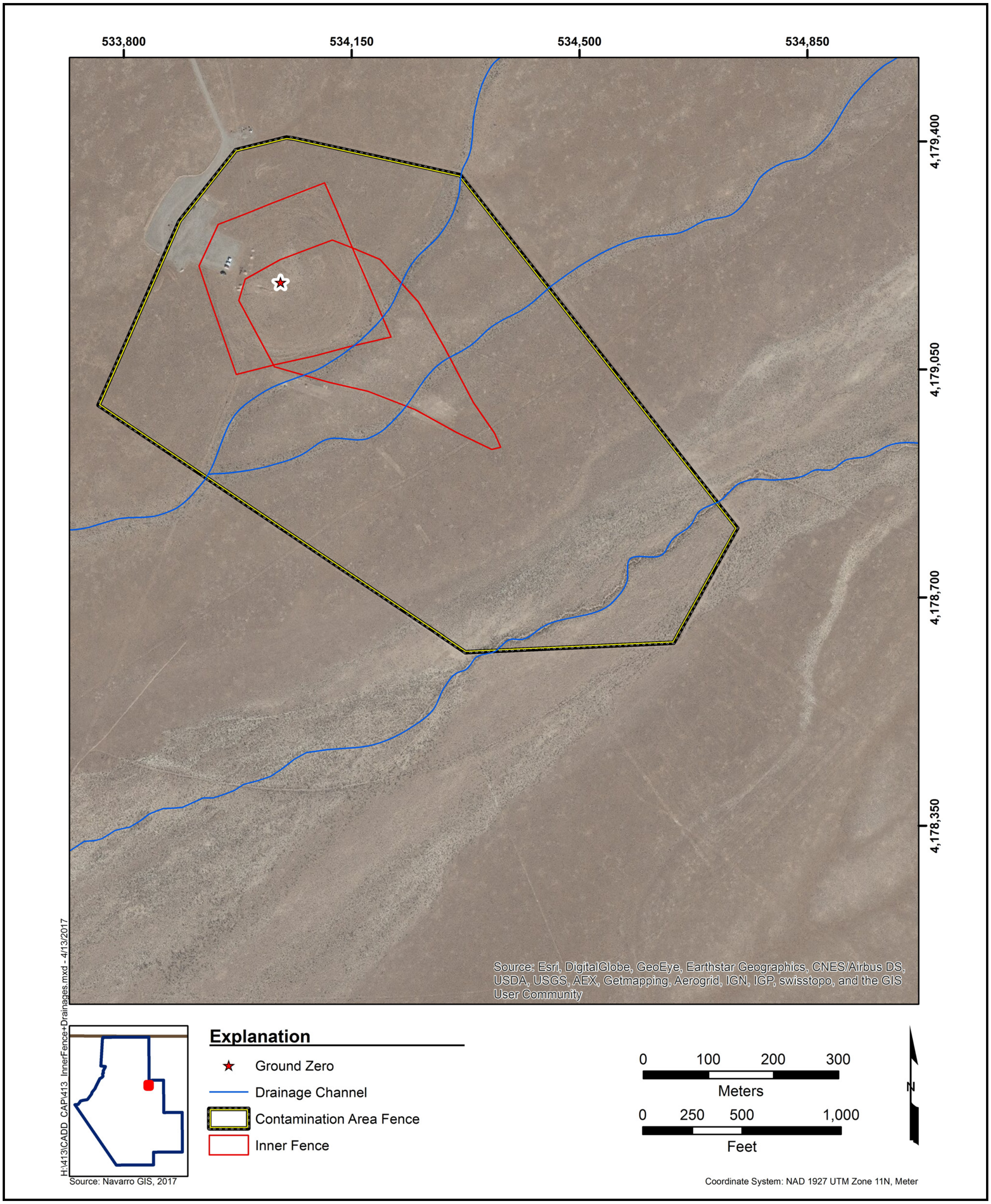

Figure 1-2
CSII Fences

CA fence at the site. The inner fences have been removed from subsequent figures throughout the document for clarity.

A detailed discussion of the history of this CAU is presented in the *Corrective Action Investigation Plan* (CAIP) *for Corrective Action Unit 413: Clean Slate II Plutonium Dispersion (TTR), Tonopah Test Range, Nevada* (NNSA/NFO, 2016c) and is not repeated herein.

1.1 Purpose

The purpose of this CADD/CAP is to present the development and evaluation of corrective action alternatives (CAAs), the rationale for the selection of preferred CAAs, and the plan for implementation of the preferred CAA for CAU 413.

1.2 Scope

The corrective action investigation (CAI) for CAU 413 was completed by demonstrating through environmental soil and thermoluminescent dosimeter (TLD) sample analytical results the nature and extent of contaminants of concern (COCs). For radiological releases, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding a final action level (FAL) of 25 millirem per year (mrem/yr). For chemical releases, a COC is defined as the presence of a contaminant above its corresponding FAL. The presence of a COC requires a corrective action. A corrective action is also required if a waste present within a release site contains a contaminant that, if released to soil, would cause the soil to contain a COC. Such a waste is considered to be potential source material (PSM) as defined in the *Soils Risk-Based Corrective Action* (RBCA) *Evaluation Process* (NNSA/NFO, 2014).

Corrective actions are planned to remove radiological contamination at levels exceeding the radiological FAL of 25 millirem per Construction Worker year (mrem/CW-yr). Verification samples will be collected to verify the completion of the corrective actions. Radiological doses presented throughout this document are a conservative estimate of maximum potential dose for FFACO closure decision-making purposes only.

1.3 CADD/CAP Contents

This CADD/CAP is divided into the following sections and appendices:

- Section 1.0, "Introduction," summarizes the purpose, scope, and contents of this CADD/CAP.
- Section 2.0, "Corrective Action Investigation Summary," summarizes the investigation field activities, the results of the CAI, and the need for corrective action.
- Section 3.0, "Evaluation of Alternatives," describes, identifies, and evaluates the steps taken to determine the preferred CAA.
- Section 4.0, "Recommended Alternative," presents the preferred CAA for CAU 413 and the rationale based on the corrective action objectives and screening criteria.
- Section 5.0, "Detailed CAP Statement of Work," discusses the plan for implementation of the preferred CAA and the methods by which the work will be verified. Also includes a discussion of the associated quality assurance (QA)/quality control (QC) and waste management requirements.
- Section 6.0, "Schedule," identifies the schedule for major corrective action activities.
- Section 7.0, "Post-closure Plan," summarizes the requirements for post-closure inspections, maintenance, and repairs.
- Section 8.0, "References," provides a list of all referenced documents used in the preparation of this CADD/CAP.
- Appendix A, *Corrective Action Investigation Results,* provides a description of the project objectives, field investigation and sampling activities, CAI results and data evaluation, waste management, and QA.
- Appendix B, *Data Assessment*, provides a data quality assessment (DQA) that reconciles data quality objective (DQO) assumptions and requirements to the CAI results.
- Appendix C, *Cost Estimates*, presents cost estimates for the construction, operation, and maintenance of the evaluated CAAs.
- Appendix D, *Evaluation of Risk*, provides documentation of the RBCA process as applied to CAU 413.
- Appendix E, *Engineering Specifications and Drawings,* are not applicable for this document because COCs will be removed and engineering controls are not needed.

- Appendix F, *Sampling and Analysis Plan,* provides the DQOs and conceptual site model (CSM) for corrective action confirmation activities.

- Appendix G, *Activity Organization*, identifies the DOE Soils Activity Lead and other appropriate personnel involved with the CAU 413 characterization and closure activities.

- Appendix H, *Sample Location Coordinates,* provides CAI sample location coordinates.

- Appendix I, *Geophysical Survey Report,* presents the results and interpretation of the geophysical surveys conducted at CAU 413.

- Appendix J, *Radiological Hot Spot Criteria,* summarizes the process for evaluation of contaminated debris and isolated areas of soil with elevated radioactivity.

- Appendix K, *Analytical Test Results*, presents the analytical results for the soil samples collected at CSII.

- Appendix L, *Nevada Division of Environmental Protection* (NDEP) comments, contains NDEP comments on the draft version of this document.

All CAI activities were performed in accordance with the following documents:

- CAIP for CAU 413, Clean Slate II Plutonium Dispersion (TTR) (NNSA/NFO, 2016c)
- Soils RBCA document (NNSA/NFO, 2014)
- *Soils Activity Quality Assurance Plan* (QAP) (NNSA/NSO, 2012)
- FFACO (1996, as amended)

All CAP activities will be performed in accordance with the following documents:

- CADD/CAP for CAU 413, Clean Slate II Plutonium Dispersion (TTR) (this document)
- Soils RBCA document (NNSA/NFO, 2014)
- Soils QAP (NNSA/NSO, 2012)
- FFACO (1996, as amended)

2.0 Corrective Action Investigation Summary

The following subsections summarize the CAI activities and results, and identify the need for corrective action at CAU 413. Detailed CAI activities and dose calculation results are presented in Appendix A. The field investigation was completed as specified in the CAIP (NNSA/NFO, 2016), with minor deviations as described in Sections A.2.1 through A.2.4.

All results are reported using the following protocol:

- Numbers were rounded to three significant digits for reporting purposes to avoid inferring more confidence in the numbers than is justified; however, the entire (unrounded) numbers were used in calculations.
- Radionuclide activities are limited to one decimal place. (i.e., there is no confidence in, or significance to, hundredths of a pCi/g).
- Dose results are limited to whole digits (i.e., there is no confidence in, or significance to, tenths of a mrem/yr).

2.1 Investigation Activities

CAI activities at CAU 413 were conducted from June 2015 through May 2016. The purpose of the CAI was to provide the additional information needed to resolve the CAU 413 DQOs and evaluate CAAs. Investigation activities included visual surveys, radiological surveys, geophysical surveys, and soil and TLD sampling. A best management practice (BMP) involving the removal of PSM was also completed during the CAI. Investigation activities were completed in accordance with the CAIP (NNSA/NFO, 2016c), except as noted in Appendix A, and in accordance with the Soils QAP (NNSA/NSO, 2012). The investigation results and the risks associated with site contamination were evaluated in accordance with the Soils RBCA document (NNSA/NFO, 2014).

To facilitate site investigation and the evaluation of DQO decisions, the releases at CAU 413 were divided into seven study groups, as shown in Table 2-1. The general investigation areas associated with the seven study groups are shown in Figure 2-1. The CAI investigation activities are summarized in the study-group-specific sections below; the dose calculation results of the CAI are summarized in Section 2.2 and discussed in detail in Appendix A.

Table 2-1
CAU 413 Study Groups

SG Number	SG Name
1	Undisturbed Areas
2	Disturbed Areas
3	Sedimentation Areas
4	Former Staging Area
5	Buried Debris
6	Potential Source Material
7	Soil Mounds

SG = Study Group

2.1.1 SG1, Undisturbed Areas

The Undisturbed Areas at CAU 413 include those areas that were defined in the CAU 413 DQOs and documented in the CAU 413 CAIP (NNSA/NFO, 2016c) as not impacted by post-test operations, exclusive of the areas defined by other study groups. Although SG1 has no precise boundary, the general extent of the investigation is shown on Figure A.3-1 by eight soil sample and TLD plots located inside the CA fence line; these are generally distributed from approximately 100 to 1,200 ft south and southeast of GZ. It is assumed that contamination from the CSII test deposited at these locations has not been mechanically disturbed since the time of the test. Because the contamination associated with SG1 is assumed to exceed the radiological FAL, the CAI activities for this study group were focused on defining corrective action boundaries. All of the CAI activities were completed as specified in the CAU 413 CAIP for SG1 including field instrument for the detection of low-energy radiation (FIDLER) and removable contamination surveys, and surface soil and TLD sampling.

Site-wide radiological surveys using a FIDLER were completed at CAU 413 in 2012. Additional FIDLER surveys were completed during the CAI to better define the distribution of contamination at the site, particularly in the areas surrounding GZ where existing FIDLER data were sparse. These FIDLER data were not used for decision making (e.g., hot spot determinations) but as relative values (i.e., decision-supporting data).

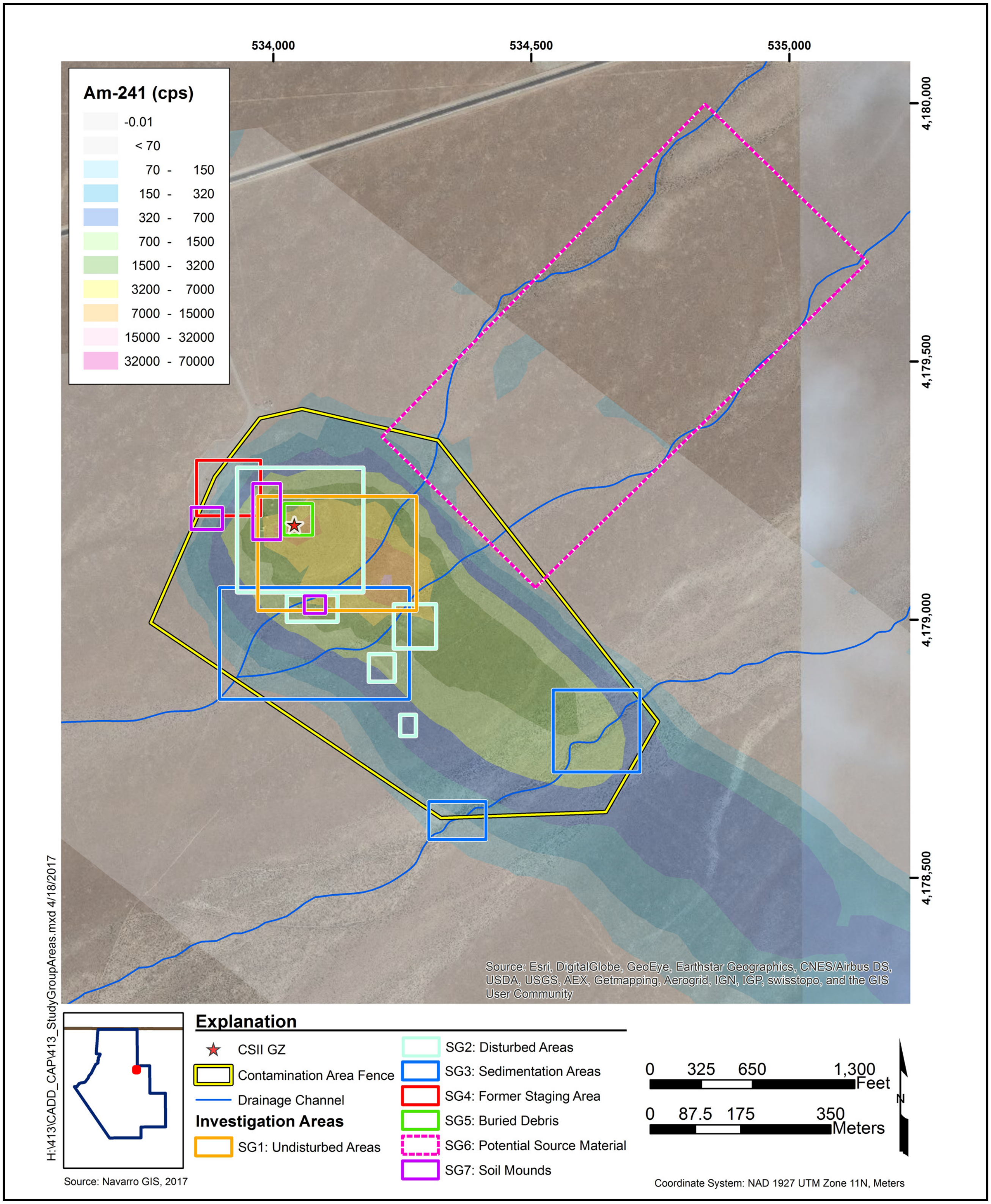

Figure 2-1
General Investigation Areas Associated with Study Groups

Removable alpha contamination surveys were also completed at CAU 413 to determine conditions within the fences at the site. These surveys were completed using the "stomp and tromp" methodology, which uses swipe samples of the ground surface to determine the activity of removable radioactive material in the soil in units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). It was assumed in the CAIP that locations meeting high contamination area (HCA) conditions (i.e., 2,000 dpm/100 cm^2) exceed the dose-based FAL and require corrective action (NNSA/NFO, 2016c).

Nine soil sample plots were established in areas of varying contamination levels identified by the 1996 KIWI and 2012 FIDLER surveys (NSTec, 2009). Two of these locations were located in SG2, Disturbed Areas but were included in the evaluation of SG1because no buried COCs were present in SG2 (see Section 2.2.1.2). One additional sample plot was established on the east side of the site outside the CA fence based on the identification of elevated FIDLER readings associated with the CAI for SG6. Four composite soil samples were collected from each of the sample plots and analyzed for gamma spectroscopy; plutonium (Pu)-241; and isotopic uranium (U), Pu, and americium (Am). One TLD was also staged at each plot.

The resolution of the DQO decision on the presence of COCs for this study group was not based on any data generated during the investigation but rather an assumption that COCs are present. This was agreed to in the DQO meeting with the CAU 413 stakeholders. Because no data were used to resolve this decision, there are no Decision I decisional data for SG1.

The resolution of the DQO decision on the extent of COC contamination for this study group was based on TLD and analytical soil sample results. Therefore, the TLD and analytical data are considered decisional data. The sample locations were selected from varying relative contamination levels using the relative spatial distribution of contamination that was derived from the FIDLER radiological survey. This use of the FIDLER radiological survey data meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). The analytical data were supplemented with information about the relative spatial distribution of contamination that was derived from radiological survey data to better define the corrective action boundary. This use of the FIDLER radiological survey data meets the definition of decision-supporting data as defined in the Soils QAP.

The corrective action boundary was expanded to include areas where HCA conditions were present outside the corrective action boundary. Although the determination of HCA conditions is very imprecise, as explained in Section 5.1.2, the initial corrective action boundaries were established for the purpose of planning. Actual corrective action boundaries will be revised based on verification soil sample results that will determine whether additional excavation is required or provide verification that the corrective action is complete. Therefore, actual corrective action boundaries may be smaller or larger than estimated herein. The corrective action boundaries were expanded to include HCA conditions because a dose to a potential receptor could not be estimated for the removable contamination. The HCA criterion does not represent dose and is used only as an indicator of when an assumption that dose exceeds the FAL may be appropriate in the absence of dose information associated with removable contamination. HCA criteria are not a basis for determining whether COCs are present; they are an additional consideration for making a conservative assumption of the need for corrective action where it cannot be determined whether COCs are present. The decision to include the additional area where HCA conditions exist is not based on dose information but rather a conservative assumption based on the presence of HCA conditions. This decision is consistent with other Soils release sites where corrective action is assumed to be necessary when the sites cannot be investigated to demonstrate that contamination information meets the definition of decision-supporting data as defined in the Soils QAP.

2.1.2 SG2, Disturbed Areas

This study group includes five areas defined in the CAU 413 DQOs and documented in the CAU 413 CAIP (NNSA/NFO, 2016c) as areas where it is likely that contamination originally deposited by the test was redistributed by activities that occurred immediately after, and in the years following, the test (see Figure A.4-1). The DQO Decision I was to determine whether COCs are present below the ground surface. COCs present in SG2 surface soil were evaluated in SG1 Decision II (resolution of the extent of surface COC contamination). All of the CAI activities were completed as specified in the CAU 413 CAIP, including radiological surveys at each disturbed area using a FIDLER, depth screening at each sample location using an alpha/beta detector, and soil sampling. No additional disturbed areas were identified during the CAI.

Before sampling, FIDLER surveys were completed within each disturbed area to further bias the sample locations to the area with the most elevated radiological readings.

At each SG2 sample location, the surface soil sample (0 to 5 centimeters [cm]) was collected for laboratory analyses, and soil depth screening was conducted to determine the presence of buried contamination. Soil samples were collected at 5-cm intervals to a depth of 30 cm below ground surface (bgs) and field screened for radioactivity. Only one subsurface soil sample exceeded the depth screening criteria for submitting a laboratory sample, as described in Section A.8.2.1 of the CAIP. The SG2 samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am.

The resolution of DQO Decision I for SG2 was based on analytical soil sample results. Therefore, the analytical data are considered decisional data. The sample locations were selected from most elevated radiological readings using the relative spatial distribution of contamination that was derived from the FIDLER radiological survey. Depth samples to be submitted for analyses were selected at each location based on the relative differences of FIDLER readings between the surface soil and subsurface soil as described in Section A.8.2.1 of the CAIP. This use of the FIDLER radiological survey data for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified in the subsurface, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved.

2.1.3 SG3, Sedimentation Areas

This study group was defined in the CAU 413 CAIP (NNSA/NFO, 2016c) as sedimentation areas within drainage channels where sediment has visibly accumulated (see Figure A.5-1). The CAI confirmed the presence of the three drainage channels identified in the CAIP; no additional drainage channels or surface water conveyances were identified during the CAI. All CAI activities specific to SG3 were completed as specified in the CAU 413 DQOs and documented in the CAU 413 CAIP, including visual surveys to identify sediment accumulation areas, radiological surveys using a FIDLER, depth screening at sample locations, and soil and TLD sampling.

A total of 12 accumulation areas within the three drainage channels were identified and sampled. FIDLER surveys were used to bias the sample locations within each accumulation area to the most radiologically elevated location. To estimate internal dose, a total of 15 soil grab samples were collected from 12 locations within SG3. At each accumulation area, soil samples were collected at 5-cm intervals to a depth of 30 cm bgs and field screened for radioactivity. The surface soil sample from each location was submitted for laboratory analyses; two subsurface soil samples exceeded the depth screening criteria for submitting a laboratory sample. The SG3 samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am. To measure external dose, one TLD was placed at a height of 1 meter (m) at the center of each SG3 sample location, with two exceptions (see Section A.5.4).

The resolution of the DQO decision on the presence of COCs for this study group was based on TLD and analytical soil sample results. Therefore, the TLD and analytical data are considered decisional data. The sample locations were selected from most elevated radiological readings using the relative spatial distribution of contamination that was derived from the FIDLER radiological survey. Depth samples to be submitted for analyses were selected at each location based on the relative differences of FIDLER readings between the surface soil and subsurface soil as described in Section A.8.2.1 of the CAIP. This use of the FIDLER radiological survey data for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved.

2.1.4 SG4, Former Staging Area

The Former Staging Area was defined in the CAU 413 CAIP (NNSA/NFO, 2016c) as a visibly distinct area of fill material northwest of the GZ (see Figure A.6-1). The staging area was used previously to stage radioactively contaminated equipment and materials. All of the CAI activities were completed as specified in the CAU 413 DQOs and documented in the CAU 413 CAIP, including soil sampling underneath the fill material at two locations within the staging area. The SG4 samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am.

The resolution of the DQO decision on the presence of COCs for this study group was based on analytical soil sample results. Therefore, the analytical data are considered decisional data. The sample locations were biased using visual and geographical information because the former staging area is a distinct feature visible in aerial photographs of the site and is readily distinguishable from surrounding soil. Within the former staging area, the two grab sample locations were selected on the edge closest to GZ. Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved.

2.1.5 SG5, Buried Debris

This study group is defined in the CAU 413 CAIP (NNSA/NFO, 2016c) as contaminated debris and soil that was buried at GZ after the CSII test (see Figure A.7-1). It was assumed that the contaminated buried debris and soil in SG5 exceeds the radiological FAL. Thus, the objective of CAI activities specified in the CAU 413 DQOs was to determine the lateral and vertical extent of buried debris. CAI activities conducted at SG5 were limited to geophysical surveys in the debris burial area.

The resolution of the DQO decision on the presence of COCs for this study group was not based on any data generated during the investigation but rather on an assumption that COCs are present. This assumption was agreed to in the CAU 413 DQOs with the CAU 413 stakeholders.

The resolution of the DQO decision on the extent of COC contamination for this study group is based on visual identification of buried debris and the collection of soil samples. Therefore, the visual survey and analytical data are considered decisional data. Locations for the excavation to identify buried debris is biased to information from the geophysical survey presented in Appendix I. Locations for the collection of soil samples from the edges of the excavation are biased to the most elevated radiological readings using the relative spatial distribution of contamination derived from a FIDLER radiological survey. This use of the geophysical survey and the FIDLER radiological survey data for biasing locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012).

2.1.6 SG6, Potential Source Material

The scope of SG6, Potential Source Material was defined in the CAU 413 CAIP (NNSA/NFO, 2016c) as material present at a site that contains radiological and/or chemical contaminants that, if released, could cause the surrounding environmental media to contain a COC (NNSA/NFO, 2014). The only PSM identified and investigated at the CAU 413 site is radiologically contaminated metal pieces and concrete debris associated with the 1963 CSII test. All of the CAI activities were completed as specified in the CAU 413 DQOs and documented in the CAU 413 CAIP, including visual surveys and radiological surveys using the FIDLER (see Figure A.8-1).

Based on debris noted in previous site visits, aerial survey data, and historical documents presented in the CAIP, visual surveys were concentrated in the area outside the CA fence to the east of GZ (herein referred to as the debris investigation area). Fifty-nine locations with visible debris (metal, concrete) on the ground surface were identified in the visual survey at CAU 413.

A comprehensive FIDLER survey was completed of the debris investigation area outside the CA fence. The FIDLER data were used to bias additional locations with elevated radioactivity that did not necessarily contain visible debris. Fifty-one such areas were identified during the FIDLER surveys.

The resolution of the DQO decision on the presence of COCs for this study group was based on FIDLER survey results of hot spots compared to the Radiological Hot Spot Criteria as described in Appendix J. Therefore, the FIDLER survey data are considered decisional data. Hot spots were determined from visible debris identified during a visual survey as well as from the most elevated radiological readings using a relative spatial distribution of contamination derived from the FIDLER radiological survey. This use of the visual and FIDLER radiological surveys for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved.

2.1.7 SG7, Soil Mounds

This study group was defined in the CAU 413 CAIP (NNSA/NFO, 2016c) as 10 visible soil mounds identified during previous investigations at the CSII site (see Figure A.9-1). Eight of the mounds are believed to be associated with a technology demonstration project conducted at the site in 1998; the other two are believed to be topsoil reserved for use in site revegetation. All CAI activities were completed as specified in the CAU 413 DQOs and documented in the CAU 413 CAIP, including soil and TLD sampling.

Two grab samples were collected at each soil mound; one from the surface of the mound (0 to 15 cm) and the other from the mound interior (15 to 30 cm from the mound surface). The SG7 samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am. One TLD was installed in the center of each mound at a height of 1 m above the mound surface.

The resolution of the DQO decision on the presence of COCs for this study group was based on TLD and analytical soil sample results. Therefore, the TLD and analytical data are considered decisional data. The sample locations were selected from random locations within the soil mounds. Therefore, no data were used for selecting soil sample locations that meet the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved.

2.2 Results

The following subsections summarize the results of the CAI for each study group. Additional detail may be found in the study-group-specific sections of Appendix A. For all study groups except SG5, the dose a receptor would receive from site contamination was compared to the radiological FAL (defined in Appendix D) to determine whether corrective action is necessary. As stated in the CAIP, for SG5 (Buried Debris) (NNSA/NFO, 2016c), it was assumed that the FAL was exceeded, so sample data were not collected.

As detailed in Appendix D, the radiological FAL of 25 mrem/yr is based on the Construction Worker (CW) exposure scenario (as specified in the CAU 413 DQOs), which assumes the most exposed worker is an adult construction worker who works at the site for 120 days per year (day/yr), 8 hours per day (hr/day), for a total of 960 hours per year (hr/yr). The construction worker spends an average of 6 hr/day outdoors, and 2 hr/day indoors during the work day. Radiological doses calculated for SG1, SG2, SG3, SG4, and SG7 are a conservative estimate of maximum potential dose for FFACO decision-making purposes only. These estimated doses were compared to the radiological FAL based on an area of contamination of 1,000 square meters (m^2). To determine whether corrective action is necessary at small areas of contamination (such as SG6 locations), the FIDLER survey data were evaluated against the hot spot criteria defined in Appendix J, which is based on an area of contamination of 1 m^2. Removable contamination is another consideration in determining whether corrective action is necessary at CAU 413. If removable alpha radioactive contamination is present that exceeds the HCA criterion of 2,000 dpm/100 cm^2 as stated in the CAIP (NNSA/NFO, 2016c), it is assumed the radiological FAL is exceeded and corrective action is required. A summary of the FAL basis and assumptions for each study group is presented in Table 2-2.

Table 2-2
FAL Basis and Assumptions for CAU 413 SGs

SG	Description	FAL	Basis/Assumption	Reference
1	Undisturbed Areas	25 mrem/CW-yr	1,000-m^2 area of contamination	Soils RBCA (NNSA/NFO, 2014)
2	Disturbed Areas			
3	Sedimentation Areas			
4	Former Staging Area			
5	Buried Debris		Assumed FAL was exceeded	CAIP (NNSA/NFO, 2016c)
6	Potential Source Material		1-m^2 (hot spot) area of contamination	Appendix J
7	Soil Mounds		1,000-m^2 area of contamination	Soils RBCA (NNSA/NFO, 2014)

In accordance with the CAU 413 DQOs, as no chemical contamination biasing factors were identified at CAU 413, no chemical analyses were completed on CAI samples.

2.2.1 Data Summary

The following subsections present a summary of the computational results for soil and TLD samples from each study group.

2.2.1.1 SG1, Undisturbed Areas

A total of 10 soil sample plots were established in areas of varying contamination levels at CAU 413 (see Figure A.3-1). A TLD was also staged at each plot to estimate external dose. The 95 percent upper confidence limit (UCL) of the average total effective dose (TED) exceeds the FAL of 25 mrem/CW-yr at locations C11, C12, and C14.

A total of 66 removable contamination swipe samples were collected to determine whether HCA conditions were present outside the estimated 25-mrem/CW-yr boundary (see Figure A.3-2). The HCA criterion of 2,000 dpm/100 cm^2 was exceeded at seven sample locations.

The CSM for CAU 413 is fully described in the CAIP (NNSA/NFO, 2016c). The contamination pattern of the radionuclides at CAU 413 is consistent with the CSM in that the radiological contamination is greatest at the release point and generally decreases with distance from the source. Information gathered during the CAI supports and validates the CSM as presented in the CAIP. No modification to the CSM was needed.

2.2.1.2 SG2, Disturbed Areas

A total of five surface soil samples and one subsurface soil sample were collected in SG2 (see Figure A.4-1). As stated in the CAIP (NNSA/NFO, 2016c), the primary objective of the SG2 investigation was to determine whether COCs are present below the ground surface at any of the five disturbed areas. Radiological field-screening results (FSRs) suggested the presence of buried contamination at one location. One surface and one subsurface soil sample were collected at this location. Subsurface contamination levels in SG2 did not exceed surface contamination levels and did not exceed the radiological FAL. However, the 95 percent UCL of the TED at the surface of location C11 exceeded the FAL of 25 mrem/CW-yr and was included in determining the extent of COC contamination for SG1.

The CSM assumed that subsurface contamination was not likely to be present at any of the SG2 locations at activities higher than that of the surface. The analytical data, and resulting dose, from the single location where field screening indicated the potential for buried contamination confirms this CSM assumption. Thus, no modification to the CSM was needed.

2.2.1.3 SG3, Sedimentation Areas

A total of 13 surface soil samples (including one field duplicate [FD]), and two subsurface soil samples were collected within the three drainages at SG3 (see Figure A.5-1). With the exception of two locations (see Section A.5.2), a TLD was also placed at each sample location. Radiological field screening suggested the presence of buried contamination at two SG3 locations (C23 and C28);

however, the calculated subsurface soil dose was below the FAL at both locations. The TED at all SG3 sample locations within drainage channels at CAU 413 was below the FAL of 25 mrem/CW-yr.

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2016c). Information gathered during the CAI supports the CSM as presented in the CAIP. No modification to the CSM was needed.

2.2.1.4 SG4, Former Staging Area

A total of three grab soil samples (including one FD) were collected from two locations within the former staging area (see Figure A.6-1). The purpose of sampling at SG4 was to determine whether radioactive contamination deposited on the surface by the CSII test had been covered over during construction of the staging area. In accordance with the CAIP (NNSA/NFO, 2016), the visible fill material was removed from each location before sample collection to ensure the samples consisted of soil. The TED did not exceed the FAL (25 mrem/CW-yr) at either of the two sample locations in SG4. The low doses calculated at the two SG4 locations confirm historical documentation that indicates the former staging area was scraped before construction, rather than placed on top of existing contamination (NNSA/NSO, 2004).

The CSM assumed that the upper layer of native soil was removed as part of the construction of the former staging area and then covered with gravel and compacted. Information gathered during the CAI supports and validates this assumption; thus, no modification to the CSM was needed.

2.2.1.5 SG5, Buried Debris

The CAIP (NNSA/NFO, 2016c) assumed that the contaminated debris and soil buried near GZ at CAU 413 exceeded the FAL of 25 mrem/CW-yr. Geophysical surveys were conducted to determine the lateral and vertical extent of the buried debris/soil (see Figure A.7-1). It is not likely that there would be significant amounts of metal buried deeply because this would have elevated overall readings above background. In addition, no anomaly was estimated to be deeper than 1 m. In any case, the geophysical surveys are only used as a starting point for excavation locations to visually determine the presence and depth of buried debris. The two most prominent features detected include a small cluster of metal debris and a linear feature of disturbed earth/metallic debris. The geophysical survey results are presented and discussed in Appendix I.

The CSM assumed the presence of buried debris near GZ, which was confirmed by the geophysical surveys completed during the CAI. Therefore, no modification to the CSM was needed.

2.2.1.6 SG6, Potential Source Material

A total of 110 locations containing visible debris and/or soil with elevated FIDLER measurements were identified during the debris investigation (see Figures A.8-2 and A.8-3). Note that the debris described in Appendix F of the CAIP had been previously removed from the site, as described in the CAIP (NNSA/NFO, 2016c). As discussed in the CAIP, contaminated debris (concrete, metal) was discovered up to 2,500 ft from GZ to the east. A faded black substance consisting of plutonium and depleted uranium was fused to the concrete and metallic debris. It is likely that the contaminated debris comprises pieces of the bunker interior that were exposed to molten metal from the test device during detonation. A photograph of one of the concrete debris pieces is provided in Figure 2-2. No hot spots exceeded the debris hot spot criterion (see Appendix J). Therefore, no corrective actions were required for the debris. However, as a BMP, all debris in excess of the soil hot spot criterion were removed from the debris investigation area during the CAI. An approximately 120-m^2 area of soil with elevated FIDLER readings was identified for which the soil hot spot criterion is not applicable (the hot spot criterion is for areas less than 1 m^2). This area was evaluated as part of SG1 using the more conservative area-based residual radioactive material guidelines (RRMGs) to determine whether the 25-mrem/CW-yr FAL was exceeded. One soil sample plot and one TLD were established at the current RMA location (sample location C29); the results are discussed with SG1 in Section A.3.2.

After debris was removed, removable contamination swipes were collected from the ground surface at each location to ensure that the remaining soil did not present HCA conditions (i.e., alpha removable contamination at levels above 2,000 dpm/100 cm^2). None of the locations presented HCA conditions after the radiologically contaminated debris was removed. A post-removal FIDLER survey (see Figure A.8-3) was also conducted to determine whether remaining soil was below the soil hot spot criterion established in Appendix J. No post-removal survey results exceeded the soil hot spot criterion.

Figure 2-2
Concrete Debris at CSII

The CSM and associated discussion for this study group are provided in the CAIP (NNSA/NFO, 2016c). Information gathered during the CAI supports and validates the CSM; therefore, no modification to the CSM was needed.

2.2.1.7 SG7, Soil Mounds

Two composite samples were collected from each of the 10 soil mounds (see Figure A.9-1). One sample was from the surface of the mound, and the other was from the mound interior. One TLD was installed at the center of each mound at a height of 1 m above the mound surface. The calculated doses for the mound surface and interior were very similar, supporting the CSM assumption that contamination in the mounds is evenly distributed. The TED did not exceed the FAL of 25 mrem/CW-yr at any sampled location within SG7.

The CSM assumed that the soil within each mound was homogenous. The sample data collected during the CAI supports this assumption; therefore, no modification to the CSM was needed.

2.2.2 Data Quality Assessment Summary

The DQA is presented in Appendix B and includes an evaluation of the data quality indicators (DQIs) to determine the degree of acceptability and usability of the reported data in the decision-making process. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

The DQA process is composed of the following five steps:

1. Review DQOs and Sampling Design.
2. Conduct a Preliminary Data Review.
3. Select the Test.
4. Verify the Assumptions.
5. Draw Conclusions from the Data.

The results of the DQI evaluation in Appendix B show that all DQI criteria were met and that the CAU 413 dataset supports the intended use in the decision-making process. Based on the results of the DQA, the nature and extent of COCs at CAU 413 have been adequately identified to develop and evaluate CAAs. The DQA also determined that information generated during the investigation supports the CSM assumptions, and the data collected met the DQOs.

2.3 Need for Corrective Action

For CAU 413, there are two considerations for determining whether COCs are present and the FAL is exceeded: (1) area-based RRMGs based on 1,000 m^2 and (2) hot spot RRMGs based on 1 m^2. The presence of a COC requires a corrective action. A corrective action was also determined for areas meeting HCA conditions because radiological dose was assumed to exceed the FAL within these areas.

As stated in the CAIP (NNSA/NFO, 2016c), it is assumed that the radiological FAL is exceeded at SG1. CAI activities and results are presented in Section A.3.0. The boundary within which the FAL is exceeded was determined from FIDLER survey results that were correlated to TED measurements.

The correlation graph, FIDLER surface, and resulting 25-mrem/CW-yr boundary for CAU 413 are shown in Figure 2-3. Corrective action is required for the areas within the estimated 25-mrem/CW-yr boundary.

A total of 66 removable contamination swipe samples were collected to determine whether HCA conditions were present outside the estimated 25-mrem/CW-yr boundary. The HCA criterion of 2,000 dpm/100 cm^2 was exceeded at seven sample locations (Figure 2-3). As stated in the CAIP, it is assumed that the radiological FAL is exceeded at those locations where removable contamination values are in excess of the HCA criterion. Therefore, the corrective action boundary was expanded to include these locations.

At SG2, there is no subsurface contamination present at levels exceeding the FAL, and there is no subsurface contamination present at levels greater than that found in the surface soil. Therefore, Decision I was resolved that no COCs are present in subsurface soils at SG2, and no corrective action is required for SG2. However, contamination present in SG2 surface soil samples was evaluated in SG1 Decision II (resolution of the extent of surface COC contamination). CAI activities and results are presented in Section A.4.0.

Because the FAL was not exceeded at any surface or subsurface sample location within SG3, SG4, SG6, or SG7, no corrective action is required for these study groups. CAI activities and results are presented in Sections A.5.0, A.6.0, A.8.0, and A.9.0, respectively.

As stated in the CAIP, it is assumed that the radiological FAL is exceeded at SG5. The boundary within which the FAL is assumed to be exceeded was determined from geophysical surveys in the debris burial area. The objective of surveying the burial area during the CAI was to confirm the locations of buried debris and obtain data to estimate the depth of burial at each location. The geophysical survey areas, the locations of buried debris/features, and the resulting corrective action boundary are shown in Figure 2-4. CAI activities and results are presented in Section A.7.0.

An evaluation of CAAs is required for all releases that require a corrective action. The CAAs are identified in Section 3.0 and were evaluated for their ability to ensure protection of the public and the environment in accordance with *Nevada Administrative Code* (NAC) 445A (NAC, 2014a), feasibility, and cost-effectiveness.

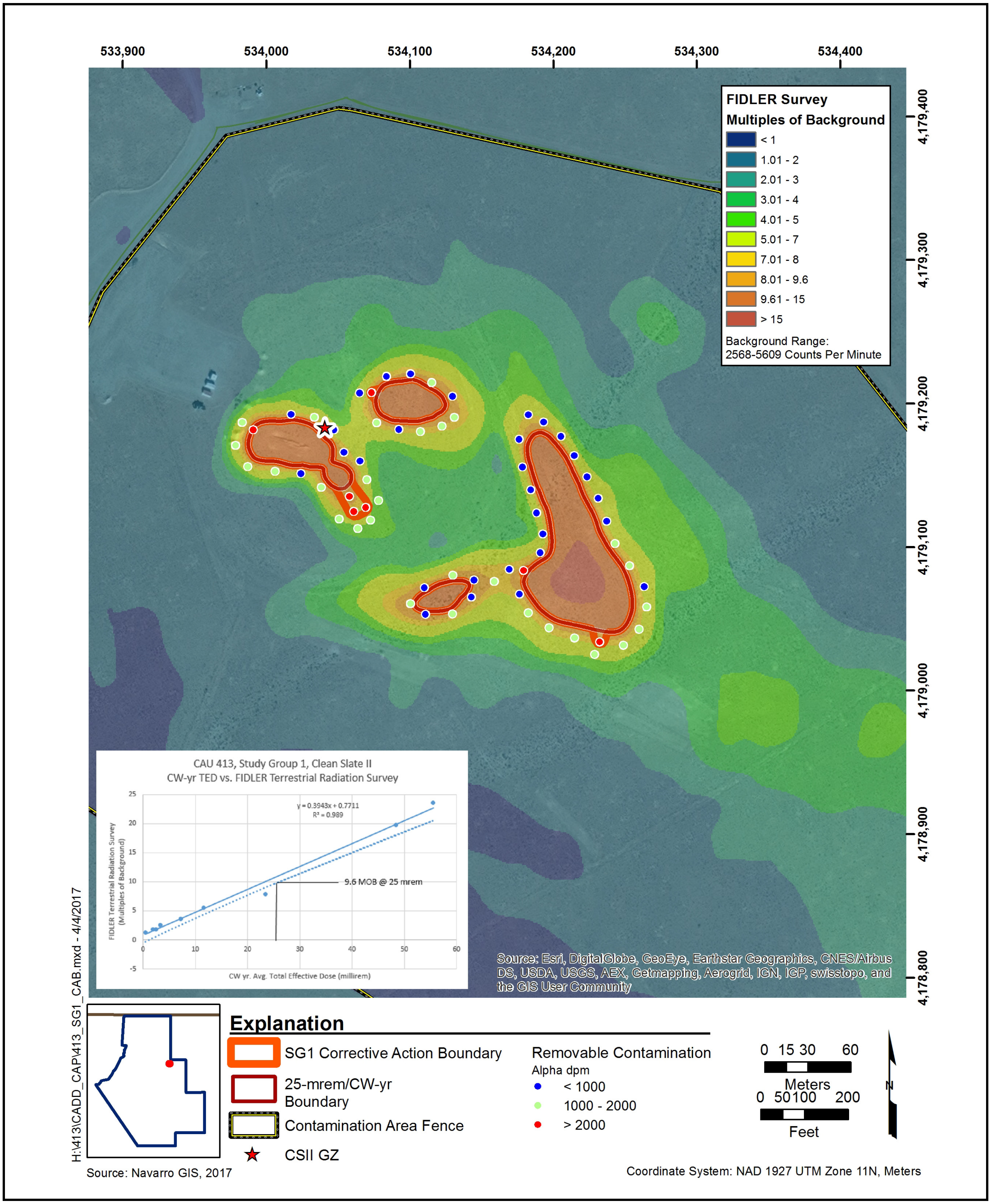

Figure 2-3
Corrective Action Boundary for SG1 with HCA Criteria Extensions

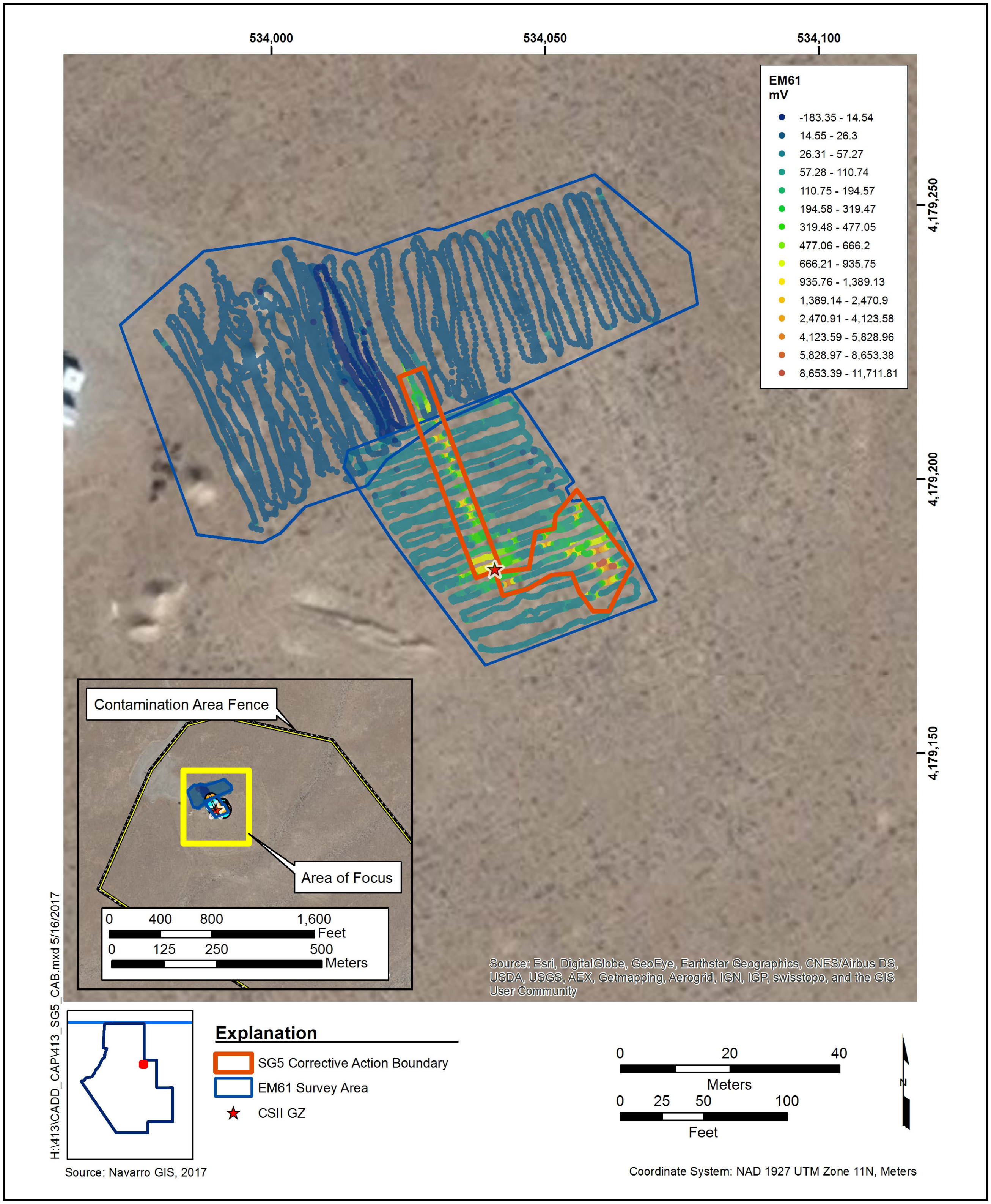

Figure 2-4
Corrective Action Boundary for SG5
Note: EM31 results are not shown because the EM61 results provided the best resolution.
(See Section A.7.1.1.)

3.0 Evaluation of Alternatives

The purpose of this section is to present the corrective action objectives for CAU 413, describe the general standards and decision factors used to screen the various CAAs, and develop and evaluate a set of selected CAAs that will meet the corrective action objectives. This CAA evaluation is intended for use in making corrective action decisions for CAU 413 conditions at the conclusion of the CAI. CAAs were not evaluated for releases that do not contain COCs or PSM. Therefore, CAAs will be evaluated for the surface COC contamination identified for SG1 and the assumed presence of subsurface COC contamination identified for SG5.

3.1 Corrective Action Objectives

The objective of the corrective action at CAU 413 is to prevent or mitigate adverse human and environmental impacts due to exposure and migration of surface and subsurface contamination. The corrective action FAL for CAU 413 is 25 mrem/CW-yr, as established in Appendix D.

The RBCA process used to establish the 25-mrem/yr FAL is described in the Soils RBCA document (NNSA/NFO, 2014). This is a risk-based process that conforms with NAC 445A.227, which lists the requirements for sites with soil contamination (NAC, 2014b). For the evaluation of corrective actions, NAC 445A.22705 (NAC, 2014c) requires the use of ASTM International (ASTM) Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the remedial standard (i.e., cleanup goal). This RBCA process defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses. These tiers are defined in Appendix D.

A Tier 1 evaluation was conducted for all detected contaminants to determine whether contaminant levels satisfy the criteria for a quick regulatory closure or warrant a more site-specific assessment. This was accomplished by comparing the radiological preliminary action level (PAL) of 25 mrem/CW-yr (established in the CAIP [NNSA/NFO, 2016c]) to the TED at each sample location. The only contaminant detected in soil samples collected at CAU 413 that exceeded Tier 1 action levels was radiological dose in SG1. The concentrations of all other sampled contaminants were below Tier 1 action levels.

As corrective actions based on the Tier 1 action level are practical and appropriate, the Tier 1 action level was established as the FAL. The radiological FAL scenario includes a FAL for area contamination; and a FAL for discrete, small areas that may contain unacceptably high concentrations of residual radioactive material (i.e., hot spots), even though the area-based dose does not exceed the area-based FAL. The hot spot FAL (i.e., criterion) was developed to address corrective action decisions for anomalous areas of radiological contamination of less than 1 m^2 (see Appendix J).

The RBCA dose evaluation does not address the potential for removable contamination to be transported to other areas. A discussion on the risks associated with removable radioactive contamination is presented in the Soils RBCA document (NNSA/NFO, 2014). As stated in the CAU 413 CAIP (NNSA/NFO, 2016c) and in Section 2.1.1 of this document, it is assumed that corrective action is required for areas containing HCA conditions, even though the area may not present a potential radiation dose to a receptor that exceeds the FAL.

A corrective action may also be required if a waste is present that contains contaminants that, if released, could cause the surrounding environmental media to contain a COC. Such a waste would be considered PSM. To evaluate wastes for the potential to result in the introduction of a COC to the surrounding environmental media, the conservative assumption is made that any physical waste containment will fail at some point and the contaminants will be released to the surrounding media. The criteria to be used for determining whether a waste is PSM are defined in the Soils RBCA document (NNSA/NFO, 2014).

3.2 Screening Criteria

The screening criteria used to evaluate and select the preferred CAAs are identified in the U.S. Environmental Protection Agency (EPA) *Guidance on RCRA Corrective Action Decision Documents: The Statement of Basis, Final Decision and Response to Comments* (EPA, 1991) and the *RCRA Corrective Action Plan* (EPA, 1994).

CAAs are evaluated based on four general corrective action standards and five remedy selection decision factors. All CAAs must meet the four general standards to be selected for further evaluation using the remedy selection decision factors.

The general corrective action standards are as follows:

- Protection of human health and the environment
- Compliance with media cleanup standards
- Control the source(s) of the release
- Comply with applicable federal, state, and local standards for waste management

The remedy selection decision factors are as follows:

- Short-term reliability and effectiveness
- Reduction of toxicity, mobility, and/or volume
- Long-term reliability and effectiveness
- Feasibility
- Cost

3.2.1 Corrective Action Standards

The following text describes the corrective action standards used to evaluate the CAAs.

Protection of Human Health and the Environment

Protection of human health and the environment is a general mandate of the *Resource Conservation and Recovery Act (*RCRA) statute (EPA, 1994). This mandate requires that the corrective action include any necessary protective measures. These measures may or may not be directly related to media cleanup, source control, or management of wastes. The CAAs are evaluated for the ability to be protective of human health and the environment through an evaluation of risk as presented in Appendix D.

Compliance with Media Cleanup Standards

The CAAs are evaluated for the ability to meet the proposed media cleanup standards. The media cleanup standards is the radiological FAL defined in Appendix D.

Control the Source(s) of the Release

The CAAs are evaluated for the ability to stop further environmental degradation by controlling or eliminating additional releases that may pose a threat to human health and the environment. Unless source control measures are taken, efforts to clean up releases may be ineffective or, at best, will essentially involve a perpetual cleanup. Therefore, each CAA must provide effective source control to ensure the long-term effectiveness and protectiveness of the corrective action.

Comply with Applicable Federal, State, and Local Standards for Waste Management

The CAAs are evaluated for the ability to be conducted in accordance with applicable federal and state regulations.

3.2.2 Remedy Selection Decision Factors

The following describes the remedy selection decision factors used to evaluate the CAAs.

Short-Term Reliability and Effectiveness

Each CAA must be evaluated with respect to its effects on human health and the environment during implementation of the selected corrective action. The following factors will be addressed for each alternative:

- Protection of the public from potential risks associated with implementation, such as fugitive dust, transportation of hazardous materials, and explosive hazards
- Protection of workers during implementation
- Environmental impacts that may result from implementation
- The amount of time until the corrective action objectives are achieved

Reduction of Toxicity, Mobility, and/or Volume

Each CAA must be evaluated for its ability to reduce the toxicity, mobility, and/or volume of the contaminated media. Reduction in toxicity, mobility, and/or volume refers to changes in one or more characteristics of the contaminated media by the use of corrective measures that decrease the inherent threats associated with that media.

Long-Term Reliability and Effectiveness

Each CAA must be evaluated in terms of risk remaining at the CAU after the CAA has been implemented. The primary focus of this evaluation is on the extent and effectiveness of the control that may be required to manage the risk posed by treatment of residuals and/or untreated wastes.

Feasibility

The feasibility criterion addresses the technical and administrative feasibility of implementing a CAA and the availability of services and materials needed during implementation. Each CAA must be evaluated for the following criteria:

- **Construction and operation.** Refers to the feasibility of implementing a CAA given the existing set of waste and site-specific conditions.
- **Administrative feasibility.** Refers to the administrative activities needed to implement the CAA (e.g., permits, use restrictions [URs], public acceptance, rights of way, offsite approval).
- **Availability of services and materials.** Refers to the availability of adequate offsite and onsite treatment, storage capacity, disposal services, necessary technical services and materials, and prospective technologies for each CAA.

Cost

Costs for each alternative are estimated for comparison purposes only. The cost estimate for each CAA includes both capital, and operation and maintenance costs, as applicable, and are provided in Appendix C. The following is a brief description of each component:

- **Capital costs.** These include direct costs that may consist of materials, labor, construction materials, equipment purchase and rental, excavation and backfilling, sampling and analysis, waste disposal, demobilization, and health and safety measures. Indirect costs are separate and not included in the estimates.
- **Operation and maintenance costs.** These costs are separate and include labor, training, sampling and analysis, maintenance materials, utilities, and health and safety measures. These costs are not included in the estimates.

3.3 Development of CAAs

This section identifies and briefly describes the CAAs considered for CAU 413. The CAAs are based on the current nature of contamination at CAU 413. Based on the review of existing data, future use, and current operations at the TTR, the following CAAs were considered for CAU 413:

- **Alternative 1.** No further action
- **Alternative 2.** Clean closure
- **Alternative 3.** Closure in place with use restrictions

3.3.1 Alternative 1 – No Further Action

Under the no further action alternative, corrective action would not be implemented. This alternative is a baseline case with which to compare and assess the other CAAs and their ability to meet the corrective action standards. This alternative is not an option for corrective actions at SG1 or SG5 because it does not meet the general corrective action standards listed in Section 3.2.

3.3.2 Alternative 2 – Clean Closure

The clean closure alternative at CAU 413 consists of the removal of surface and subsurface soil and debris that exceed or are assumed to exceed the FAL of 25 mrem/CW-yr. For SG1, this alternative would remove all material in areas defined in Section 2.3 as requiring further corrective action, including removal of approximately 9,500 m^2 of soil to a depth of approximately 15 cm bgs, resulting in a total of approximately 1,400 cubic meters (m^3) of soil to be removed. For SG5, this alternative would remove all material in areas defined in Section 2.3 as requiring further corrective action, including removal of an estimated volume of buried debris of approximately 430 m^3. Based on the geophysical survey, the maximum depth of burial for the contaminated soil and debris is 1 m; however, excavation is planned for up to a depth of 1 m. Contaminated soil and debris would be disposed of at an offsite facility, and excavated areas would be returned to surface conditions compatible with the intended future use of the site.

3.3.3 Alternative 3 – Closure in Place with Use Restrictions

The closure in place alternative for CAU 413 includes the establishment of FFACO URs at locations that exceed, or are assumed to exceed, the FAL of 25 mrem/CW-yr. Specifically, the locations within

SG1 that exceed the FAL and the buried debris and soil in SG5 would require URs. The establishment of URs is intended to restrict inadvertent contact with contaminated media by prohibiting any activity that would cause a site worker to be exposed to COCs exceeding the risk evaluation basis as presented in Appendix D.

3.4 Evaluation and Comparison of Alternatives

The three CAAs evaluated by the U.S. Air Force (USAF), NDEP, and DOE at the CAU 413 CAA meeting conducted on August 24, 2016, in Falls Church, Virginia, were no further action, clean closure, and closure in place. As shown in Table 3-1, the CAAs of clean closure and closure in place meet the general corrective action standards; the no further action CAA does not meet these standards. Clean closure and closure in place were further evaluated based on the five remedy selection decision factors. The advantages and disadvantages of each CAA were discussed in the meeting and are summarized in Table 3-2. For each remedy selection decision factor, the meeting participants selected the preferred alternative of the two CAAs, without consideration of any other decision factor. These results were then reviewed with any other pertinent considerations to determine the recommended CAA for CAU 413. The CAA of clean closure using the CW exposure scenario was recommended for CAU 413.

3.4.1 Alternatives Eliminated From Detailed Study

The alternatives presented in this section were not proposed, discussed, or offered during the CAA meeting, as they were not considered viable closure methods. However, several alternatives considered in the 1990s and 2000s to evaluate remediation options for plutonium-contaminated soil at DOE sites generated information that is reported in this section. The overall objective of these efforts was to identify treatment technologies that could be implemented individually or in combination, to reduce cleanup costs and remediation waste volumes in the implementation of a corrective action. The technologies evaluated included attrition scrubbing, physical separation, gravity separation, chemical extraction, flotation, bioremediation, magnetic separation, and in situ vitrification. Some of the studies used contaminated soil from CAU 413, and others used plutonium-contaminated soil from the other Clean Slate sites or sites located on the Nevada National Security Site (NNSS). A summary of the technology studies is presented in Table 3-3.

Table 3-1
General Corrective Action Standards

No Further Action	Clean Closure	Closure in Place with URs
PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT		
Because no action is taken, the no further action alternative is not protective of human health or the environment.	The clean closure alternative is protective as the contamination is removed, preventing future exposure. Less potential dose to future generations. More potential dose and physical risk to site workers. The clean closure alternative increases the potential for short-term environmental damage during clean-up activities.	The closure in place alternative is protective as it would prevent exposure to the contamination through administrative means. More potential impact to future generations Less potential dose and physical risk to site workers.
COMPLIANCE WITH MEDIA CLEAN-UP STANDARDS AND COMPLIANCE WITH APPLICABLE FEDERAL, STATE, AND LOCAL STANDARDS FOR WASTE MANAGEMENT		
The no further action alternative does not comply with standards established by the FFACO process.	The clean closure alternative complies with clean-up standards established with NDEP through the FFACO process.	The closure in place alternative complies with standards established by the FFACO process.
CONTROL THE SOURCE(S) OF THE RELEASE		
Because no action is taken, the no further action alternative does not control the source(s) of the release.	The clean closure alternative is more protective as the source of the release(s) is removed.	The closure in place alternative reduces risk as long as controls are in place and are effective.

Table 3-2
Remedy Selection Decision Factors
(Page 1 of 2)

Clean Closure [a]	Closure in Place with URs
LONG-TERM RELIABILITY AND EFFECTIVENESS	
Reliable and effective in the long term since removal of the contaminated media eliminates the future exposure of site workers and the environment. May reduce posting requirements under 10 CFR 835 (CFR, 2017) and facilitate future potential release of the area under DOE Order 458.1 (DOE, 2013). After FFACO requirements are met, remaining contamination will be subject to DOE radiation control requirements.	Reliable and effective in the long term only if controls remain in place and effective.

Table 3-2
Remedy Selection Decision Factors
(Page 2 of 2)

Clean Closure [a]	Closure in Place with URs
REDUCTION OF TOXICITY, MOBILITY, AND/OR VOLUME	
Reduce the onsite mobility and volume of contamination since the contamination is removed. Provides reduction in dose by removing contamination exceeding the FAL.	Provides no reduction in the toxicity, mobility, or volume of the contamination.
SHORT-TERM RELIABILITY AND EFFECTIVENESS	
Presents short-term risk to site workers during corrective action implementation. This risk is based on the use of heavy equipment, exposure to contaminated soil, and travel to/from the site. Introduces short-term risks during waste management activities (large volumes of contaminated soil and debris being removed). Presents short-term risk to the public from the transport of radioactive waste to the offsite disposal facility on public highways.	Presents minimal short-term risk to site workers during travel to/from the site, and installation/maintenance of UR signs.
FEASIBILITY	
This alternative is feasible and can be implemented. This alternative would require the most planning, resources, and time to implement, considering labor, equipment, transportation, and waste management and disposal.	This alternative is feasible. This alternative is easily and quickly implemented, due to the limited actions involved.
COST	
$3M (rough order of magnitude) - large disposal costs (assumes disposal on NNSS) - labor intensive - no maintenance costs	$50,000 (rough order of magnitude) Maintenance cost: $1,000 per year - no waste - no disposal costs - labor intensive The closure in place alternative would require long-term monitoring-radiological/demarcation and posting. The estimated annual costs for post-closure monitoring do not include potential future costs for additional radiological surveys or road maintenance that may be required under the DOE Radiation Control program.

[a] Recommended alternative

Table 3-3
Summary of Previous Soil Treatability Studies

Soil Treatment Technology	Origin of Soil Used in Study	Conclusions	Reference
Attrition scrubbing and wet screening	CSI; CSII; CSIII	Soils >150 microns could not be reliably cleaned.	McKinley, 1996
Segmented gate system	CSII	Poor results; not cost-effective and would add time to cleanup schedule.	BN, 1998; Hoeffner, 2003
Attrition scrubbing and wet sieving	CSII	40% reduction of contaminated soil by removing >300-µm size fraction. Attrition scrubbing/wet sieving may be able to increase ability to separate plutonium from soil; needs additional study.	Torrao et al., 2003; Hoeffner, 2003
Magnetic separation		Poor results.	
Chemical extraction		Has potential; needs additional study.	
Attrition scrubbing/wet sieving followed by magnetic separation	CSIII	Mass reduction was good; removal of plutonium was poor.	Papelis et al., 1996; Hoeffner, 2003
Attrition scrubbing/wet sieving followed by multiple technologies		Removal of plutonium was good; mass reduction was poor.	
Attrition scrubbing/wet sieving followed by flotation		Mass reduction was good; removal of plutonium was poor.	
Magnetic separation	NNSS, Area 11	No concentration of radioactivity observed.	
Gravity separation	NNSS, Area 11	Poor mass balance.	
Bioremediation	NNSS, not specified	Promising; requires 15% soil moisture, aeration, continuous maintenance. Difficult to apply to TTR soils.	Jerger et al., 2003
Soil washing	NNSS, not specified	Viable, but leachate recycle and reuse issues must be resolved.	Hoeffner, 2003
High-capacity flotation	Unknown	Cannot meet treatment goals.	Hoeffner, 2003
Soil stabilization	NNSS, Area 8	Significant degradation of emulsion after 20 months of exposure. Not a viable long-term option.	Desotell et al., 2008

CSI = Clean Slate I
CSIII = Clean Slate III
µm = Micrometer

A comprehensive review of these previous studies was presented in a report published in 2003 (Hoeffner, 2003). This report also presented the results of three additional treatability studies conducted specifically on soil from CSII. These additional studies included bioremediation, soil washing, and high-capacity flotation.

The following CAAs and technologies were eliminated from the detailed study:

- Clean closure with onsite consolidation and/or disposal on TTR
- In situ vitrification
- Volume reduction by magnetic separation, gravity separation, chemical extraction, flotation, bioremediation, and segmented gate processing

Magnetic separation of the plutonium from soil, use of an air-sparged hydrocyclone, and other advanced chemical (soil washing) and physical (segmented gate) methods were evaluated. Based on the CSII soil type (Leavitt, 1974), these volume reduction methods do not appear to be appropriate for separating the radiological contaminants from the soil matrix. While the techniques have been implemented on pilot-scale projects, none have proven technically and/or cost-effective for a site of the magnitude of CSII. It is anticipated that if these volume reduction techniques were implemented, there would be inadequate volume reduction to make them cost-effective.

Onsite consolidation and/or disposal at the TTR were identified as potential CAAs during the initial screening. These CAAs included excavating the contaminated soil from the CSII site and permanently disposing of the contaminated soil at a central location on the TTR. The drawback of CAAs involving soil disposal on the TTR is control of the site(s). The U.S. Department of Defense (DoD) land withdrawal was renewed in 1999 for an additional 25 years. If the DoD were to not renew the land withdrawal in 2023, the CAAs would require either the DOE or DoD to maintain control and monitor the site(s). The TTR waste disposal site management would be similar to the NNSS disposal site management. Long-term disposal site management issues include future land use, the changing of regulatory requirements pertaining to management of a disposal site(s), and the remoteness of the disposal site(s) from an existing support base if the DoD and/or DOE no longer had a regional presence. It will be more difficult for DOE and/or DoD to effectively and efficiently manage the disposal site(s) under remote conditions. Given these major constraints, the CAA soil disposal on the TTR does not appear as viable as other CAAs.

In situ stabilization by chemical and physical means was also evaluated as a potential CAA. One option for this CAA included in situ vitrification. While in situ vitrification techniques have been implemented on pilot-scale projects, none have proven technically effective for stabilizing a relatively thin layer of soil on a scale the size of CSII. Other potential difficulties associated with this CAA include costly technological development that may be required to evaluate this CAA, the unknown adverse short-term human health impacts associated with this CAA, and the uncertain long-term reliability of this type of CAA. Given these drawbacks, the in situ vitrification CAA has been eliminated from further evaluation.

In situ soil stabilization has been pilot- and bench-scale tested for the Plutonium Valley sites (Area 11) at the NNSS (Talmage and Chilton, 1987) and at other semi-arid sites (Nyhan, 1989). The successful soil stabilizing methods tested included polymers, iron oxide, and asphalt stabilization. A drawback is that these tests were either pilot- and/or bench-scale, and have not been implemented on a scale the size of the CSII site. Also, after several years of observation, the programs are usually discontinued; therefore, the long-term results are not known. A drawback of the in situ soil stabilization CAA is the possibility of significant adverse human health and environmental impacts, depending on the soil stabilization method employed.

The long-term reliability and effectiveness of the in situ soil stabilization CAAs is difficult to calculate. Some in situ soil stabilization methods tested started to break down or decompose after several years, while others appear to last for more than 40 years. Another drawback in the stabilization technique is that the effectiveness of the process depends on the specific type of soil, and it is not known with certainty how long the soil will remain stabilized and the contaminants immobilized. Although soil stabilization CAAs immobilize the contaminants and reduce and/or eliminate the human health risk in the short term, these risks may rise back to the same level before soil stabilization if the stabilizing material breaks down.

4.0 Recommended Alternative

The CAA of clean closure was selected as the recommended CAA for CAU 413 in the CAA meeting conducted on August 24, 2016 based on an evaluation of the remedy selection decision factors presented in Table 3-2.

The corrective action of clean closure consists of the removal of surface soil in the areas defined in Section 3.2 that require further corrective action. These areas were defined based on a conservative estimate of maximum potential dose for FFACO decision-making purposes only. The estimated area and volume of soil and debris to be removed is presented in Table 4-1. Figure 4-1 shows the initial estimate of the area to be remediated, which is a combination of the area where dose exceeds the FAL, the area that exceeds HCA criteria, and the surficial extent of the buried debris. The volumes are based on estimated excavation depths of 15 cm and 1 m for SG1 and SG5, respectively. Although these areas and volumes may be very imprecise, the initial corrective action boundaries were established for the purpose of planning. Actual corrective action boundaries will be revised based on verification soil sample results that will determine whether additional excavation is required or provide verification that the corrective action is complete. Therefore, actual corrective action boundaries may be smaller or larger than estimated herein.

Table 4-1
Estimated Corrective Action Areas and Volumes for CAU 413

Release	Area (m^2)	Volume (m^3)
Surface Soil [a]	9,500	1,400
Subsurface Debris	430	430

[a] Includes surface soil that exceeds HCA criterion.

The corrective action of clean closure is consistent with the clean closures completed in 1996 and 1997 at two other similar Operation Roller Coaster sites: CAU 411: Double Tracks Plutonium Dispersion (Nellis) (NNSA/NFO, 2016a) and CAU 412: Clean Slate I Plutonium Dispersion (TTR) (NNSA/NFO, 2016b). Both of these involved the excavation of soil and debris in a manner similar to the recommended corrective action for CAU 413.

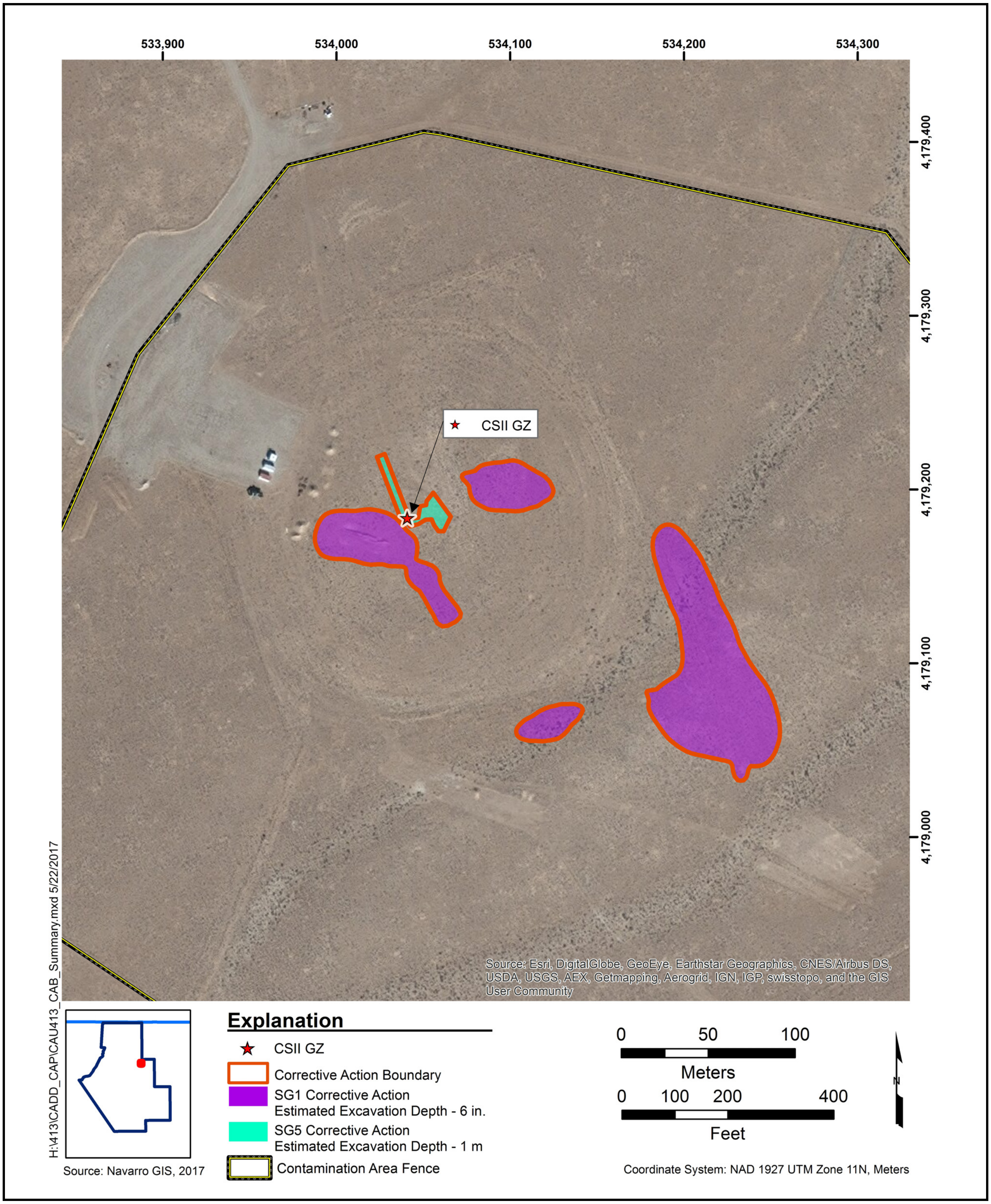

Figure 4-1
Corrective Action Areas at CAU 413

The corrective action recommendations by USAF, NDEP, and DOE for CAU 413 are based on the assumption that activities on the TTR will be limited to those that are industrial in nature and that the TTR will maintain controlled access (i.e., restrict public access and residential use). Should the future land use of the TTR change such that these assumptions are no longer valid, additional evaluation will be required.

5.0 Detailed CAP Statement of Work

This section presents the detailed statement of work for implementation of the recommended CAA of clean closure at CAU 413. Included are a summary of QC requirements and waste management activities.

5.1 Preferred CAA

The preferred CAA for the CAU 413 is clean closure using the CW land use scenario. The corrective action of clean closure consists of the removal of the contaminated areas defined in Section 2.3.

5.1.1 Site Preparation

A temporary field office and support area may be established outside the exclusion zone during mobilization activities. Electricity may be provided through onsite generators and a distribution system. Potable water will be supplied, as required.

The corrective action effort will use the existing roads and staging areas at the site. If necessary, the road and staging areas will be restored and/or expanded to accommodate project needs. In order to maintain control of the site and delineate work areas, existing fencing may be reconfigured, additional fencing installed, and/or fencing removed during the progression of field activities. Figure 5-1 is a conceptual site layout for corrective action implementation.

5.1.2 Excavation Activities

The CAI results confirmed that, except for the buried contamination in SG5, all contamination exceeding the FAL is limited to a depth of 5 cm below the original ground surface. Given the constraints of the heavy equipment to be used in the corrective action, approximately 15 cm of soil will be removed from the corrective action boundary defined in Section 4.0. In addition, the buried material in SG5 will be excavated to a minimum of 1 m bgs or until debris is no longer visible. The total estimated volume of soil and debris to be removed is approximately 1,800 m^3 based on the assumption that the area defined in Section 4.0 contains buried material. If the actual area of buried material is larger or smaller, the actual waste volume may be larger or smaller.

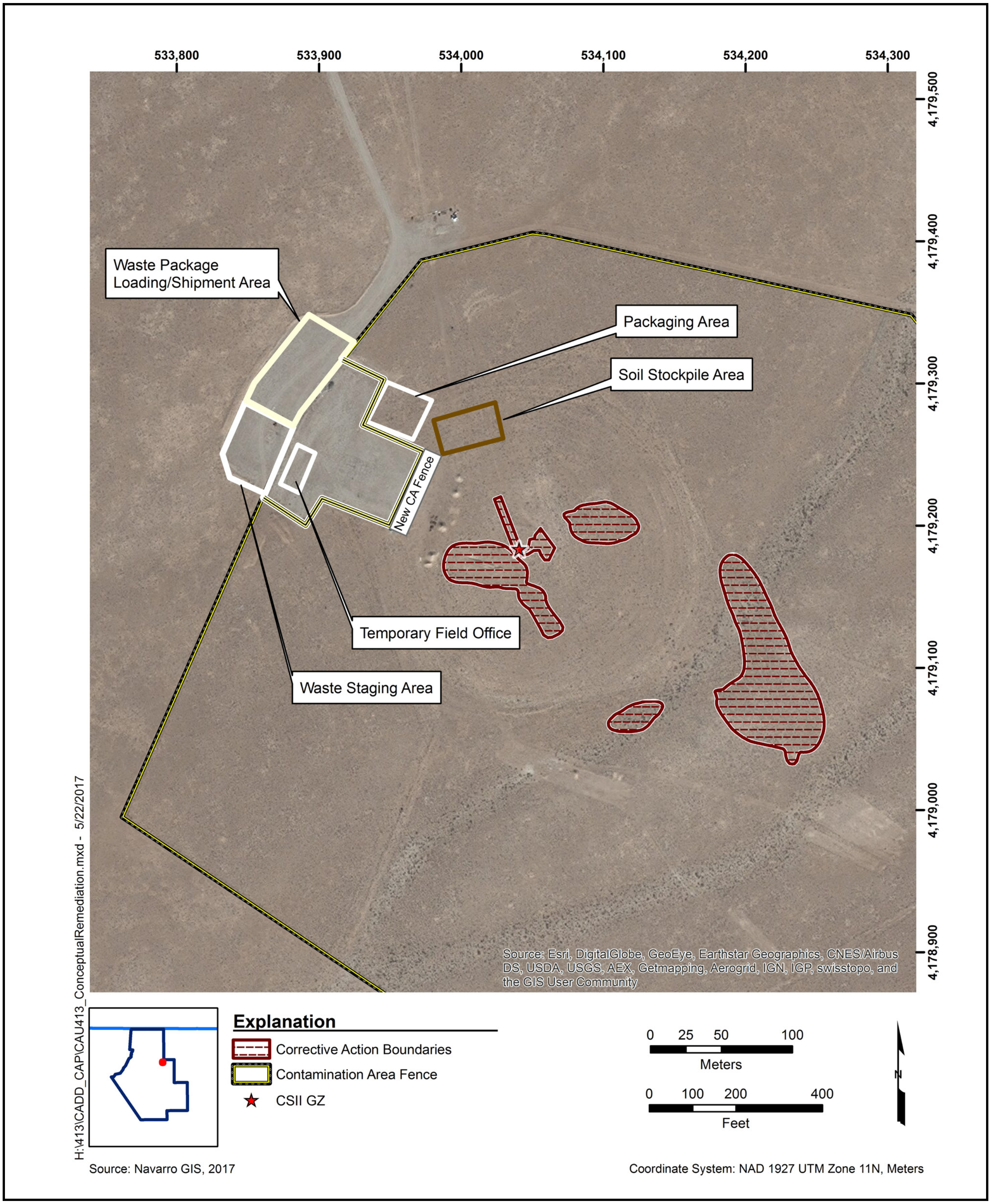

Figure 5-1
Conceptual Site Layout for Corrective Action Implementation

After staking the boundaries of the remediation area, heavy equipment (e.g., excavator, grader, front-end loader, backhoe) will be used to excavate soil and debris from the corrective action areas. Excavated material will be stockpiled within the CA boundary or loaded directly into appropriate waste packages (Figure 5-1). Hand-held or heavy equipment may be used to size-reduce contaminated material. The excavated material will be wet down to minimize dust generation, as needed. Waste packages will be loaded, surveyed for release from the CA, and staged for loading and transport for disposal. Each waste container may include a combination of debris and soil to meet weight and activity concentration requirements. See Figure 5-1 for a conceptual site layout and Section 5.3 for a discussion on waste management.

All initial corrective action boundaries established for the CAA of clean closure were established for the purpose of planning the areas and volumes to be excavated. The excavation will be guided by visual surveys, radiological surveys, and geophysical surveys, as appropriate. Upon completion of excavation, a comprehensive FIDLER survey will be performed and recorded with a Global Positioning System (GPS) to select the locations for verification soil sampling. Soil sampling will be completed in accordance with Section 5.4 and Appendix F. Results of the soil sampling will determine whether additional excavation is required or provide verification that the corrective action is complete. Therefore, corrective action waste volumes may be less or more than estimated herein.

5.1.3 Site Restoration

At the completion of excavation activities, the excavated areas may be recontoured and backfilled, as necessary. Only natural revegetation of the site is planned because the active revegetation of the Double Tracks site did not provide better results than the natural revegetation of the CSI site. Final actions will be documented in the closure report (CR).

5.2 Construction Quality Assurance/Quality Control

Construction activities are limited to excavation and recontouring. No engineered structures will be constructed as part of site closure. Therefore, a construction QA/QC plan is not required.

5.2.1 Construction Field Sample Collection Activities

No engineered structures will be constructed at CAU 413; therefore, the collection of samples to verify construction QA/QC is not required.

5.2.2 Construction Laboratory/Analytical Data Quality Indicators

Construction QA/QC samples will not be collected, and no structural testing will be required; therefore, an evaluation of laboratory/analytical DQIs is not necessary.

5.3 Waste Management

The onsite management and ultimate disposition of wastes will be determined based on a determination of the waste type (e.g., industrial, low-level, hazardous, hydrocarbon, mixed), or the combination of waste types. A determination of the waste type will be guided by several factors, including, but not limited to, the analytical results of samples either directly or indirectly associated with the waste, historical site knowledge, knowledge of the waste generation process, field observations, field-monitoring results, FSRs, and/or radiological survey/swipe results.

5.3.1 Waste Minimization

Closure activities are planned to minimize the generation of remediation wastes. Administrative controls, including decontamination procedures and waste characterization strategies, will minimize waste generated during site closure. Controls will be in place to minimize the use of hazardous materials and unnecessary generation of hazardous and/or mixed waste. Special care will be given to segregate the waste streams to avoid the generation of additional waste. Low-level waste (LLW) will be minimized by using radiological survey instrumentation to guide excavation activities. If hydrocarbon-impacted soil is created (e.g., from an equipment leak/release), field screening may be used to guide excavation to minimize hydrocarbon waste.

5.3.2 Generated Wastes

The waste streams anticipated to be generated during the implementation of clean closure at CAU 413 include radiologically contaminated soil and debris from the corrective action areas, decontamination fluids, personal protective equipment (PPE), disposable sampling equipment, and small quantities of non-contaminated industrial solid waste. Although not anticipated, hydrocarbon waste (debris, soil) may be generated from leaks/spills from heavy equipment used during corrective action implementation.

Approximately 1,800 m^3 of radiologically contaminated soil and debris could be excavated. Expansion of the soil volume, estimated to be 30 percent based upon experience with similar sites, will occur during packaging. Compactable radioactive waste—such as booties, gloves, and filters that become contaminated during closure activities—will be dispositioned in the same waste stream. Therefore, the net volume of LLW (e.g., soil, debris, compactable waste) may be approximately 2,400 m^3. LLW will be removed from the CSII site and transported to the Area 5 Radioactive Waste Management Complex (RWMC) for disposal in accordance with the *Nevada National Security Site Waste Acceptance Criteria* (NNSSWAC) (NNSA/NFO, 2016d). All low-level radioactive waste must meet the characterization, packaging, certification, and shipping waste acceptance criteria established in the NNSSWAC.

Equipment that becomes contaminated during closure activities may be disposed of directly or may be decontaminated using water or a water/detergent mixture. Small equipment and/or tools will be decontaminated over 208-liter (55-gallon [gal]) drums or other container. For larger pieces of equipment that cannot be readily decontaminated over a drum, a decontamination pad will be constructed by lining a bermed area large enough to hold the heavy equipment. Contaminated tools and equipment will be decontaminated using a pressure washer or steam cleaner. Alternatively, decontamination can be performed using dry techniques or using a solution of industrial detergent and water. Rinsate may be solidified with inert material and/or allowed to evaporate.

All radiologically impacted equipment and materials used at CAU 413 will be radiologically surveyed before release from the site to verify that the free release criteria are met.

5.3.3 Waste Characterization and Disposal

All waste disposal decisions will be based on process knowledge, CAI samples, and direct samples of the waste, when necessary. Waste characterization and disposal will be determined based on a review of analytical results and compared to federal and state regulations, permit limitations, and disposal facility acceptance criteria. Waste shipping and disposal documentation for CAU 413 will be included in the CR.

These waste streams are anticipated to be characterized into the following waste types:

Industrial Solid Waste. Industrial solid waste, if generated, will be collected, managed, and disposed of in accordance with the solid waste regulations and the permits for operation of the NNSS Solid Waste Disposal Sites. The most commonly generated industrial solid waste includes disposable sampling equipment and PPE that will be collected in plastic bags and marked in accordance with requirements. Industrial solid waste generated at CAU 413 will be disposed of in the Area 9 U10c landfill.

Low-Level Radioactive Waste. Low-level radioactive waste, if generated, will be managed in accordance with the contractor-specific waste certification program plan, DOE orders, and the requirements of the current version of the *Nevada National Security Site Waste Acceptance Criteria* (NNSA/NFO, 2016d). Potential radioactive waste containers will be staged and managed at a designated radioactive material area (RMA).

The LLW generated during closure activities will be managed and disposed according to all applicable regulations. Radiologically contaminated waste will be packaged in approved containers and disposed in a permitted landfill. LLW may be staged in an RMA before transport and disposal. LLW generated at CAU 413 that meets the waste acceptance criteria will be disposed of at the Area 5 RWMC or other acceptable LLW disposal facility.

Hydrocarbon Waste. Hydrocarbon waste may be generated if there is a release during corrective action implementation. Waste characterization samples of the hydrocarbon waste will be collected and analyzed if sufficient process knowledge is not available concerning the source of the release. Suspected hydrocarbon solid waste, if generated, will be managed on site in a drum or other appropriate container until fully characterized.

5.4 Confirmation of Corrective Actions

To ensure that the corrective action objectives have been met at CAU 413, corrective action implementation will be confirmed using a combination of radiological surveys and soil sampling. Confirmation of corrective actions consists of the following:

- The results of a post-remediation FIDLER survey will be used to bias soil sample plot locations to locations within each remediation area with the most elevated readings. A minimum of one soil sample will be collected from each sample plot established at each of the six areas identified by the corrective action boundary shown in Figure 4-1. Should higher areas of radioactivity not be distinguishable, soil sample locations will be selected at random.

- Removable contamination surveys will be conducted at the sample plot areas to verify that HCA conditions no longer exist.

- At least two duplicate soil samples will be collected.

- The subsurface excavation area will be visually inspected to ensure that all visible debris has been removed.

- Geophysical surveys will be completed to verify that all debris has been removed from the subsurface excavation area.

All samples collected for corrective action confirmation will be analyzed for gamma spectroscopy. The plan for collecting data of sufficient quality and quantity to support clean closure is presented in Appendix F.

5.5 Permits

Before beginning corrective action field activities, planning documents and permits will be prepared. These documents may include radiological work permits, work control packages, utility clearance, excavation permits, and blind penetration permits. A *National Environmental Policy Act* (NEPA) Checklist will be completed before corrective actions at the site. Excavation activities will follow all applicable federal, state, and local laws; regulations; and permits regarding protection of the environment. Activities will be conducted in compliance with DOE Sandia Field Office current Class II Air Quality Operating Permit (#AP8733-0680.03) for the TTR (Beausoleil, 2014). In particular, the permit's *Surface Area Disturbance Permit Fugitive Dust Control and Process Equipment Emission Control Plan,* dated October 17, 2014, for the proposed surface disturbance activities will be implemented for the proposed activities. That plan is included as a part of the TTR's Class II Air Quality Operating Permit.

6.0 Schedule

The following are the anticipated dates for implementation of clean closure at CAU 413:

- **Mobilization and Site Preparation.** January 2017
- **Remediation, Waste Transportation and Disposal.** February through October 2017
- **Verification of Corrective Actions.** October 2017
- **Site Restoration.** October 2017
- **Demobilization.** October 2017

7.0 Post-closure Plan

Implementation of the CAA of clean closure will reduce contamination levels such that there will be no post-closure requirements under the FFACO (1996, as amended). This does not preclude other radiological control requirements for residual radioactive materials remaining after the completion of FFACO corrective actions.

7.1 Inspections

No post-closure inspections will be required because no fencing or signage will be required under the CAA of clean closure.

7.2 Monitoring

No post-closure monitoring will be required because no fencing or signage will be required under the CAA of clean closure.

7.3 Maintenance and Repair

No post-closure maintenance or repair will be required because no fencing or signage will be required under the CAA of clean closure.

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Appendix A

Corrective Action Investigation Results

A.1.0 Introduction

This appendix presents the CAI activities and dose estimates for CAU 413, Clean Slate II Plutonium Dispersion (TTR). CAU 413 comprises one CAS, TA-23-02CS, Pu Contaminated Soil. To facilitate site investigation and the evaluation of DQO decisions, the reporting of investigation results and the evaluation of DQO decisions were organized into seven study groups (Table A.1-1). Although the need for corrective action is evaluated separately for each release, CAAs are applied to the FFACO CAS.

Table A.1-1
CAU 413 Study Groups

SG Number	SG Name
1	Undisturbed Areas
2	Disturbed Areas
3	Sedimentation Areas
4	Former Staging Area
5	Buried Debris
6	Potential Source Material
7	Soil Mounds

Additional information regarding the history of the site, planning, and the scope of the investigation is presented in the CAU 413 CAIP (NNSA/NFO, 2016).

A.1.1 Investigation Objectives

The objective of the CAI was to provide sufficient information to evaluate and select CAAs and support the closure of CAU 413. This objective was achieved by identifying the nature and extent of COCs and identifying potential corrective action wastes.

For radiological contamination, a COC is defined as the presence of radionuclides that jointly present a dose to a receptor exceeding the FAL of 25 mrem/yr. For other types of contamination, a COC is defined as the presence of a contaminant at a concentration exceeding its corresponding FAL concentration (see Section A.2.4).

A.1.2 Contents

This appendix describes CAI activities and dose estimates. The contents of this appendix are as follows:

- Section A.1.0 describes the investigation background, objectives, and the contents of this document.
- Section A.2.0 provides an investigation overview.
- Sections A.3.0 through A.9.0 provide study-group-specific information regarding CAI field activities, sampling methods, and dose estimates.
- Section A.10.0 summarizes waste management activities.
- Section A.11.0 discusses the QA and QC processes followed and the results of QA/QC activities.
- Section A.12.0 provides a summary of the CAI results.
- Section A.13.0 lists the cited references.

The complete field documentation and laboratory data—including field activity daily logs (FADLs), sample collection logs (SCLs), analysis request/chain-of-custody forms, laboratory certificates of analyses, and analytical results—are retained in CAU 413 files as hard copy documents or electronic media.

A.2.0 Investigation Overview

Field investigation and sampling activities for the CAU 413 CAI were conducted between June 2015 and May 2016. Investigation activities included visual surveys, radiological surveys, geophysical surveys, surface and subsurface soil sampling, and TLD sampling.

The investigation and sampling program adhered to the requirements set forth in the CAIP (NNSA/NFO, 2016) (except any deviations described herein) and in accordance with the Soils QAP (NNSA/NSO, 2012), which establishes requirements, technical planning, and general quality practices. The investigation results and the risk associated with site contamination were evaluated in accordance with the Soils RBCA document (NNSA/NFO, 2014).

In accordance with the graded approach described in the Soils QAP (NNSA/NSO, 2012), the quality required of a dataset will be determined by its intended use in decision making. Data used to define the presence of COCs are classified as decisional and will be used to make corrective action decisions. Survey data are classified as decision supporting and are not used, by themselves, to make corrective action decisions.

The study groups were investigated by collecting TLD samples for external radiological dose calculations and collecting soil samples for the calculation of internal radiological dose. The field investigation was completed as specified in the CAIP (NNSA/NFO, 2016) with deviations as described in Sections A.2.1 through A.2.4, which provide the general investigation and evaluation methodologies.

A.2.1 Sample Locations

All sample locations for CAU 413 were selected judgmentally, using biasing factors such as radiological survey results and/or the presence of debris. Soil samples were collected from the initial locations presented in the CAIP (NNSA/NFO, 2016) and modified as prescribed in Section A.8.2.1 of the CAIP. The predetermined locations were adjusted to the locations of the highest radioactivity observed in the additional FIDLER surveys.

At locations where soil sample plots were established, soil samples were collected following a probabilistic approach. One or more composite samples were collected within each sample plot, and TLDs were located near the center of each sample plot. The subsample aliquot locations for each sample were identified using a predetermined random-start, triangular grid pattern.

All sample locations and points of interest were surveyed with a GPS instrument. Appendix F presents these GPS data in a tabular format. Additional information on the selection of sample locations is found in the CAIP and the study-group-specific sections (see Sections A.3.0 through A.9.0). Except as noted in the following sections, CAU 413 sampling locations were accessible, and sampling activities at planned locations were not restricted.

A.2.2 Investigation Activities

The investigation activities conducted at CAU 413 completed all of the field investigation activities specified in the CAIP (NNSA/NFO, 2016). The investigation strategy provided the necessary information to establish the nature and extent of contamination associated with each study group.

A.2.2.1 Radiological Surveys

Ground-based radiological surveys using a FIDLER were conducted at CAU 413 to identify the general distribution of radiological contamination and to bias sampling locations during the CAI. Count-rate and position data were collected and recorded at 1-second intervals via a Trimble Systems GeoXT GPS unit. The travel speed was approximately 1 to 2 meters per second with the radiation detector at a height of approximately 0.5 m above the ground surface. Count rates for the FIDLER are recorded in units of counts per minute (cpm).

Many surveys were conducted at CSII between 2012 and 2016, and the data from these individual surveys were combined into one dataset. However, while each survey produced valid relative differences in radioactivity over the surface area of the release site, the numerical range of values from one day to another or from one instrument to another may be significantly different. This is a result of differences in instrument efficiencies as well as daily variations in background cosmic, terrestrial, and radon radiation. Therefore, to be able to combine different surveys into one dataset, the data must be converted into comparable units. This was accomplished by transforming the data to make them relative to the background radiation level of the specific day as measured by the survey instrument used for the survey. The resulting normalized transformed survey data are presented in units of multiples of background (MOB).

Each day, before conducting the field survey, a background radiation level was established for that day's survey for that particular instrument. This was done at a location that had been determined to have field conditions (e.g., soil type, elevation, vegetative cover) similar to what was observed over most of the site to be surveyed but was not impacted by contaminants from the release. The location used to establish the background radiation level is shown on Figure A.2-1. The background radiation level was established as the average of the one-second readings (in cpm) collected over a five-minute interval. Each of the survey values for that day were divided by this background to produce a value representing a multiple of the background level, expressed in units of MOB. When the radiation survey results are related to the background level and expressed in terms of MOB, the results of surveys conducted on different days and using different instruments become comparable and can be combined for the purpose of defining relative contamination levels over the surface area of a release site. The survey point data were combined together in a Geographic Information Systems database for subsequent analysis. This was done for all of the radiation surveys conducted at Soils Activity release sites and has been verified by comparing results from different surveys at overlapping survey locations.

FIDLER survey data were captured in the field as discrete data points that coincide with the path walked/driven by the field technician. Values from the individual data points from the CAU 413 FIDLER surveys exhibit patterns of radioactivity that are representative of two different release distributions. These two release distributions support the CSM associated with the liquid and gaseous phases of the test material released by the CSII test as described in Section A.8.2. The FIDLER survey data that were determined to be associated with the liquid phase (i.e., hot spots) were separated from the FIDLER survey data that were determined to be associated with the gaseous phase (i.e., airborne deposition). This was done by identifying and separating out those data points (or sets of data points) whose values are anomalous to the values of the surrounding data points that are consistent with the CSM element of airborne deposition (i.e., a generally consistent decrease in activity with distance from the release point). The separated data point values were used to represent hot spots that are evaluated independently of the airborne deposition contamination

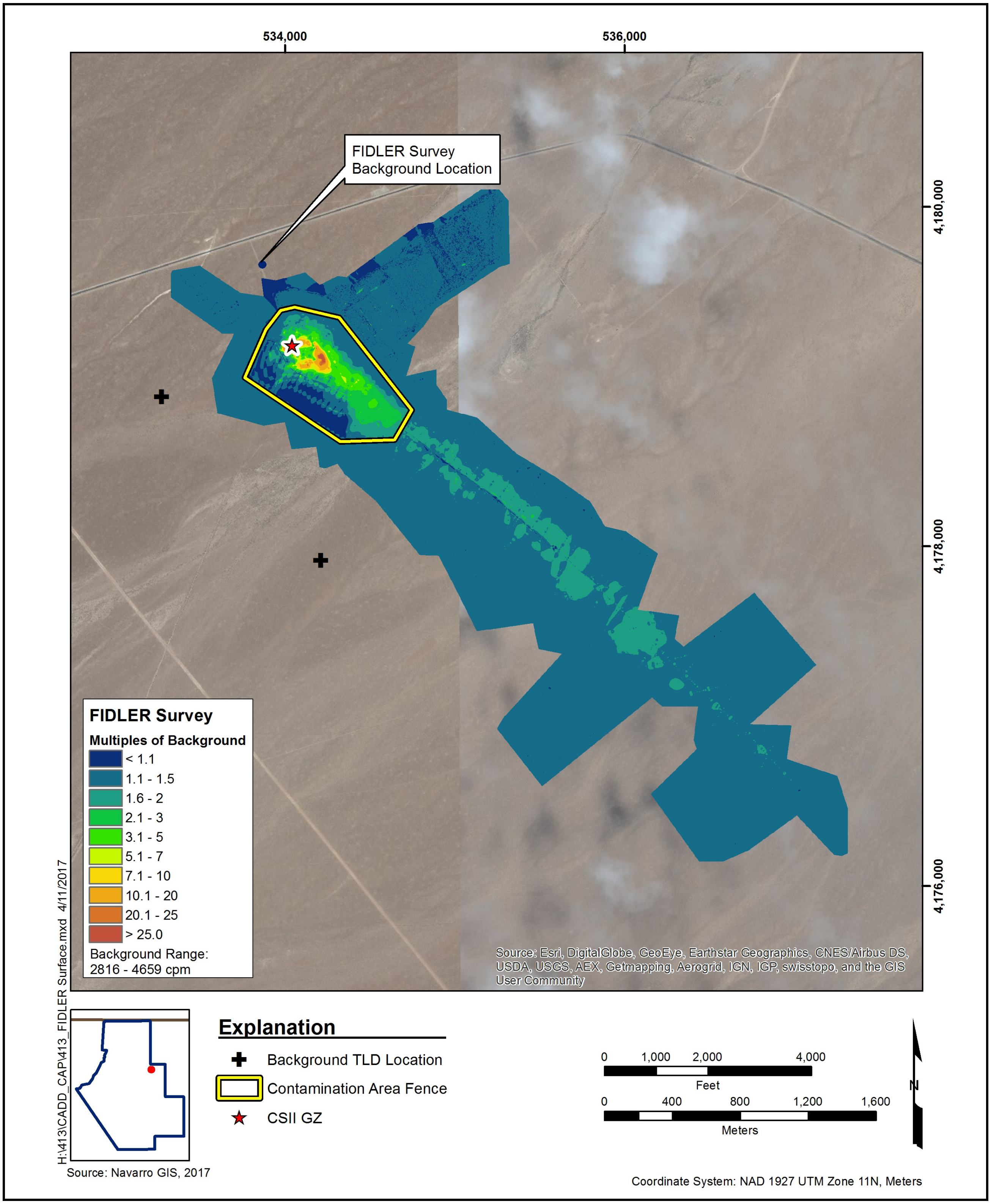

Figure A.2-1
FIDLER Survey Results
(Composite of 2012, 2015, and 2016 data)

(see Sections 2.2.1.6 and A.8.0 associated with SG6). The remaining data points were used to create a continuous spatial distribution (i.e., interpolated surface) using an inverse distance weighted interpolation technique of the geostatistical analyst extension of the ArcGIS software.

This interpolated surface provided estimated values for areas in between data points while largely maintaining the original data point values (i.e., limiting the impact of averaging data over an area). The resulting interpolative surface represents the distribution of airborne contaminants from the CSII test. Figure A.2-1 presents the interpolated FIDLER surface for the entire CAU 413 site and is a composite of FIDLER data collected in 2012, 2015, and 2016.

In accordance with the CAIP (NNSA/NFO, 2016), a radiological survey of a small area south of the CA fence was conducted during the CAI to investigate an anomalous detection of cesium (Cs)-137 identified in a 1992 soil sample from this area (Culp and Howard, 1993). The CAIP states that Cs-137 is not a contaminant of potential concern (COPC) for CAU 413 and is not in the CSM. This area was surveyed to determine whether a questionable and anomalous sample result could indicate the presence of a small area of Cs-137 contamination that would violate the CSM. A radiation survey using a PRM-470 instrument was conducted in the area of the 1992 sample location to see whether there is a gamma signature above background levels that would violate the CSM and require the CSM to be reevaluated. This was evaluated by visually inspecting the spatial results to see whether a pattern of elevated readings could be identified and by looking for any statistical anomaly. No patterns of elevated readings were identified; and the coefficient of variation of the dataset was 0.12, indicating very consistent readings throughout the survey area. The PRM-470 instrument was selected due to its ability to detect the strong gamma signature from Cs-137. Because the survey did not detect anomalous radioactivity in this area, further investigation of the area is not warranted, and corrective action is not required. The area of the survey and the approximate location of the original reported anomaly are shown in Figure A.2-2.

Removable alpha contamination surveys were also completed at CAU 413 to determine conditions within the CA and inner fences at the site. It was assumed in the CAIP that locations meeting HCA conditions exceed the dose-based FAL and require corrective action (NNSA/NFO, 2016).

Figure A.2-2
PRM-470 Survey Area
Note: All PRM-470 survey results were indistinguishable from background.

Study-group-specific FIDLER survey results are presented and discussed in the following subsections.

A.2.2.2 Radiological Field Screening

During the CAI, site-specific field-screening levels (FSLs) were determined each day before soil sampling. A location was selected in the vicinity of the site with a minimal probability of being impacted from releases or site operations. Ten or more surface soil aliquots, from the top 5 cm of soil, were collected at random locations within the selected area. The aliquots were then mixed, and 10 one-minute static counts were obtained for both alpha and beta/gamma measurements. The FSLs for both alpha and beta/gamma were calculated by multiplying the sample standard deviation by 2 and adding that value to the sample average.

Radiological field screening was used at CAU 413 to evaluate the presence of buried contamination and to aid in the selection of biased samples for laboratory analyses. Radiological field screening was limited to radiological parameters and was conducted using an NE Electra instrument. To determine whether buried contamination was present at a sample location, soil screening samples were collected and field screened for radioactivity in 5-cm-depth increments to a total depth of 30 cm bgs or the native soil interface. These FSRs were used to determine whether a subsurface contamination layer(s) could be distinguished from surface contamination. Buried contamination was considered to be present only if the depth interval reading exceeded the FSL and there was a greater than 20 percent difference between the depth interval reading and the surface soil reading. For locations where it was determined that buried contamination was present, the surface interval and the subsurface depth interval with the highest reading were sent for offsite laboratory analyses.

A.2.2.3 TLD Sampling

TLDs (Panasonic UD-814 model) were staged at CAU 413 sample locations with the objective of collecting in situ measurements to determine the external radiological dose. TLDs were placed at three background locations at CAU 413 to measure background radiation. The background TLDs are deployed to measure dose from natural sources in areas unaffected by CAU-related releases. One of the background TLD locations (B02) was located in the debris field, and therefore considered to not be representative of natural conditions. This TLD was not used in the calculation of external dose at

CAU 413 (see Section A.3.2.4). The other two background TLDs (Figure A.2-1) were placed in locations with the same geomorphological properties as the release site but outside the influence of the release. Therefore, they were determined to be representative of the general area and were used as a good estimate of average background dose for all of the TLDs placed within the release plume.

Each TLD was placed at a height of approximately 1 m above the ground surface, which is consistent with TLD placement in the NNSS routine environmental monitoring program. Once retrieved from the field locations, the TLDs were analyzed by automated TLD readers that are calibrated and maintained by the NNSS management and operating (M&O) contractor. This approach allowed for the use of existing QC procedures for TLD processing. Details of the environmental monitoring TLD program and TLD QC are presented in Section A.11.0. All readings conformed to the approved QC program and are considered representative of the external radiological dose at each location.

A.2.2.4 Soil Sampling

Soil sampling at CAU 413 included a combination of sampling techniques, including collection of samples from soil sample plots and the collection of grab and composite samples. At sample plots, four composite samples were collected. Each composite sample was composed of nine random subsample locations, resulting in a total of 36 subsamples collected from each plot. Each subsample was collected using a “vertical-slice cylinder and bottom-trowel” method. This required the insertion of the 9-cm-inside-diameter cylinder to a depth of 5 cm, excavation of the outside soil along one side of the cylinder (to permit trowel placement), and horizontal insertion of a trowel along the bottom of the cylinder. This method captured a cylindrical-shaped section of the soil from 0 to 5 cm bgs.

At locations with the potential for buried contamination, subsurface grab samples were collected as described in Section A.2.2.2. The surface sample at each location, and any subsurface depth samples that exceeded the screening criteria, were sent to the laboratory for analysis. Composite samples were also collected consisting of soil collected from six subsample locations.

A.2.3 Dose Calculations

Soil and TLD data are used to calculate a TED that could potentially be received by a human receptor at the site. The following subsections discuss the process for calculating dose from the soil and TLD data.

A.2.3.1 Internal Dose Calculations

Internal dose was calculated using the radionuclide analytical results from soil samples and the corresponding RRMG (NNSA/NFO, 2014). The internal dose RRMG concentration for a particular radionuclide is that concentration in surface soil that would cause an internal dose to a receptor of 25 mrem/yr (under the appropriate exposure scenario) independent of any other radionuclide (assuming that no other radionuclides contribute dose). The internal dose RRMG for each detected radionuclide (in picocuries per gram [pCi/g] of soil) was derived using RESRAD computer code (Yu et al., 2001) under the appropriate exposure scenario (NNSA/NFO, 2014).

The total internal dose corresponding to each surface soil sample was calculated by adding the dose contribution from each radionuclide. For each sample, the radionuclide-specific analytical result was divided by its corresponding internal RRMG (NNSA/NFO, 2014) to yield a fraction of the 25-mrem/yr dose and then multiplied by 25 to yield an internal dose estimate (in mrem/yr) at that sample location. Soil concentrations of Pu isotopes are inferred from gamma spectroscopy results as described in the representativeness discussion of Section B.1.1.1.1. The internal doses for all radionuclides detected in a soil sample were then summed to yield an internal dose for that sample. For probabilistic samples, a 95 percent UCL was calculated for the internal dose in each sample plot using the results of all soil samples collected at that plot (NNSA/NFO, 2014). For judgmental sample locations where only one sample was collected, statistical inferences could not be calculated, and the single analytical result was used to calculate the internal dose.

A.2.3.2 External Dose Calculations

At CAI sample locations where TLDs were placed (i.e., sample plots in SG1, sedimentation areas in SG3, and soil mounds in SG7), external dose was calculated using direct TLD measurements. The TLDs used at CAU 413 contain four individual elements. External dose at each TLD location is determined using the readings from TLD elements 2, 3, and 4. Each of these elements is considered a separate independent measurement of external dose. A 95 percent UCL of the average of these measurements was calculated for each TLD location. Element 1 is designed to measure dose to the skin and is not relevant to the determination of the external dose for the purpose of this investigation.TLD Element 1 is less sensitive to low-energy photons, is more variable, and is not replicated within the TLD badge. As the other three elements overrespond to low-energy photons, the predictions of external dose are conservatively high.

At sample locations where no TLD was placed (i.e., disturbed areas in SG2, former staging area in SG4) and where subsurface soil samples were collected, a TLD-equivalent external dose was estimated by multiplying the RESRAD-derived external dose by a correction factor. This results in a more conservative (higher) estimate of external dose than if the RESRAD external dose was used without correction. This correction factor was developed to account for an observed difference between RESRAD-derived external dose and TLD readings as described in the Soils RBCA document (NNSA/NFO, 2014). The correction factor was derived by evaluating previous data from Soils Activity sites where both TLD and RESRAD-derived external dose data were available. The correlations were made using the Industrial Area scenario (as doses for this scenario were calculated for all Soils release sites). As external dose is directly related to exposure time, the correlation is the same for any period of exposure. Therefore, the Industrial Area scenario provides the most accurate results because it is the scenario that uses the longest exposure time. Evaluation of these data showed good correlation between these paired data, with a weighted average correction factor of 1.58 for average TLD values and 1.69 for 95 percent UCL TLD values. The correlation of TLD dose to RESRAD external dose is presented in Figure A.2-3. This evaluation also demonstrated that this correction factor was not influenced by the type of test (e.g., weapons test or safety experiment) as shown in Figure A.2-4, where the percent external dose represents different types of tests (i.e., weapons tests have a high percentage of external dose and safety experiments have a higher percentage of internal dose). The correction factor is also not influenced by the amount of activity present (Figure A.2-5). However, it demonstrated that at very low external dose levels (as external doses approached zero), the relationship between RESRAD-derived external dose and TLD external dose had no correlation. Therefore, attempting to use site-specific data to correct RESRAD-derived external dose at sites where external dose is low can result in erratic and erroneous results.

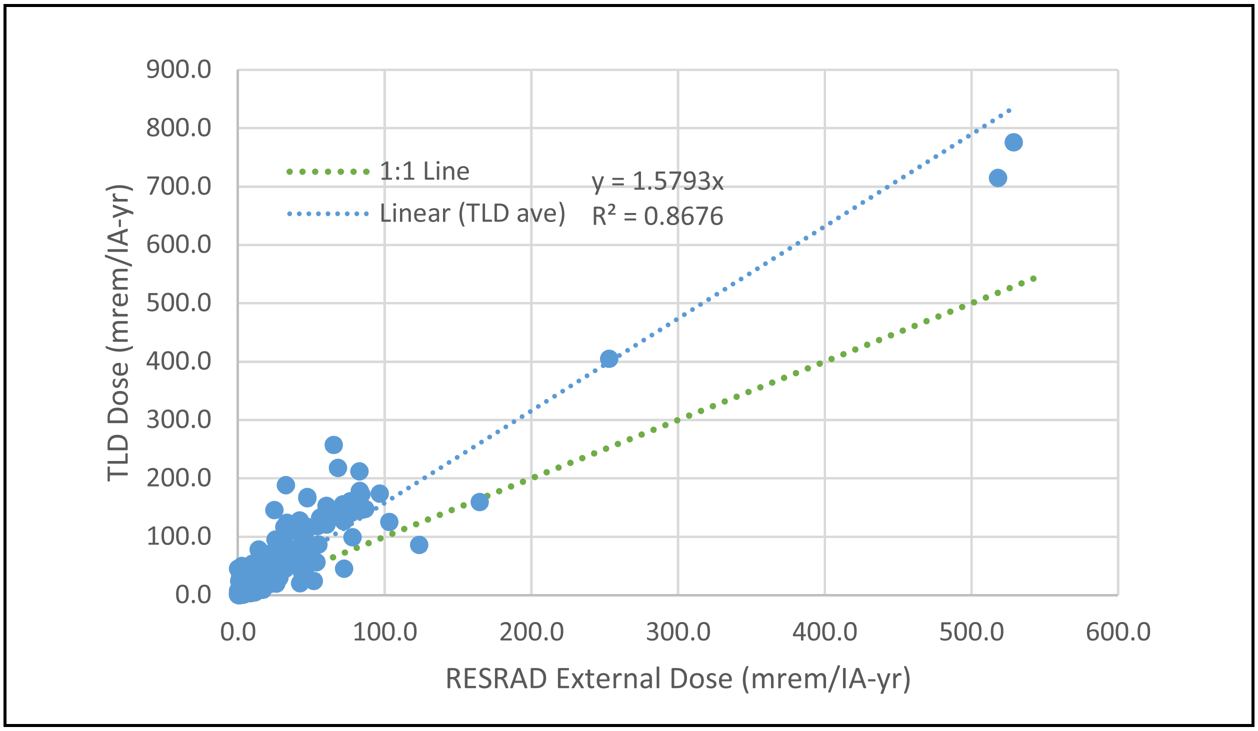

Figure A.2-3
Correlation of TLD Dose to RESRAD External Dose

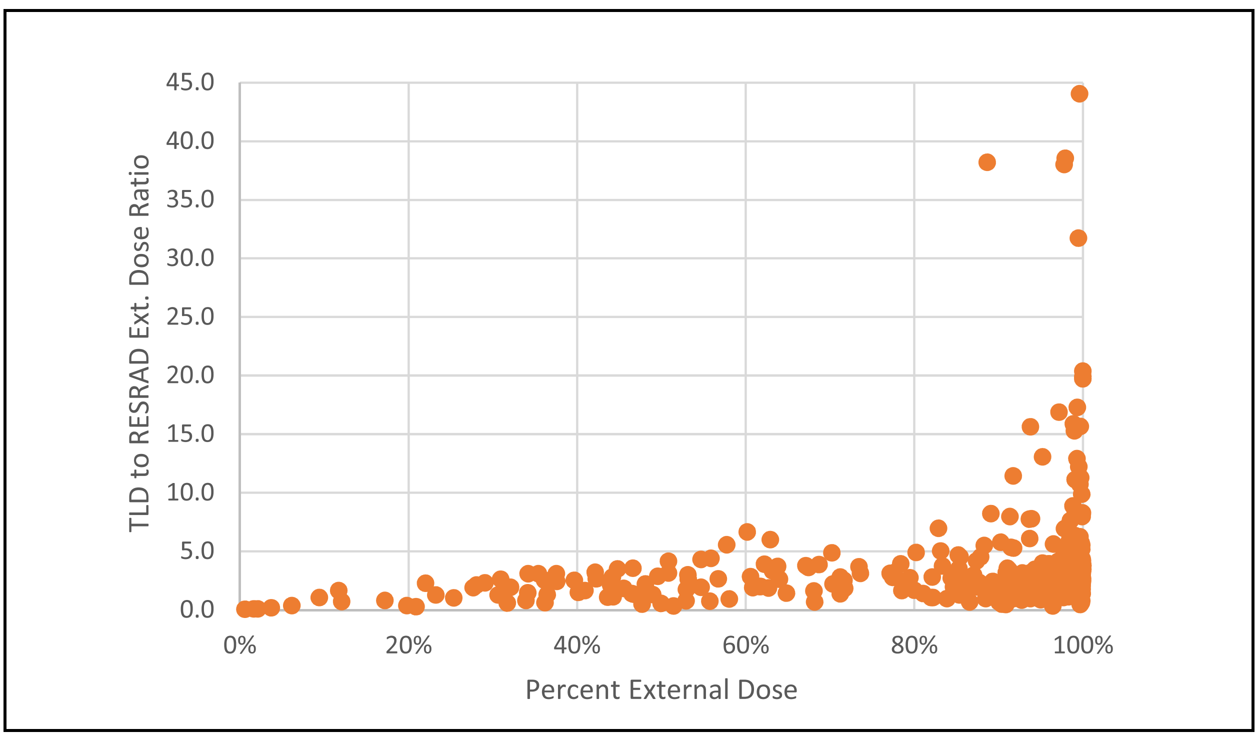

Figure A.2-4
Correlation of Correction Factor to Release Type

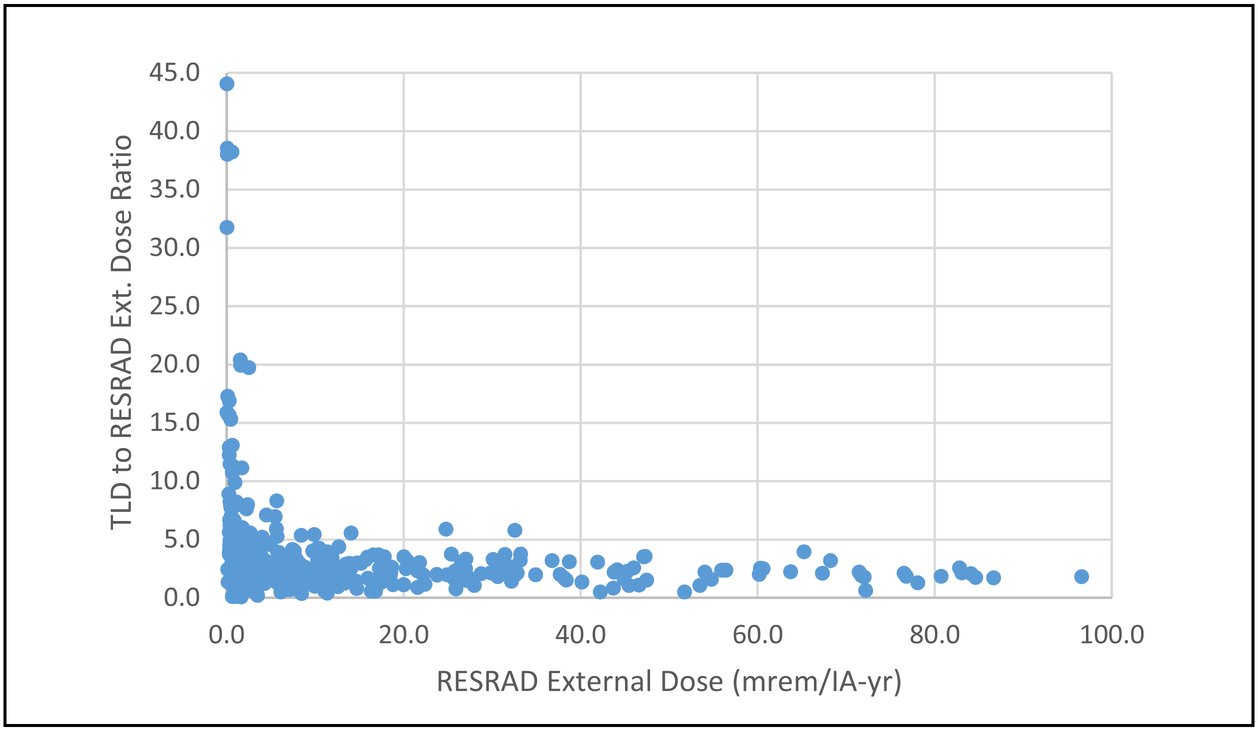

Figure A.2-5
Correlation of Correction Factor to External Dose

A.2.3.3 Total Effective Dose

The calculated TED represents the sum of the internal dose and the external dose for each sample location. The calculated TED is an estimate of the true (unknown) TED. It is uncertain how well the calculated TED represents the true TED. If a calculated TED were directly compared to the FAL, any significant difference between the true TED and the calculated TED could lead to decision errors.

To reduce the probability of a false-negative decision error for probabilistic sampling results, a conservative estimate of the true TED (i.e., the 95 percent UCL) is used to compare to the FAL. By definition, there will be a 95 percent probability that the true TED is less than the 95 percent UCL of the calculated TED. The probabilistic sampling design as described in the CAIP (NNSA/NFO, 2016) conservatively prescribes using the 95 percent UCL of the TED for DQO decisions. The 95 percent UCL of the TED is also used for determining the presence or absence of COCs (DQO Decision I). For sample locations where a TLD and multiple soil samples are collected (i.e., sample plots), this is calculated as the sum of the 95 percent UCL of the internal and external doses. For grab sample locations where a TLD sample was collected or a TLD-equivalent is calculated, TED is calculated as the sum of the 95 percent UCL of the external dose and the single internal dose estimate.

A minimum number of samples is required to assure sufficient confidence in dose statistics for probabilistic sampling such as the average and 95 percent UCL (EPA, 2006). As stated in the CAIP, if the minimum sample size criterion cannot be met, it must be assumed that contamination exceeds the FAL. The calculation of the minimum sample size is described in Section B.1.1.1.1.

To reduce the probability of a false-negative decision error for judgmental sampling results, samples were biased to locations of higher radioactivity. Samples from these locations will produce TED results that are higher than from adjacent locations of lower radioactivity (within the exposure area that is being characterized for dose). This will conservatively overestimate the true TED of the exposure area and protect against false-negative decision errors.

A.2.4 Comparison to Action Levels

The radiological action level is based on an annual dose limit of 25 mrem/yr. This dose limit is specific to the potential cumulative annual hours of exposure to site contamination. The radiological PAL was established in the CAIP (NNSA/NFO, 2016) based on a dose limit of 25 mrem/yr over an annual exposure time of 960 hours (i.e., the CW exposure scenario, in which a site worker is exposed to site contamination for 8 hr/day and 120 day/yr). The radiological FAL is established in Appendix D.

Radiological doses calculated soil sample and TLD results were compared to the area-based radiological FAL. To determine whether corrective action is necessary at small areas of anomalous elevated radioactivity (i.e., hot spots), the data were evaluated against the hot spot criteria defined in Appendix J. Removable contamination is another consideration in determining whether corrective action is necessary at CAU 413. If removable alpha radioactive contamination is present that exceeds the HCA criteria as stated in the CAIP, it is assumed the radiological FAL is exceeded and corrective action is required. A summary of the FAL basis and assumptions for each study group is presented in Table A.2-1.

Table A.2-1
FAL Basis and Assumptions for CAU 413 Study Groups

Study Group	Description	FAL	Basis/Assumption	Reference
1	Undisturbed Areas	25 mrem/CW-yr	1,000-m^2 area of contamination	Soils RBCA (NNSA/NFO, 2014)
2	Disturbed Areas			
3	Sedimentation Areas			
4	Former Staging Area			
5	Buried Debris		Assumed FAL was exceeded	CAIP (NNSA/NFO, 2016)
6	Potential Source Material		1-m^2 (hot spot) area of contamination	Appendix J
7	Soil Mounds		1,000-m^2 area of contamination	Soils RBCA (NNSA/NFO, 2014)

A.3.0 SG1, Undisturbed Areas

The Undisturbed Areas at CAU 413 include those areas not impacted by post-test operations (including the approximately 120-m^2 area currently posted as an RMA, as described in Section 2.2.1.6), exclusive of the areas defined by other study groups. It is assumed that contamination from the CSII test deposited at these locations has not been mechanically disturbed since the time of the test. The only movement of contamination from the surface of the Undisturbed Areas is assumed to be attributable to natural processes, such as precipitation, wind, and surface water flow. Additional detail on the history of SG1 is provided in the CAIP (NNSA/NFO, 2016).

A.3.1 CAI Activities

The CAI activities specific to the SG1 investigation included radiological surveys, including FIDLER and removable contamination surveys, and surface soil and TLD sampling.

A.3.1.1 Radiological Surveys

Radiological surveys were completed at CAU 413 as described in Section A.2.2.2. These surveys were used in the determination of the 25-mrem/CW-yr corrective action boundary, which is discussed in Section A.3.3.

A.3.1.2 Soil Samples

In accordance with the CAIP (NNSA/NFO, 2016), nine soil sample plots were established in areas of varying contamination levels identified by the 1996 KIWI and 2012 FIDLER surveys (NSTec, 2009). One additional sample plot was established on the east side of the site outside the CA fence based on elevated FIDLER readings. Four composite soil samples were collected from each of the sample plots (C08 through C16 and C29) as described in Section A.2.2.4. All soil samples were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am analyses. A summary of the soil samples is provided in Table A.3-1; sample plot locations are shown on Figure A.3-1. The analytical data are provided in Appendix K.

Table A.3-1
SG1 Sample Plot Soil Samples
(Page 1 of 2)

Location	Sample Number	Depth (cm bgs)
C08	AB3A601	0 - 5
	AB3A602	
	AB3A603	
	AB3A604	
C09	AB3A605	0 - 5
	AB3A606	
	AB3A607	
	AB3A608	
C10	AB3A609	0 - 5
	AB3A610	
	AB3A611	
	AB3A612	
C11	AB3A621	0 - 5
	AB3A622	
	AB3A623	
	AB3A624	
C12	AB3A625	0 - 5
	AB3A626	
	AB3A627	
	AB3A628	
C13	AB3A629	0 - 5
	AB3A630	
	AB3A631	
	AB3A632	
C14	AB3A633	0 - 5
	AB3A634	
	AB3A635	
	AB3A636	

Table A.3-1
SG1 Sample Plot Soil Samples
(Page 2 of 2)

Location	Sample Number	Depth (cm bgs)
C15	AB3A617	0 - 5
	AB3A618	
	AB3A619	
	AB3A620	
C16	AB3A613	0 - 5
	AB3A614	
	AB3A615	
	AB3A616	
C29	AB3A644	0 - 5
	AB3A645	
	AB3A646	
	AB3A647	

A.3.1.3 TLD Samples

One TLD was placed in the center of each of the soil sample plots (locations C08 through C16 and C29) to measure external dose (Figure A.3-1). Table A.3-2 provides information for the TLDs placed at SG1 sample locations.

A.3.2 Investigation Results

The following subsections discuss the removable contamination survey results and present the internal, external, and TED for soil and TLD samples collected in SG1. The radiological results are reported as doses that are a conservative estimate of maximum potentials dose for FFACO decision-making purposes only.

A.3.2.1 Removable Contamination Surveys

In accordance with the CAIP (NNSA/NFO, 2016), removable contamination surveys were completed at each SG1 sample plot located within the CA fence.

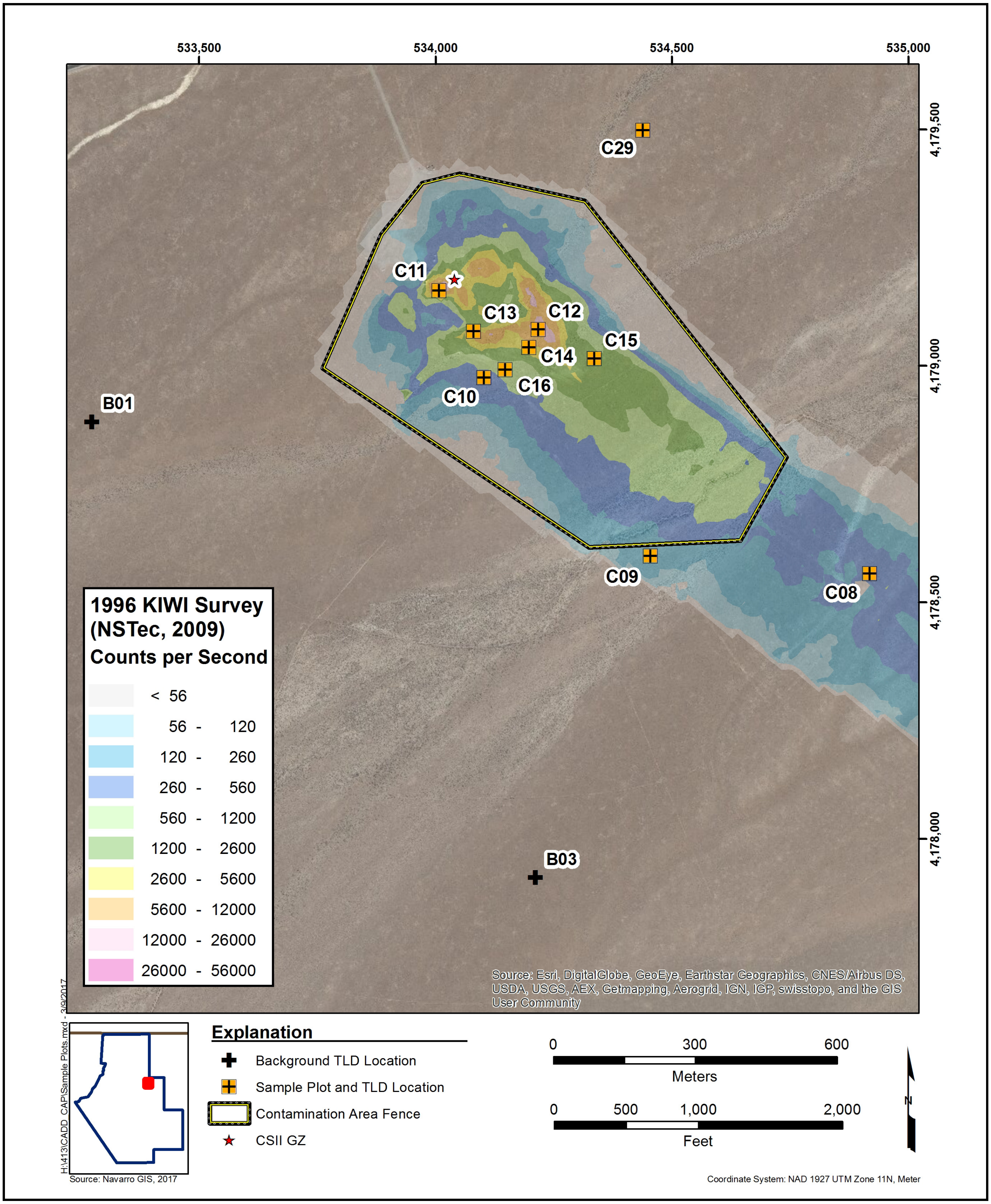

Figure A.3-1
SG1 Sample Plot and TLD Locations

Table A.3-2
SG1 TLDs

Location	TLD Number	Date Placed	Date Removed	Purpose
C08	4661	06/30/2015	12/07/2015	Sample Plot
C09	4325	06/30/2015	12/08/2015	Sample Plot
C10	5272	07/13/2015	12/08/2015	Sample Plot
C11	3769	07/16/2015	12/08/2015	Sample Plot
C12	4794	07/16/2015	12/08/2015	Sample Plot
C13	4927	07/28/2015	12/08/2015	Sample Plot
C14	4820	07/28/2015	12/08/2015	Sample Plot
C15	3693	07/15/2015	12/08/2015	Sample Plot
C16	5269	07/13/2015	12/08/2015	Sample Plot
C29	6455	10/28/2015	04/11/2016	Sample Plot
B01	4855	07/07/2015	12/07/2015	Background
B03	4701	07/08/2015	12/07/2015	Background

Note: The background TLD at location B02 was not used to calculate background external dose (Section A.3.1.3).

Additional removable contamination surveys were completed at CAU 413 to define areas that exceed the HCA criterion of 2,000 dpm/100 cm^2. A total of 66 removable contamination swipe samples were collected in the areas surrounding GZ outside the estimated 25-mrem/CW-yr boundary. The HCA criterion was exceeded at seven sample locations. Swipe samples were collected around each of the seven locations to delineate the extent of the area above the HCA criterion. The sample locations and the corresponding range of removable alpha contamination values are shown in Figure A.3-2. As stated in the CAIP, it is assumed that areas that exceed the HCA criterion require corrective action.

A.3.2.2 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each SG1 sample plot were determined as described in Section A.2.3.1. The standard deviation, number of samples, minimum sample size, and 95 percent UCL of the internal dose at the sample plots for each exposure scenario are presented in Table A.3-3. The minimum sample size requirements were met for all sample locations except C11. In accordance with the Soils RBCA document (NNSA/NFO, 2014), if the

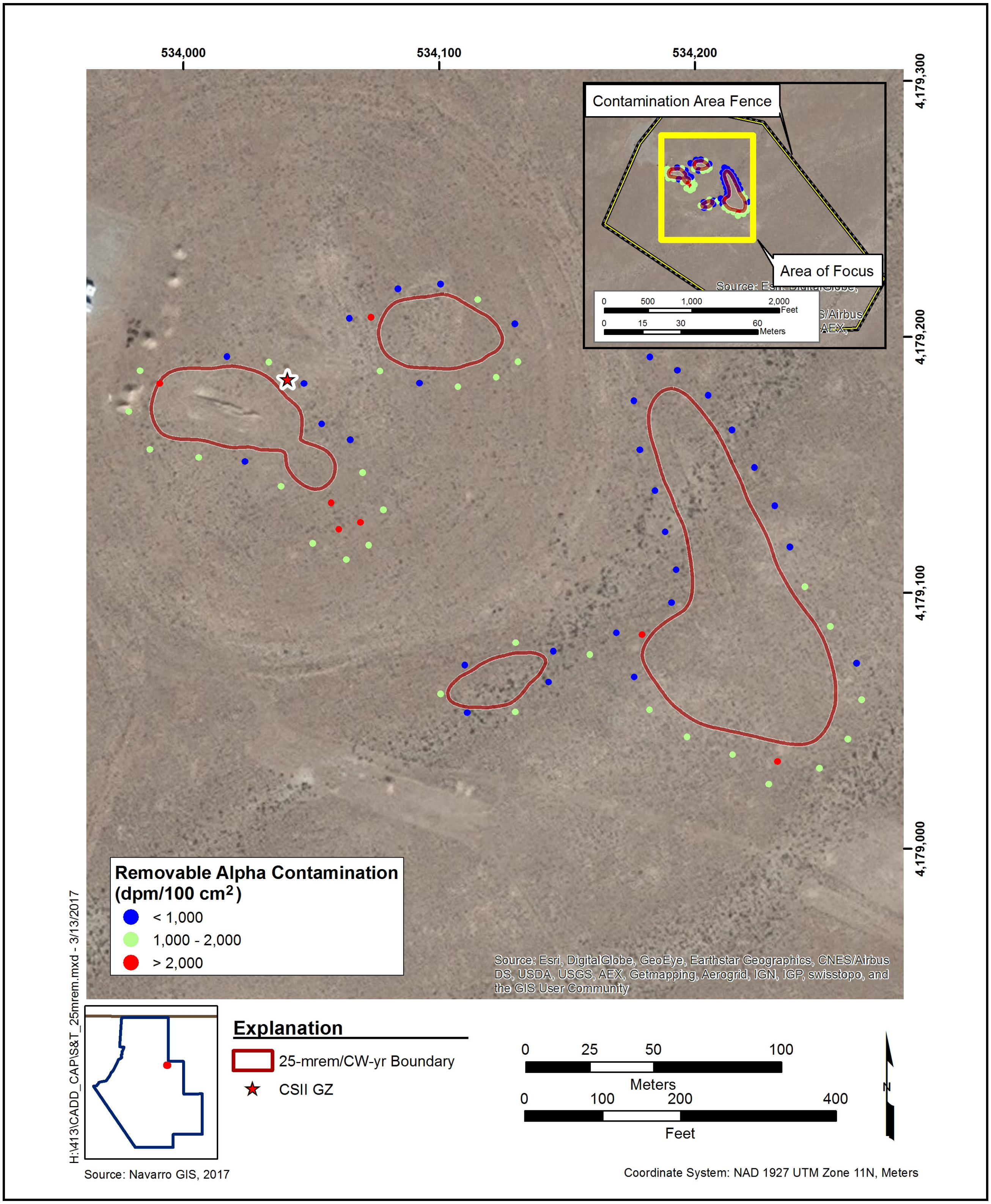

Figure A.3-2
Removable Contamination Sample Locations

Table A.3-3
Average and 95% UCL Internal Dose at Sample Plots in SG1

Sample Location	Standard Deviation (CW Scenario)	Number of Samples	Minimum Sample Size (CW Scenario)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
				Average	95% UCL	Average	95% UCL
C08	0.3	4	3	2	3	3	3
C09	0.1	4	3	0	1	1	1
C10	0.1	4	3	1	1	1	2
C11	18.6	4	15	**39**	**61**	**50**	**78**
C12	7.5	4	3	**45**	**54**	**58**	**69**
C13	1.5	4	3	10	11	12	15
C14	1.5	4	3	19	21	24	**27**
C15	0.9	4	3	5	6	7	8
C16	0.9	4	3	2	3	3	4
C29	0.6	4	3	1	2	1	2

mrem/IA-yr = Millirem per Industrial Area year

Bold indicates the values exceeding 25 mrem/yr.

minimum sample size requirement is not met, additional samples may be collected or it may be assumed that the sample location exceeds the FAL. Sample location C11 is the closest sample plot to GZ and was placed in one of the locations of highest radiological readings as indicated by the 1996 KIWI survey (NSTec, 2009). Because it was anticipated that the FAL would be exceeded at this location, additional samples were not collected.

A.3.2.3 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at each SG1 sample plot were determined as described in Section A.2.3.2. External dose was calculated for the CW exposure scenario for each TLD location. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for the exposure scenarios are presented in Table A.3-4. The minimum sample size requirements were met for all TLD locations.

Table A.3-4
Average and 95% UCL External Dose at Sample Plots in SG1

Sample Location	Standard Deviation (CW Scenario)	Number of Elements	Minimum Sample Size (CW Scenario)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
				Average	95% UCL	Average	95% UCL
C08	0.3	3	3	0	0	0	0
C09	0.0	3	3	0	0	0	0
C10	0.6	3	3	1	1	2	2
C11	5.2	3	3	10	13	20	**27**
C12	3.8	3	3	10	13	22	**27**
C13	2.6	3	3	2	4	4	8
C14	3.5	3	3	5	7	10	14
C15	1.8	3	3	2	3	4	6
C16	1.0	3	3	1	2	2	3
C29	1.2	3	3	0	1	1	2

Bold indicates the values exceeding 25 mrem/yr.

A.3.2.4 Total Effective Dose

The TED for each sample plot location was calculated by adding the external dose values and the internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the CW and Industrial Area (IA) exposure scenarios are presented in Table A.3-5. The 95 percent UCL of the average TED exceeds the FAL of 25 mrem/CW-yr at locations C11, C12, and C14. The 95 percent UCL of the average TED is shown with each sample plot location in Figure A.3-3.

Considering radioactive decay mechanisms only (with contamination erosion and transport mechanisms removed), TED at the sampled location with the maximum TED (C11) will not significantly decay in the next 1,000 years. The TED at this location is currently driven by Am-241 and Pu-239/240, which contribute about 98 percent of the total dose for locations where dose is greater than 1/4 of the FAL.

Table A.3-5
Average and 95% UCL TED at Sample Plots in SG1

Sample Location	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
	Average	95% UCL	Average	95% UCL
C08	2	3	3	4
C09	0	1	1	1
C10	2	2	3	4
C11	**48**	**74**	**70**	**105**
C12	**55**	**67**	**80**	**96**
C13	12	15	17	22
C14	23	**28**	**34**	**41**
C15	7	9	11	14
C16	3	5	5	8
C29	1	3	2	4

Bold indicates the values exceeding 25 mrem/yr.

A.3.3 Nature and Extent of COCs

The 95 percent UCL of the average TED exceeds the FAL of 25 mrem/CW-yr at locations C11, C12, and C14. Thus, the FAL is exceeded and corrective action is required for SG1. In order to determine the boundary within which the FAL is exceeded, the FIDLER survey surface (Section A.2.2.1) was correlated with the TED from SG1 sample plots and from location C11 (SG2 surface soil location exceeding the FAL). This correlation process is described in the Soils RBCA document (NNSA/NFO, 2014). For CAU 413, the correlation has a high correlation coefficient of 0.99, indicating a strong relationship. The correlation graph, FIDLER surface, and resulting 25-mrem/CW-yr boundary for SG1 are shown in Figure A.3-4.

As described in Section A.3.2.1 and shown on Figure A.3-2, the HCA criterion of 2,000 dpm/100 cm^2 removable alpha contamination was exceeded at seven sample locations outside the 25-mrem/CW-yr boundary for SG1. As it is assumed that the dose-based FAL is exceeded and corrective action is required, the corrective action boundary was expanded to include these locations as shown in Figure A.3-5.

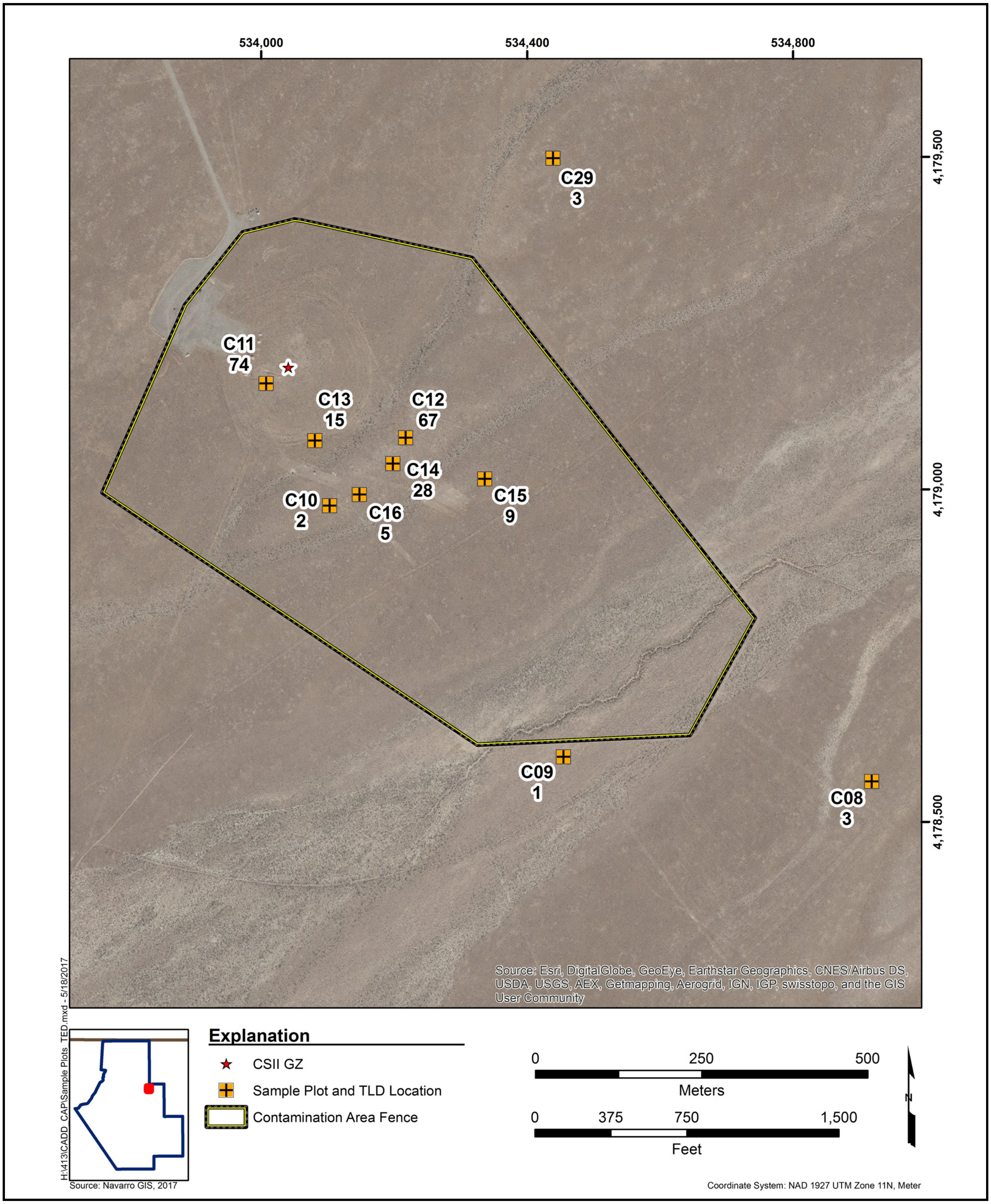

Figure A.3-3
95% UCL of the TED (mrem/CW-yr) at SG1 Sample Plot Locations

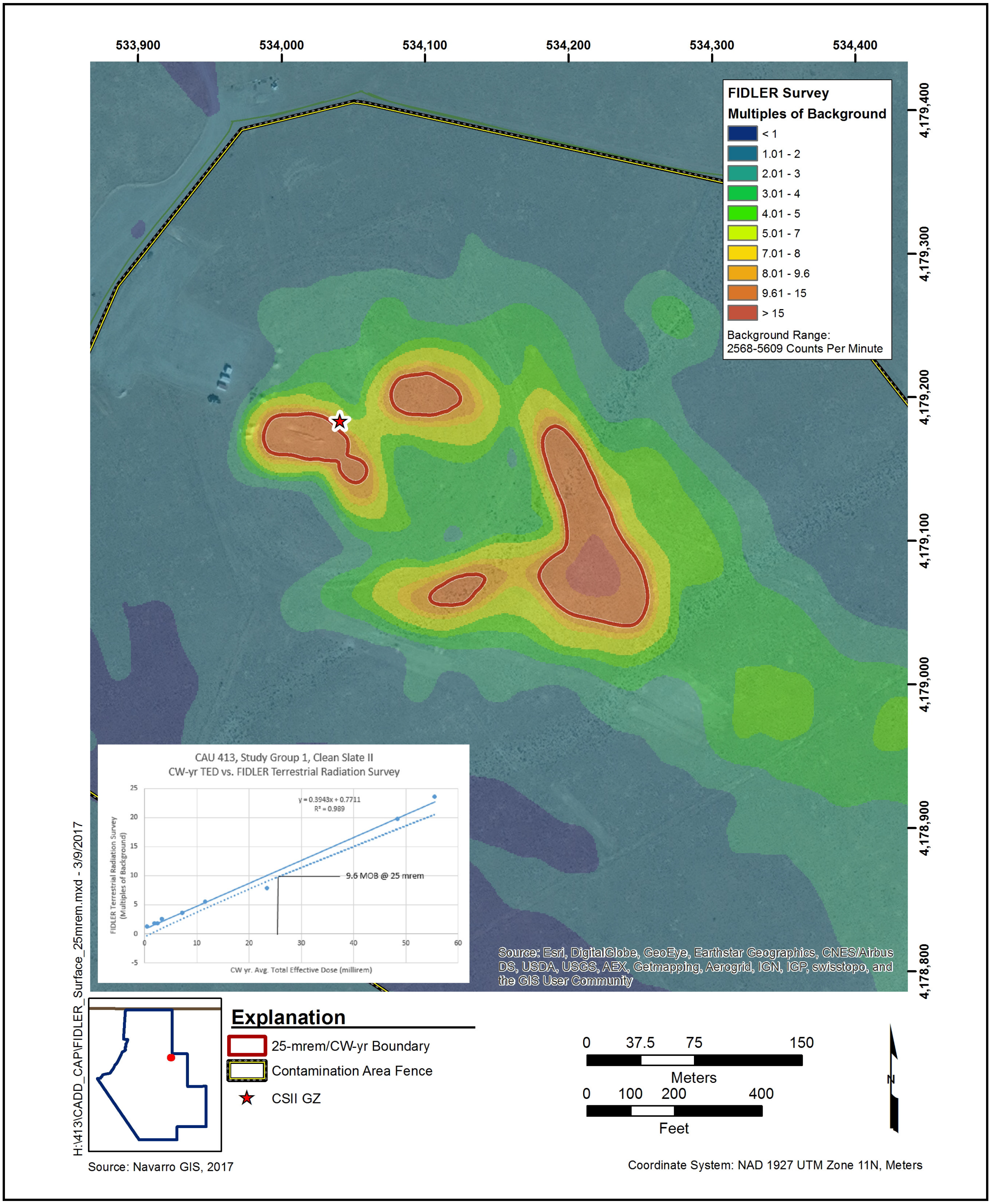

Figure A.3-4
25-mrem/CW-yr Boundary for SG1

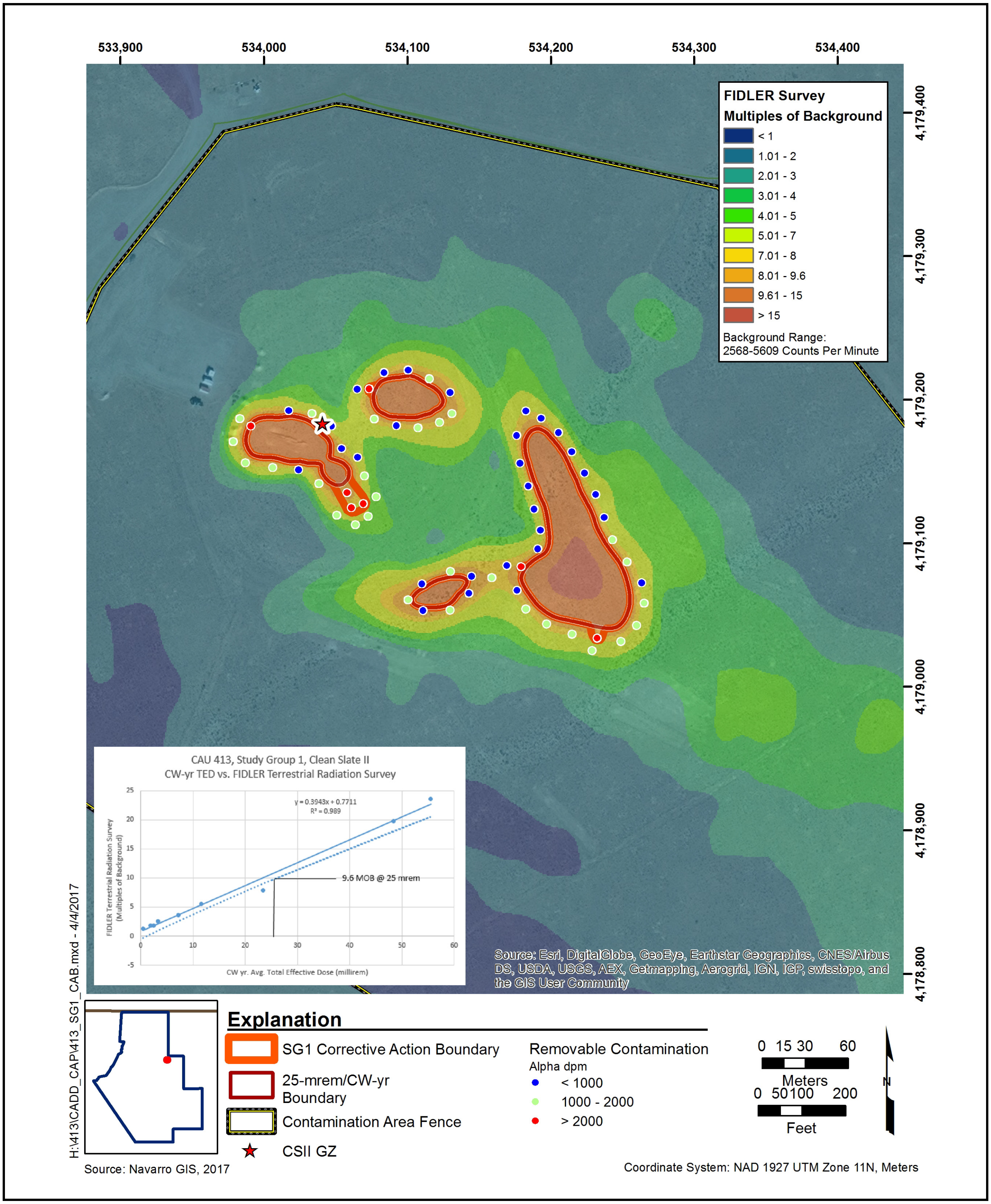

Figure A.3-5
Corrective Action Boundary for SG1

All initial corrective action boundaries established for the CAA of clean closure were established for the purpose of planning the areas and volumes to be excavated. The excavation will be guided by visual surveys, radiological surveys, and geophysical surveys, as appropriate. Upon completion of excavation, a comprehensive FIDLER survey will be performed and recorded with a GPS instrument to select the locations for verification soil sampling. Soil sampling will be completed in accordance with Section 5.4 and Appendix F. Results of the soil sampling will determine whether additional excavation is required or provide verification that the corrective action is complete. Therefore, corrective action waste volumes may be less or more than estimated herein.

A.3.4 Deviations/Revised CSM

The information gathered during the CAI supports the CSM as presented in the CAIP (NNSA/NFO, 2016). No revisions to the CSM were necessary and there were no deviations to the planned activities in the CAIP except for the number of background samples as explained in Section A.2.2.3. This deviation did not affect any DQO decisions.

A.4.0 SG2, Disturbed Areas

This study group includes those locations where it is likely that contamination originally deposited by the test was redistributed by activities that occurred immediately after, and in the years following, the test (e.g., post-test cleanup, technology demonstration project). Five such areas were investigated during the CAI. Additional detail on the history of SG2 is provided in the CAIP (NNSA/NFO, 2016).

A.4.1 CAI Activities

CAI activities specific to SG2 included radiological surveys at each disturbed area using a FIDLER, depth screening at each sample location using an alpha/beta detector, and soil sampling. One sample location was evaluated at each of the five disturbed areas. No additional disturbed areas were identified during the CAI.

A.4.1.1 Radiological Surveys

Before sampling, FIDLER surveys were completed within each disturbed area to further bias the sample locations to the area with the most elevated radiological readings. The sample locations are shown in Figure A.4-1.

A.4.1.2 Soil Samples

At each SG2 sample location (C01, C02, C03, C05, and C11), soil depth screening was conducted to determine the presence of buried contamination. Soil samples were collected at 5-cm intervals to a depth of 30 cm bgs and field screened for radioactivity. The surface soil sample (0 to 5 cm) from each location was collected for laboratory analyses. The only location at which radiological field-screening criteria were exceeded at depth was at sample location C11 from 5 to 10 cm bgs. As a result, only one subsurface soil sample (AB3A035) was collected and sent for laboratory analyses from SG2. All SG2 soil samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am. A summary of the SG2 samples collected is provided in Table A.4-1; sample locations are shown on Figure A.4-1. The analytical data are provided in Appendix K.

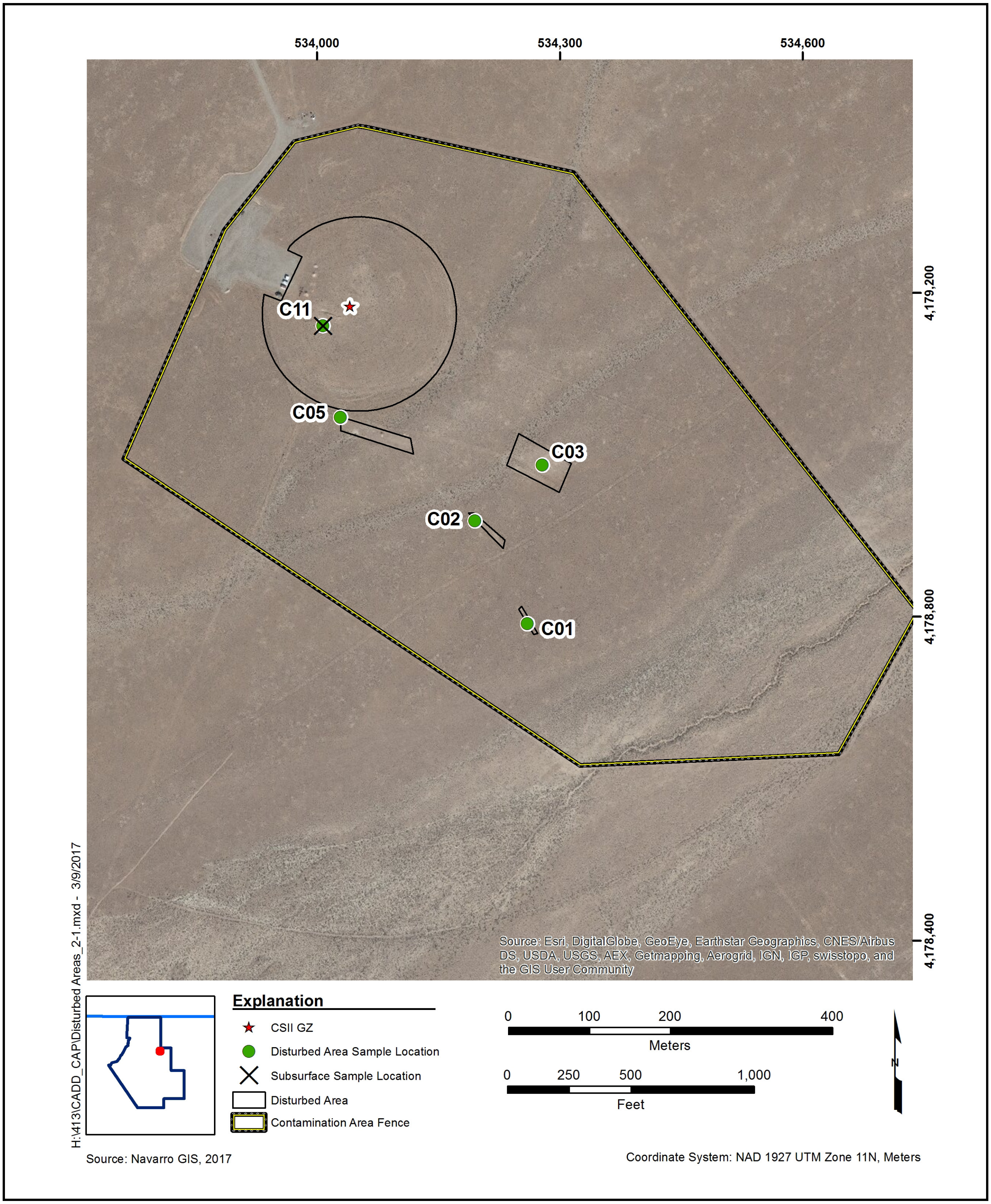

Figure A.4-1
SG2 Sample Locations

Table A.4-1
SG2 Soil Samples

Location	Sample Number	Sample Depth (cm bgs)
C01	AB3A040	0 - 5
	AB3A041 (FD)	
C02	AB3A042	0 - 5
C03	AB3A043	0 - 5
C05	AB3A039	0 - 5
C11	AB3A034	0 - 5
	AB3A035	5 - 10

A.4.2 Investigation Results

The following subsections present the internal, external, and TED results for surface and subsurface soil samples collected at SG2. The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/CW-yr.

A.4.2.1 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each SG2 sample location (Figure A.4-1) were determined as described in Section A.2.3.1. The internal doses for each exposure scenario are presented in Table A.4-2.

A.4.2.2 External Radiological Dose Calculations

In accordance with the CAIP (NNSA/NFO, 2016), TLDs were not placed at SG2 sample locations because the DQO decision for SG2 was based upon the presence of COCs in the subsurface. However, as location C11 was collocated with an SG1 sample plot location where a TLD had been placed, data from this TLD were used to calculate external dose for the surface soil at location C11. For the subsurface soil at location C11 and for the other four SG2 sample locations where no TLDs were placed, external dose was estimated as described in Section A.2.3.1. External dose was calculated for the CW exposure scenarios for each sample location. The external dose for each exposure scenario are presented in Table A.4-3.

Table A.4-2
Average Internal Dose at Sample Locations in SG2 [a]

Sample Location	Sample Depth (cm bgs)	Number of Samples	Construction Worker (mrem/CW-yr)	Industrial Area (mrem/IA-yr)
C01	0 - 5	2	1	1
C02	0 - 5	1	0	0
C03	0 - 5	1	8	10
C05	0 - 5	1	7	9
C11	0 - 5	1	**42**	**54**
	5 - 10	1	7	9

[a] A 95% UCL internal dose for SG2 sample locations was not calculated because there were fewer than 3 samples collected at each location.

Bold indicates value exceeds 25 mrem/yr.

Table A.4-3
Average and 95% UCL External Dose at Sample Locations in SG2

Sample Location	Sample Depth (cm bgs)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
		Average	95% UCL	Average	95% UCL
C01	0 - 5	0	0	0	0
C02	0 - 5	0	0	0	0
C03	0 - 5	1	1	2	2
C05	0 - 5	1	1	2	2
C11	0 - 5 [a]	10	13	20	**27**
	5 - 10 [b]	1	1	1	2

[a] External dose for this interval is from TLD Number 3769 associated with C11 sample plot in SG1.
[b] External dose for this interval was calculated in accordance with Section A.2.3.2.

Bold indicates value exceeds 25 mrem/yr.

A.4.2.3 Total Effective Dose

The average TED for each SG2 sample location was calculated by adding the average external dose values and the single internal dose values. The 95 percent UCL of the TED for each sample location was calculated by adding the 95 percent UCL of the external dose values and the single internal dose values. Values for both the average TED and the 95 percent UCL of the TED for the CW and IA exposure scenarios are presented in Table A.4-4. Of the five disturbed areas, sample location C11 was the only SG2 location where the 95 percent UCL of the average TED at the surface exceeded the FAL of 25 mrem/CW-yr. The 95 percent UCL of the average TED is shown with each SG2 sample location in Figure A.4-2.

Table A.4-4
Average and 95% UCL of the TED at Sample Locations in SG2

Sample Location	Sample Depth (cm bgs)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
		Average	95% UCL	Average	95% UCL
C01	0 - 5	1	1	2	2
C02	0 - 5	0	0	1	1
C03	0 - 5	9	9	12	12
C05	0 - 5	8	8	11	11
C11	0 - 5	**51**	**55**	**74**	**81**
	5 - 10	8	8	11	11

Bold indicates value exceeds 25 mrem/yr.

A.4.3 Nature and Extent of COCs

As stated in the CAIP (NNSA/NFO, 2016), the primary objective of the SG2 investigation was to determine whether buried contamination that could present a dose in excess of the FAL was present at any of the five disturbed areas. Radiological FSRs suggested the presence of buried contamination at one location (C11) at a depth of 5 to 10 cm bgs. The estimated dose for subsurface soil at this location, however, does not exceed the FAL (Table A.4-4). Radiological field screening did not suggest buried contamination at any of the other four disturbed areas; therefore, buried COC contamination is not present in SG2.

Because there is no subsurface contamination present at levels exceeding the FAL and no subsurface contamination present at levels greater than that found in the surface soil, the SG2 surface sample results are included in the evaluation of SG1. Therefore, no COCs are present associated with buried contamination in SG2 that require corrective action.

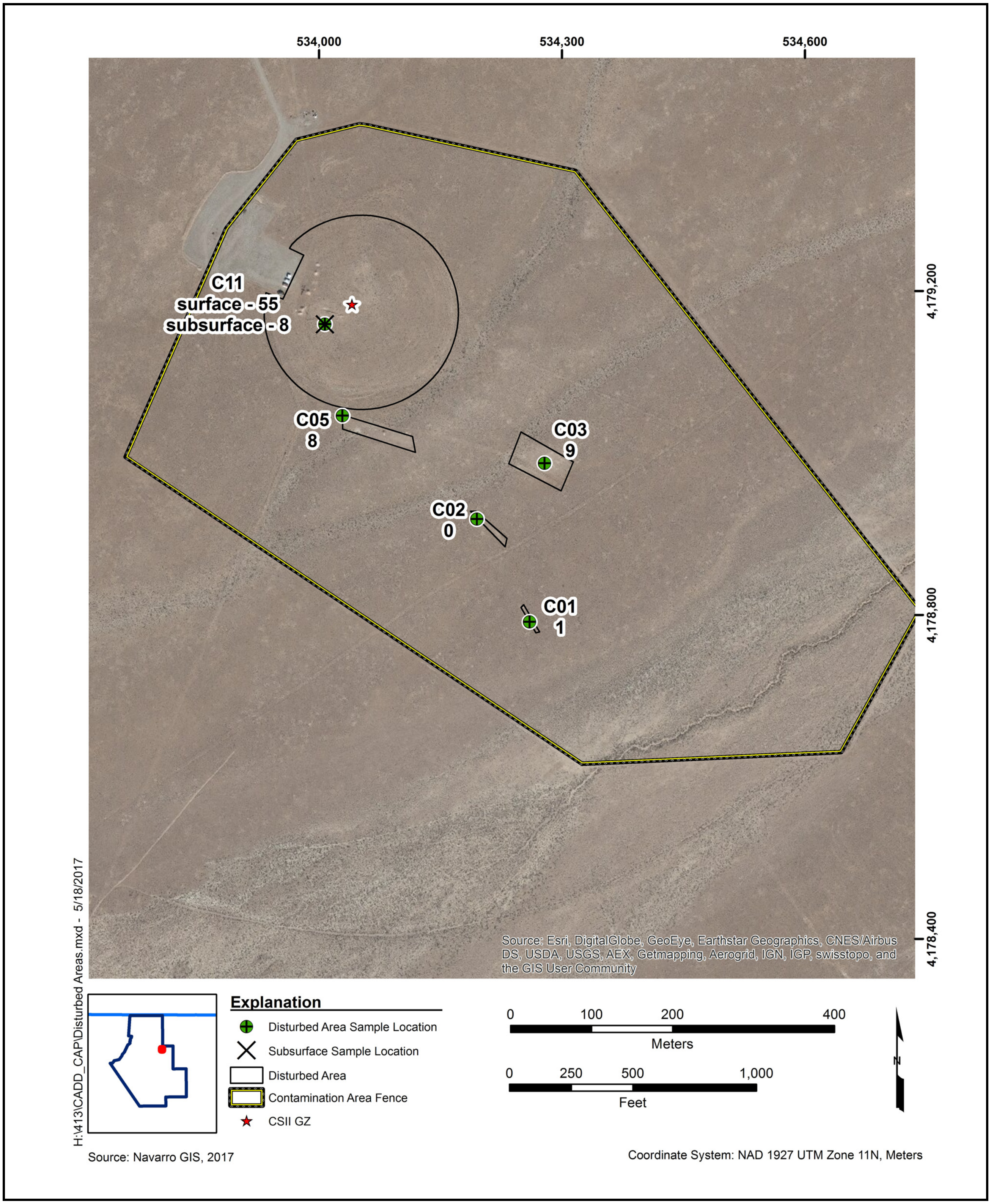

Figure A.4-2
95% UCL of the TED (mrem/CW-yr) at SG2 Sample Locations

A.4.4 Deviations/Revised CSM

The CAIP requirements (NNSA/NFO, 2016) were met at SG2, with no deviations. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.5.0 SG3, Sedimentation Areas

This study group consists of sedimentation areas within drainage channels where sediment has visibly accumulated. These channels may serve as transport mechanisms for contamination originally deposited on the ground surface during the CSII test. The potential also exists for contamination in these accumulation areas to have been buried over time by subsequent erosion events. The CAIP (NNSA/NFO, 2016) identified three drainage channels that transect the CA fence at CAU 413 in the northern portion of the site (Figure A.5-1). No additional drainage channels or surface water conveyances were identified during the CAI.

A.5.1 CAI Activities

CAI activities specific to SG3 included visual surveys to identify sampling locations, radiological surveys using a FIDLER, depth screening at sample locations, and soil and TLD sampling.

A.5.1.1 Visual Surveys

Visual surveys of the three drainage channels identified at CAU 413 were conducted to identify sediment accumulation areas within and outside the CA fence. A total of 12 accumulation areas (8 inside the CA fence and 4 outside the CA fence) were identified for sampling (Figure A.5-1).

A.5.1.2 Radiological Surveys

Radiological surveys using a FIDLER were completed at each sedimentation area selected for sampling by the visual survey. Sample locations were placed at the most radiologically elevated area within each sedimentation area, or at the approximate center of the area if radiological biasing factors were not present.

A.5.1.3 Soil Samples

A total of 15 grab soil samples (including 1 FD) were collected from 12 locations within SG3, as presented in Table A.5-1. At each sample location (C17 through C28), radiological depth screening was conducted to determine the presence of buried contamination, in accordance with Section A.2.2.2. Soil samples were collected at 5-cm intervals to a depth of 30 cm bgs and field

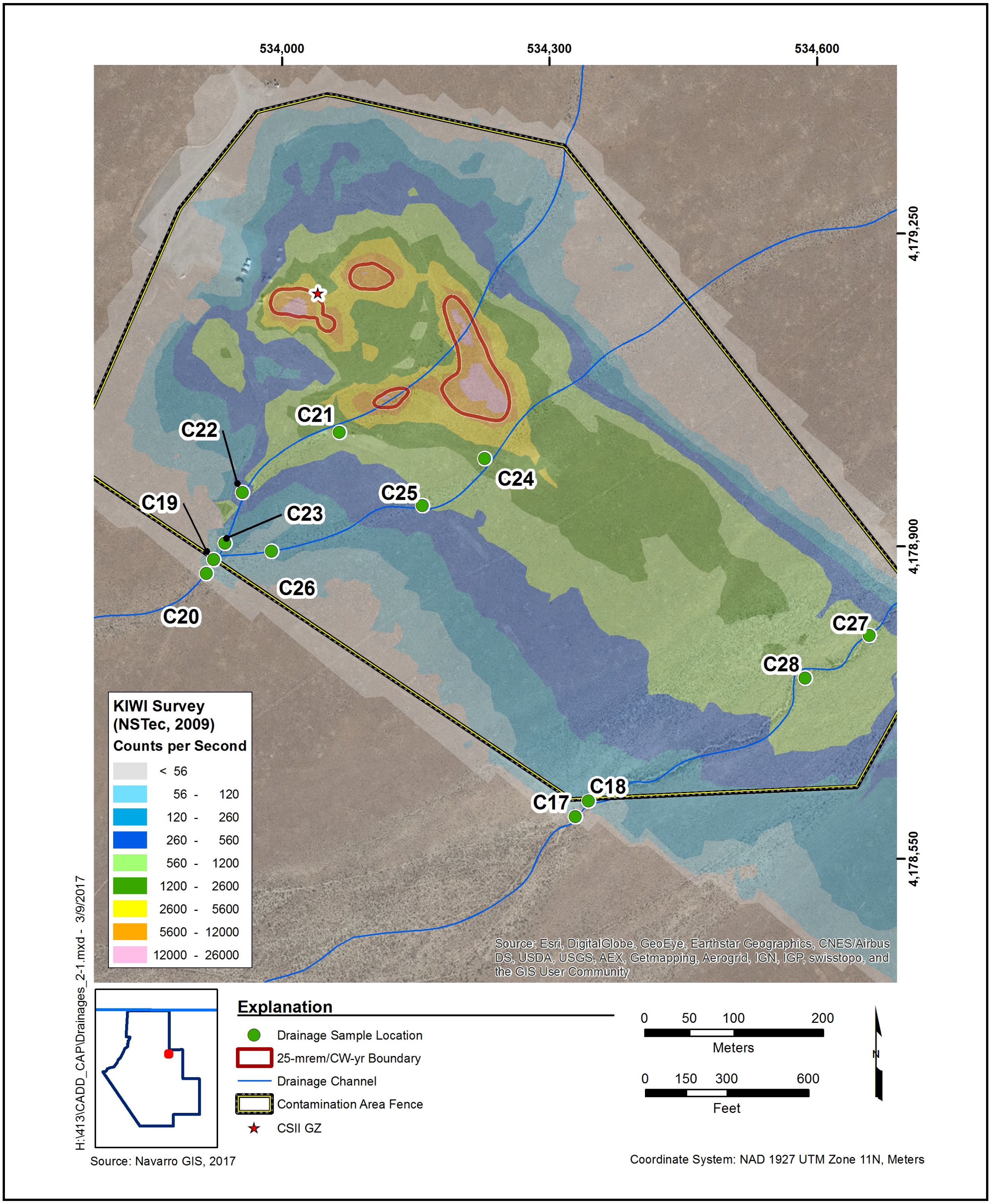

Figure A.5-1
SG3 Sample Locations

Table A.5-1
SG3 Soil Samples

Sample Location	Sample Number	Depth (cm bgs)
C17	AB3A001	0 - 5
C18	AB3A002	0 - 5
C19	AB3A021	0 - 5
	AB3A022 (FD)	
C20	AB3A023	0 - 5
C21	AB3A024	0 - 5
C22	AB3A025	0 - 5
C23	AB3A026	0 - 5
	AB3A027	25 - 30
C24	AB3A033	0 - 5
C25	AB3A032	0 - 5
C26	AB3A031	0 - 5
C27	AB3A044	0 - 5
C28	AB3A045	0 - 5
	AB3A036	5 - 10

screened for radioactivity. The surface soil sample (0 to 5 cm) from each location was submitted for laboratory analyses. At two locations, C23 and C28, the buried contamination criteria established in the CAIP (NNSA/NFO, 2016) were exceeded, suggesting the presence of contamination at depth. At these two locations, in addition to the surface soil sample, a sample from the depth interval with the highest FSR was also collected and submitted for analyses. All SG3 soil samples were analyzed for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am.

A.5.1.4 TLD Samples

To measure external dose, one TLD was placed at a height of 1 m at the center of SG3 sample locations C17, C19, and C21 through C28 (Figure A.5-1). A TLD was not placed at locations C18 or C20, as explained in Section A.5.4. All TLDs were measured by the NNSS environmental TLD monitoring program. Table A.5-2 provides information for the TLDs placed at SG3 sample locations.

Table A.5-2
SG3 TLDs

Location	TLD Number	Date Placed	Date Removed
C17	1104	06/30/2015	12/07/2015
C18	No TLD		
C19	4633	07/08/2015	12/07/2015
C20	No TLD		
C21	3512	07/09/2015	12/08/2015
C22	5015	07/09/2015	12/08/2015
C23	3437	07/09/2015	12/08/2015
C24	5136	07/14/2015	12/08/2015
C25	5161	07/14/2015	12/08/2015
C26	3276	07/14/2015	12/08/2015
C27	3818	07/28/2015	12/08/2015
C28	4828	07/28/2015	12/08/2015

A.5.2 Investigation Results

The following subsections present the internal, external, and TED results for surface and subsurface soil samples collected at SG3. The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/CW-yr.

A.5.2.1 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at each SG3 sample location were determined as described in Section A.2.3.1. The internal doses for each exposure scenario are presented in Table A.5-3.

A.5.2.2 External Radiological Dose Calculations

TLDs were placed at all SG3 sample locations except C18 and C20. External dose was calculated in accordance with Section A.2.3.2 for locations where TLDs were placed. For sample locations C18 and C20, external dose was estimated as stated in Section A.5.4. External dose was calculated for the

Table A.5-3
Average Internal Dose at Sample Locations in SG3 [a]

Sample Location	Sample Depth (cm bgs)	Number of Samples	Construction Worker (mrem/CW-yr)	Industrial Area (mrem/IA-yr)
C17	0 - 5	1	0	0
C18	0 - 5	1	0	0
C19	0 - 5	2	0	0
C20	0 - 5	1	0	0
C21	0 - 5	1	3	4
C22	0 - 5	1	1	1
C23	0 - 5	1	0	0
	25 - 30	1	0	0
C24	0 - 5	1	9	11
C25	0 - 5	1	2	3
C26	0 - 5	1	1	1
C27	0 - 5	1	0	1
C28	0 - 5	1	2	2
	5 - 10	1	2	2

[a] A 95% UCL internal dose for SG3 sample locations was not calculated because there were fewer than 3 samples collected at each location.

CW exposure scenarios for each sample location. The external dose for each exposure scenario are presented in Table A.5-4.

A.5.2.3 Total Effective Dose

The TED for each SG3 sample location was calculated by adding the external dose values and the internal dose values. The average TED and the 95 percent UCL of the TED for the CW and IA exposure scenarios are presented in Table A.5-5. The 95 percent UCL of the average TED did not exceed the FAL of 25 mrem/CW-yr at any sampled location within SG3. The 95 percent UCL of the average TED is shown with each SG3 sample location in Figure A.5-2.

Table A.5-4
Average and 95% UCL External Dose at Sample Locations in SG3

Sample Location	Sample Depth (cm bgs)	Standard Deviation (CW Scenario)	Number of Elements	Minimum Sample Size (CW Scenario)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
					Average	95% UCL	Average	95% UCL
C17	0 - 5	1.1	3	3	0	1	1	2
C18[a]	0 - 5	N/A	N/A	N/A	0	1	1	2
C19	0 - 5	0.3	3	3	0	0	0	1
C20[a]	0 - 5	N/A	N/A	N/A	0	0	0	1
C21	0 - 5	0.9	3	3	0	1	1	2
C22	0 - 5	0.6	3	3	0	1	0	1
C23	0 - 5	0.0	3	3	0	0	0	0
	25 - 30	N/A	N/A	N/A	0	0	0	0
C24	0 - 5	0.3	3	3	2	2	4	5
C25	0 - 5	2.4	3	3	1	3	2	5
C26	0 - 5	2.1	3	3	1	2	2	4
C27	0 - 5	0.9	3	3	0	1	1	2
C28	0 - 5	3.3	3	3	1	3	2	7
	5 - 10	N/A	N/A	N/A	0	0	0	0

[a] A TLD was not placed at this sample location (Section A.5.2).

N/A = Not applicable.

Table A.5-5
Average and 95% UCL TED at Sample Locations in SG3
(Page 1 of 2)

Sample Location	Sample Depth (cm bgs)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
		Average	95% UCL	Average	95% UCL
C17	0 - 5	1	1	1	2
C18	0 - 5	1	1	1	3
C19	0 - 5	0	0	0	1
C20	0 - 5	0	1	1	1
C21	0 - 5	3	4	4	5

Table A.5-5
Average and 95% UCL TED at Sample Locations in SG3
(Page 2 of 2)

Sample Location	Sample Depth (cm bgs)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
		Average	95% UCL	Average	95% UCL
C22	0 - 5	1	2	2	3
C23	0 - 5	0	0	0	0
	25 - 30	0	0	0	0
C24	0 - 5	11	11	15	16
C25	0 - 5	3	5	5	8
C26	0 - 5	2	3	3	5
C27	0 - 5	1	1	1	3
C28	0 - 5	3	5	4	9
	5 - 10	2	2	3	3

A.5.3 Nature and Extent of COCs

The TED at all surface and subsurface SG3 sample locations within drainage channels at CAU 413 were below the FAL of 25 mrem/CW-yr. Although radiological field screening suggested the presence of elevated readings at SG3 locations C23 and C28, the subsurface soil dose was less contaminated than the surface and was below the FAL at both locations (Table A.5-5). Therefore, no corrective action is required. However, any remaining radiological contamination will be managed in compliance with applicable DOE requirements. The SG3 data verify that contamination at levels exceeding the FAL is not migrating in drainages; and sediments have not covered, or buried, contamination at levels exceeding the FAL over time.

A.5.4 Deviations/Revised CSM

The CAIP stated that one TLD would be placed at each sample location in SG3 to measure external dose (NNSA/NFO, 2016). A TLD was not placed at sample locations C18 or C20. These two locations are outside the CA fence and approximately 1 m downgradient from sample locations C17 and C19, respectively. Based on the correlation of TED to the interpolative radiation survey surface described in Section A.2.2.1 and that external dose is approximately 28 percent of TED, the change in

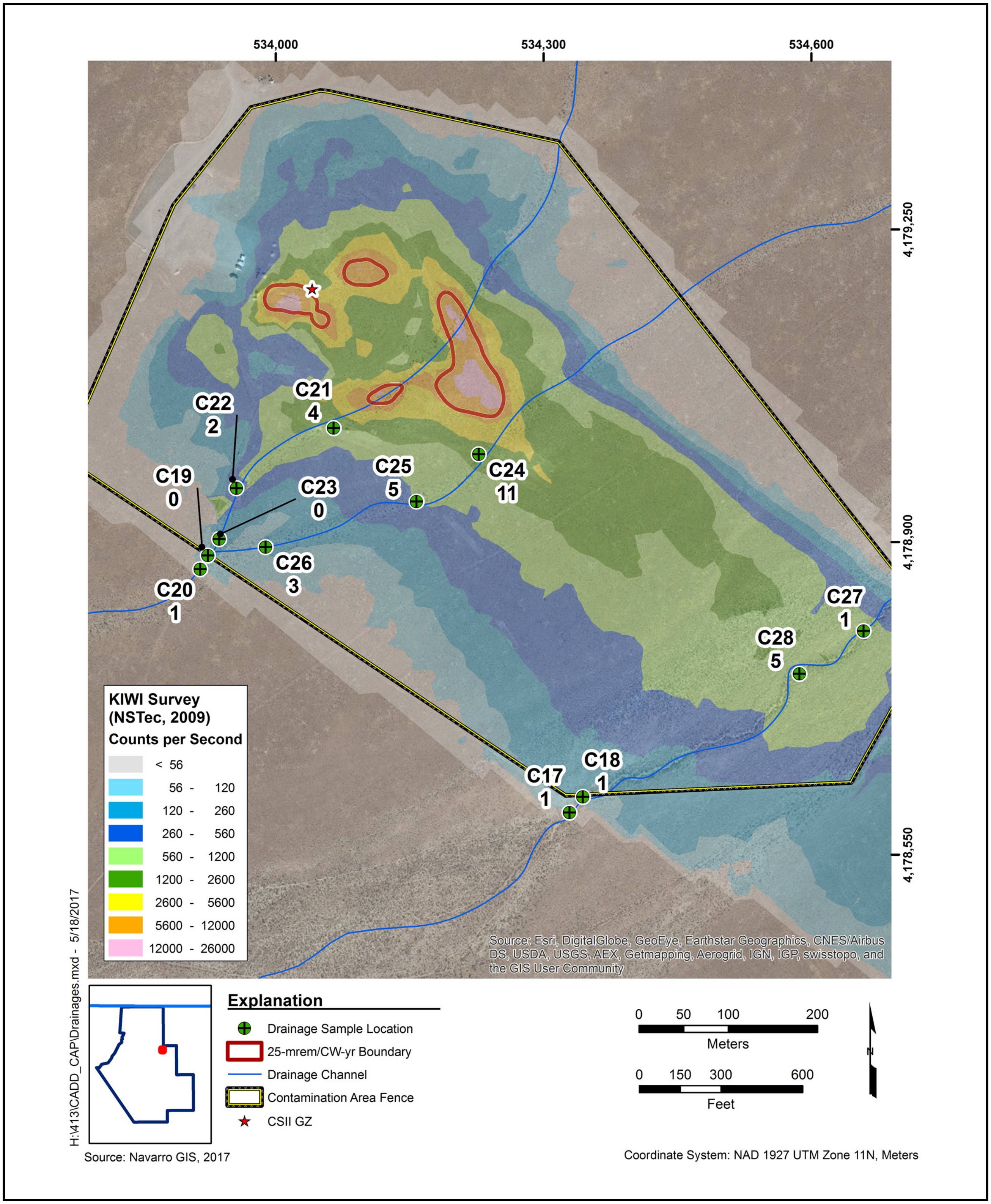

Figure A.5-2
95% UCL of the TED (mrem/CW-yr) at SG3 Sample Locations

external dose per meter of distance at these locations is approximately 0.008 mrem/CW-yr. Due to their close proximity to sample locations where TLDs were placed, the external dose derived from TLDs at the upgradient locations C17 and C19 were also used as the external dose for locations C18 and C20, respectively. This deviation does not adversely impact data usability or DQO decisions at these sample locations.

The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

A.6.0 SG4, Former Staging Area

The Former Staging Area is located northwest of GZ and is a visibly distinct area of fill material. Before construction of the staging area in the 1990s, the upper layer of native soil was removed and the area was covered with gravel and compacted (NNSA/NSO, 2004). The staging area was used to stage radioactively contaminated equipment and materials that were removed and disposed of in the fall of 2014 (NNSA/NFO, 2016).

A.6.1 CAI Activities

The CAI activities conducted at SG4 consisted of soil sampling underneath the fill material at two locations within the staging area.

A.6.1.1 Soil Samples

A total of three grab soil samples (including one FD) were collected from two locations (C06 and C07) within the staging area (Figure A.6-1). The purpose of sampling at SG4 was to determine whether radioactive contamination deposited on the surface by the CSII test had been covered over during construction of the staging area. In accordance with the CAIP (NNSA/NFO, 2016), the visible fill material was removed from each location before sample collection, to ensure the samples consisted of soil. Samples AB3A028 and AB3A029 (FD) were collected at location C06 at approximately 15 to 20 cm below the staging area surface; sample AB3A030 was collected at location C07 at approximately 20 to 25 cm below the staging area surface. The three samples were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am analyses. The analytical data are provided in Appendix K.

A.6.2 Investigation Results

The following subsections present the internal, external, and TED results for surface and subsurface soil samples collected at SG4. The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/CW-yr.

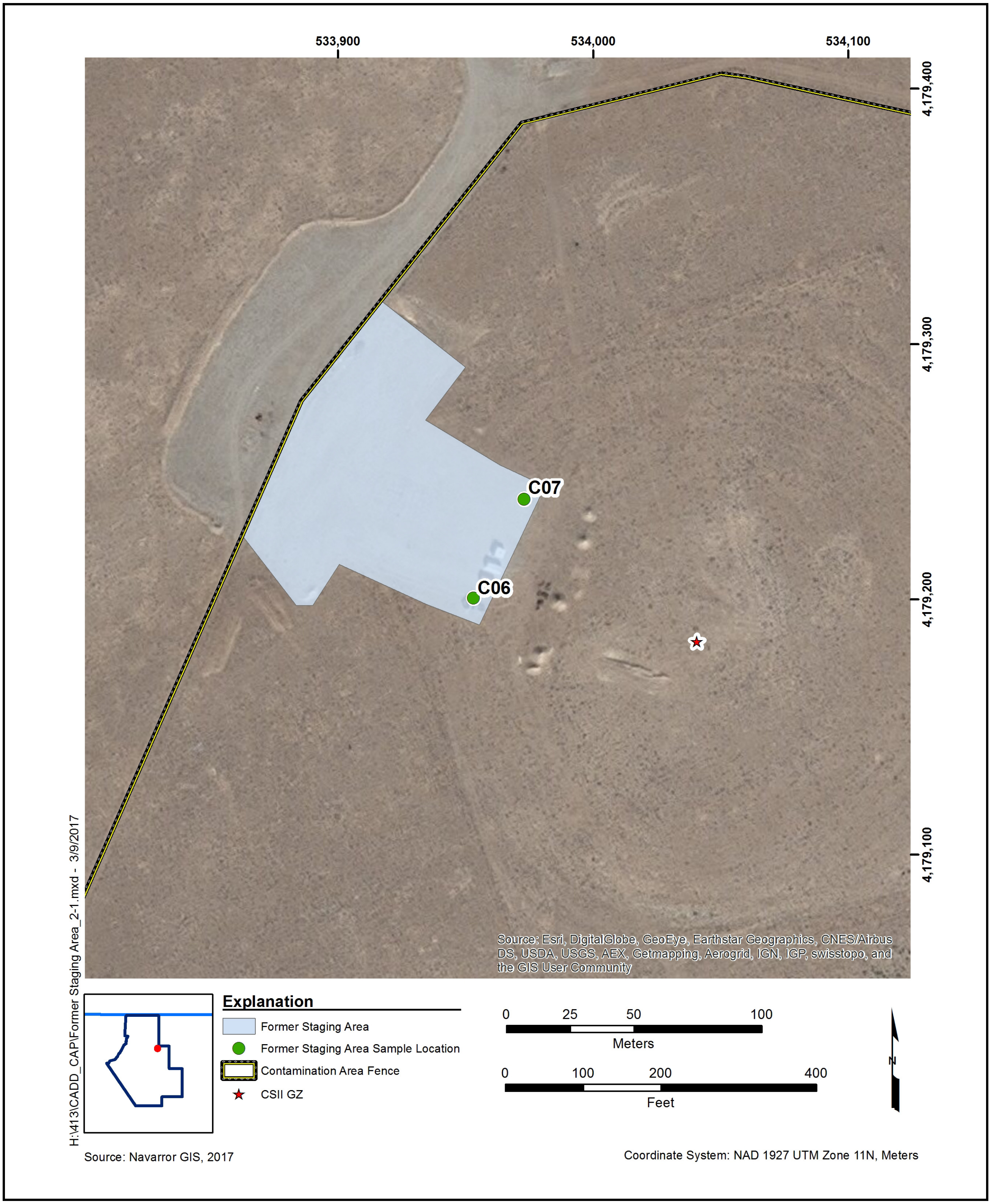

Figure A.6-1
SG4 Sample Locations

A.6.2.1 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at SG4 were determined as described in Section A.2.3.1. The average internal dose for each exposure scenario is presented in Table A.6-1.

Table A.6-1
Average Internal Dose at Sample Locations in SG4 [a]

Sample Location	Number of Samples	Construction Worker (mrem/CW-yr)	Industrial Area (mrem/IA-yr)
C06	2	0	0
C07	1	0	0

[a] A 95% UCL internal dose for SG4 sample locations was not calculated because there were fewer than 3 samples collected at each location.

A.6.2.2 External Radiological Dose Calculations

TLDs were not placed at the two SG4 sample locations; therefore, external dose was estimated as described in Section A.2.3.2. External dose was calculated for the CW exposure scenarios for each sample location. The estimated external dose for each exposure scenario is presented in Table A.6-2.

Table A.6-2
Average and 95% UCL External Dose at Sample Locations in SG4

Sample Location	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
	Average	95% UCL	Average	95% UCL
C06	0	0	0	0
C07	0	0	0	0

A.6.2.3 Total Effective Dose

The TED for each sample location was calculated by adding the 95 percent UCL of the calculated external dose and the average internal dose. The TED for the SG4 samples are presented in Table A.6-3. The average TED is shown with each SG3 sample location in Figure A.6-2.

Table A.6-3
Average and 95% UCL TED at Sample Locations in SG4

Sample Location	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
	Average	95% UCL	Average	95% UCL
C06	0	0	1	1
C07	0	0	0	0

A.6.3 Nature and Extent of COCs

The low doses calculated at the two SG4 locations confirm historical documentation presented in the CAIP (NNSA/NFO, 2016) that indicates the former staging area was scraped before construction, rather than placed over existing contamination. The TED did not exceed the FAL (25 mrem/CW-yr) at either of the two sample locations in SG4. Therefore, no corrective action is required.

A.6.4 Deviations/Revised CSM

There were no deviations from the CAIP (NNSA/NFO, 2016) in SG4. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

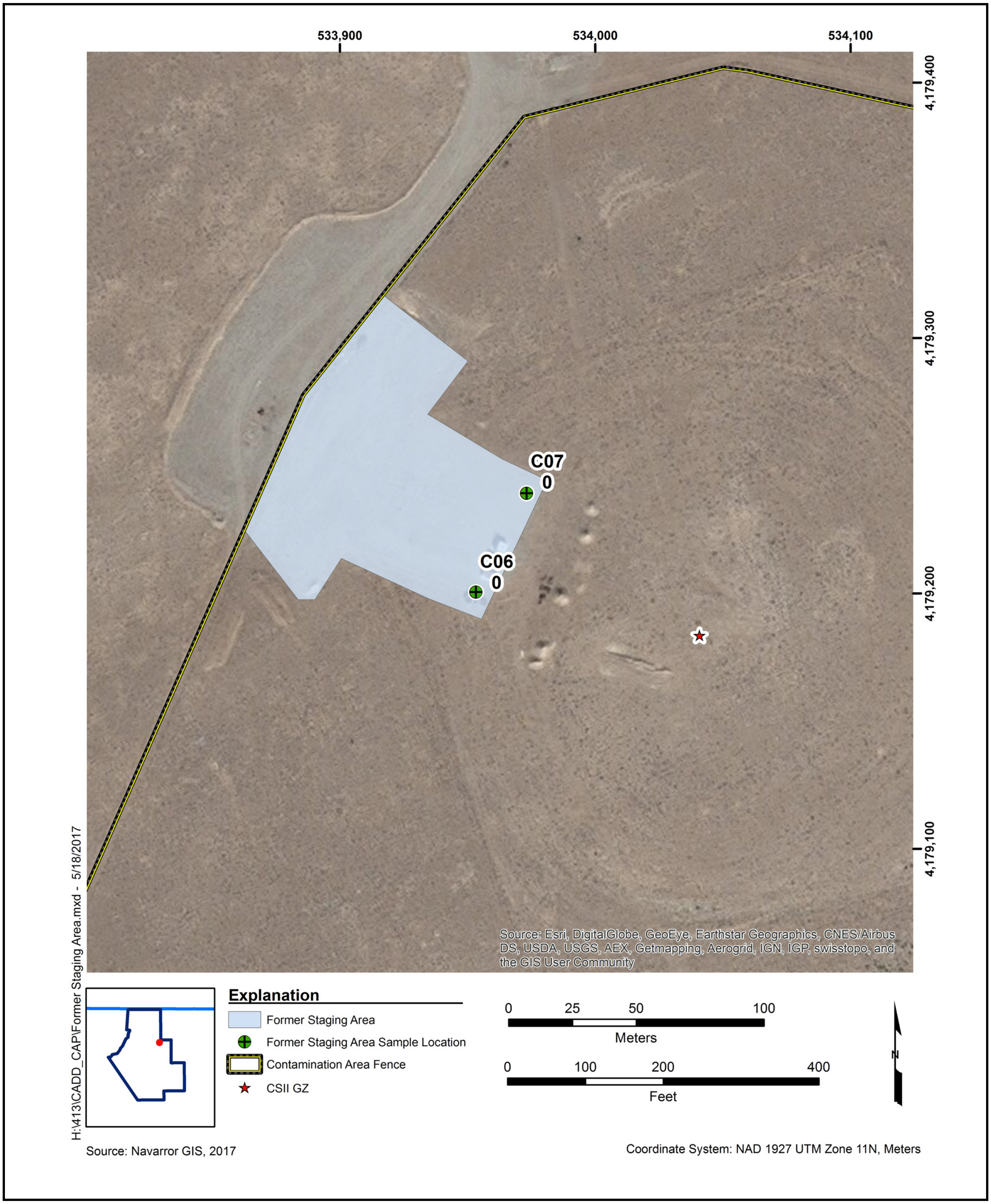

Figure A.6-2
Average TED (mrem/CW-yr) at SG4 Sample Locations

A.7.0 SG5, Buried Debris

This study group includes the contaminated debris and soil that were buried at GZ after the CSII test.

A.7.1 CAI Activities

As stated in the CAIP (NNSA/NFO, 2016), it is assumed that the contaminated debris and soil buried in the GZ area exceeds the radiological FAL. Thus, the objective of CAI activities at SG5 was to determine the lateral and vertical extent of buried debris. CAI activities conducted at SG5 were limited to geophysical surveys in the debris burial area.

A.7.1.1 Geophysical Surveys

Geophysical surveys using an EM31 electromagnetic ground conductivity meter and an EM61 metal detector (see Appendix I) were conducted during the CAI. The EM31-MK2 earth conductivity meter measures the conductivity of the soil as well as detecting the presence of metal. The EM61-MK2A four channel time domain metal detector detects both ferrous and non-ferrous conductive objects. The initial area to be surveyed coincides with the area surveyed with geophysical instruments in 1996 (NNSA/NFO, 2016). The geophysical surveys in this initial area were expanded during the CAI subsequent to data processing to ensure complete coverage of the subsurface features. The objective of surveying the burial area during the CAI was to confirm the locations of buried debris and obtain data to estimate the depth of burial at each location. The EM61 provided the best results, and these results were used to determine locations and depths of buried debris. The EM61 survey areas and the locations of buried debris/features are shown in Figure A.7-1.

A.7.2 Investigation Results

A summary of the geophysical survey is provided below; a complete report of the geophysical data and its interpretation is presented in Appendix I.

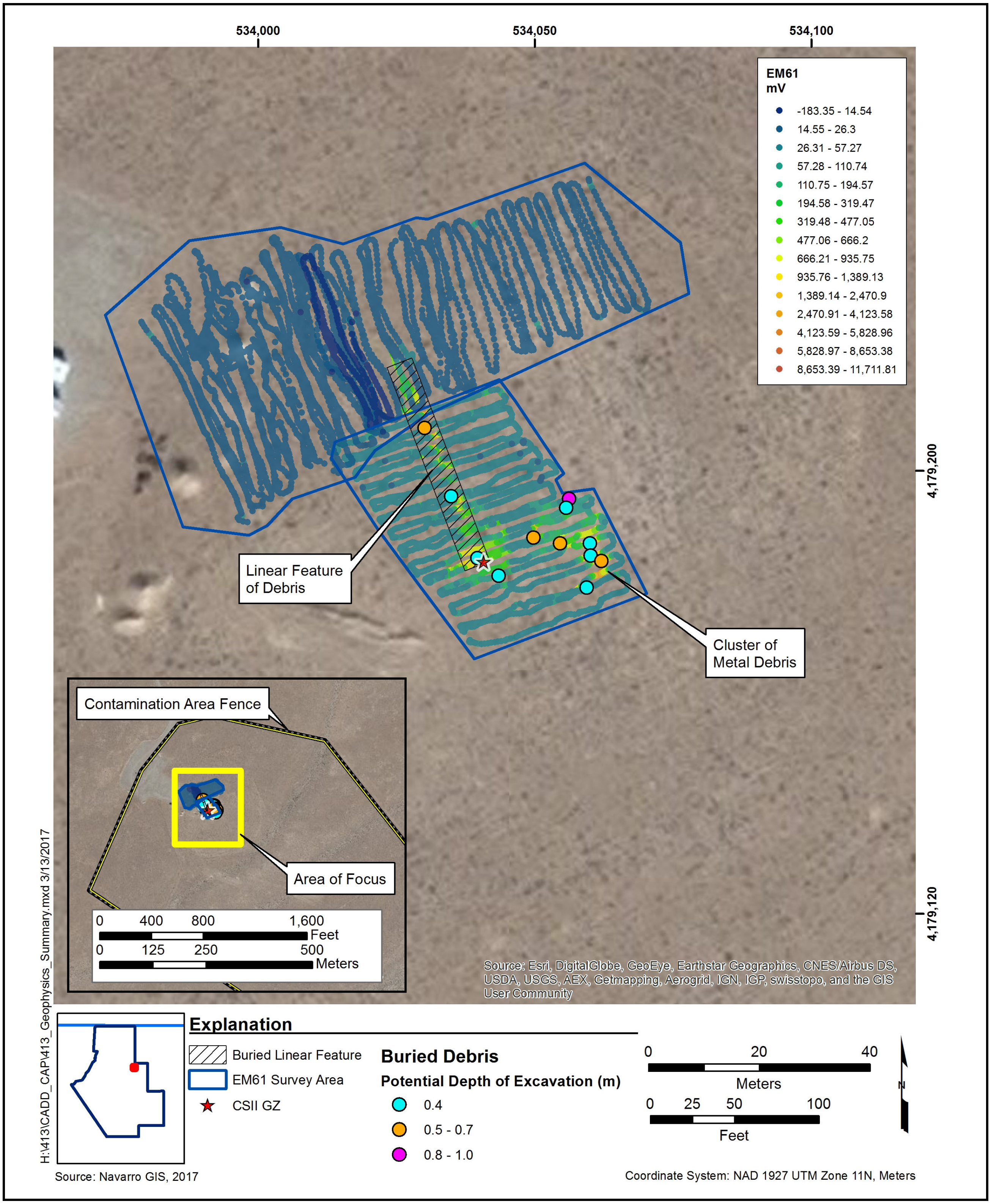

Figure A.7-1
SG5 Geophysical Survey Areas and Location of Anomalies

A.7.3 Nature and Extent of COCs

In general, the geophysical instrument responses were low and did not suggest a significant volume of buried debris in the surveyed areas. The two most prominent features include a cluster of metal debris approximately 15 m east of GZ and a linear feature of disturbed earth/metallic debris that extends from GZ approximately 40 m to the northwest. Based on the historical information about the burial area (NNSA/NFO, 2016), it is possible that this feature is a disposal trench or a linear piece of debris (e.g., metal instrument tower). The burial depths for the debris were estimated using the geophysical data and range from 0.4 to 1 m bgs.

The CAI geophysical survey dataset corroborates the 1996 geophysical surveys shown in the CAIP. The two most prominent features (the linear feature and the cluster of metal debris) are clearly shown in both datasets, with similar instrument response strengths and comparable spatial distribution in relation to GZ. No additional burial areas around GZ were identified in the CAI or 1996 surveys. The objectives of the CAI surveys were met by (1) confirming the extent of the burial area suggested by the 1996 data and (2) providing information relating to the depth of debris burial.

The extent of the buried debris was estimated as the rectangle shown in Figure A.7-2 (associated with the potential location of a backfilled trench) and an area represented by a polygon that encompasses the remaining cluster of anomalies. The combined area of 430 m^2 is conservatively assumed to contain debris to a depth of 1 m (the deepest detection in the survey). The total volume estimate for the buried debris of 430 m^3 applies a level of conservatism for the extent of buried debris given the spatial distribution of the anomalies and the overall uncertainty with regard to the actual distribution of debris.

A.7.4 Deviations/Revised CSM

No deviations to the CAIP (NNSA/NFO, 2016) were noted for this study group. The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

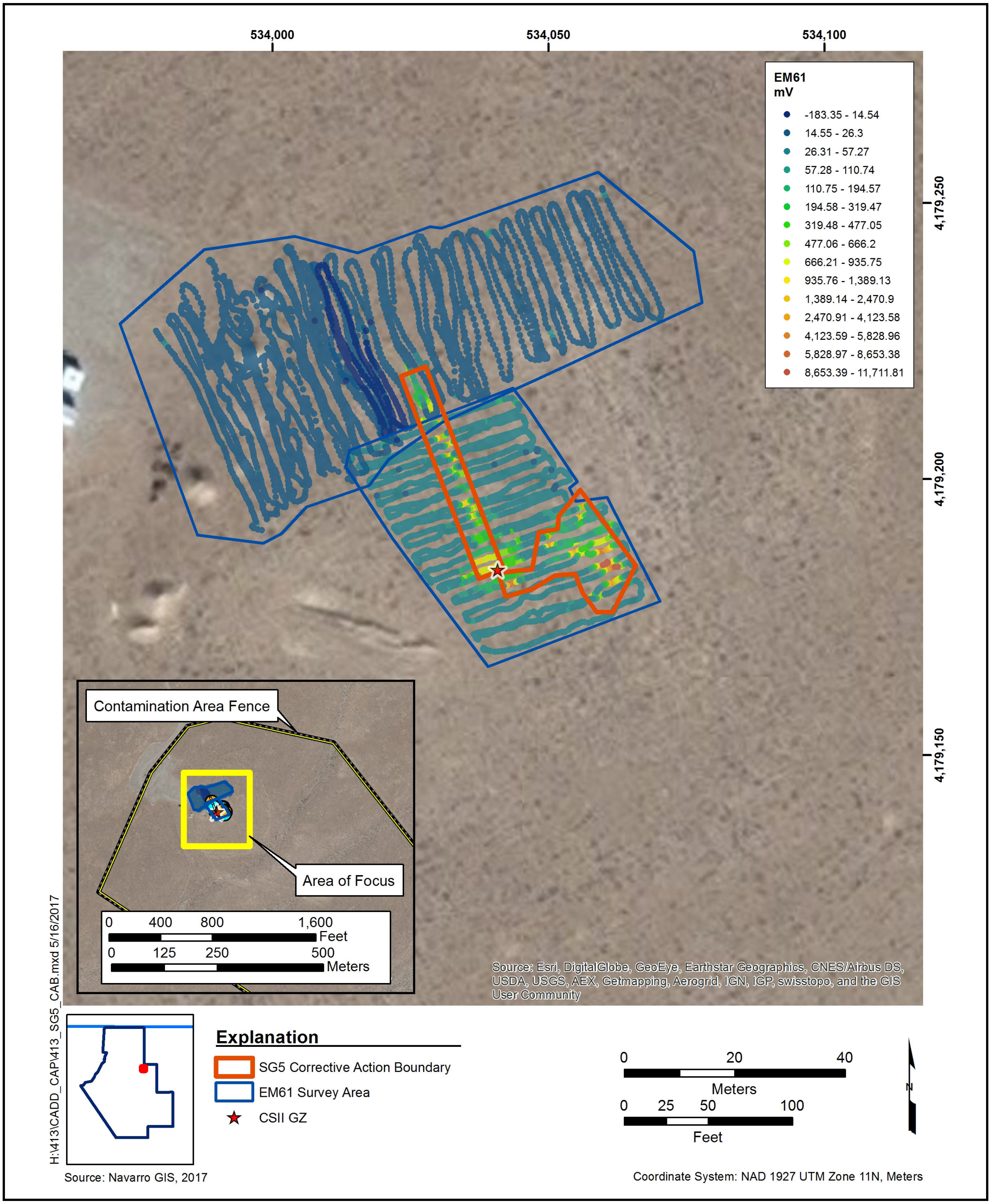

Figure A.7-2
SG5 Estimated Extent of Buried Debris

A.8.0 SG6, Potential Source Material

PSM is defined as a material present at a site that contains radiological and/or chemical contaminants that, if released, could cause the surrounding environmental media to contain a COC (NNSA/NFO, 2014). The only PSM identified and investigated at the CAU 413 site is radiologically contaminated metal pieces and concrete debris associated with the 1963 CSII test.

A.8.1 CAI Activities

The CAI activities conducted at SG6 locations involved visual surveys and radiological surveys using the FIDLER.

A.8.1.1 Visual Surveys

Visual surveys were concentrated in the area outside the CA fence to the east of GZ as shown in Figure A.8-1. This area was selected based on (1) historical information presented in the CAIP (NNSA/NFO, 2016) that suggested that debris ejected from the CSII test was thrown out in an eastward direction from GZ, (2) isolated areas of detected radioactivity on the northeastern periphery of the 2006 aerial radiation survey flightpath, and (3) the observation of radioactively contaminated metal fragments in the area during previous investigations. Fifty-nine locations with visible debris (metal, concrete) on the ground surface were identified in the visual survey at CAU 413.

A.8.1.2 Radiological Surveys

A comprehensive FIDLER survey was completed of the debris investigation area outside the CA fence as shown in Figure A.8-1. The FIDLER results were used to target additional locations with elevated radioactivity that did not necessarily contain visible debris. Fifty-one areas with elevated FIDLER readings were identified during the FIDLER surveys.

A.8.2 Investigation Results

A total of 110 locations containing visible debris and/or soil with elevated FIDLER measurements were identified during the SG6 debris investigation. The results of the visual and radiological surveys support the CSM elements of separate distributions for the different physical states of the source

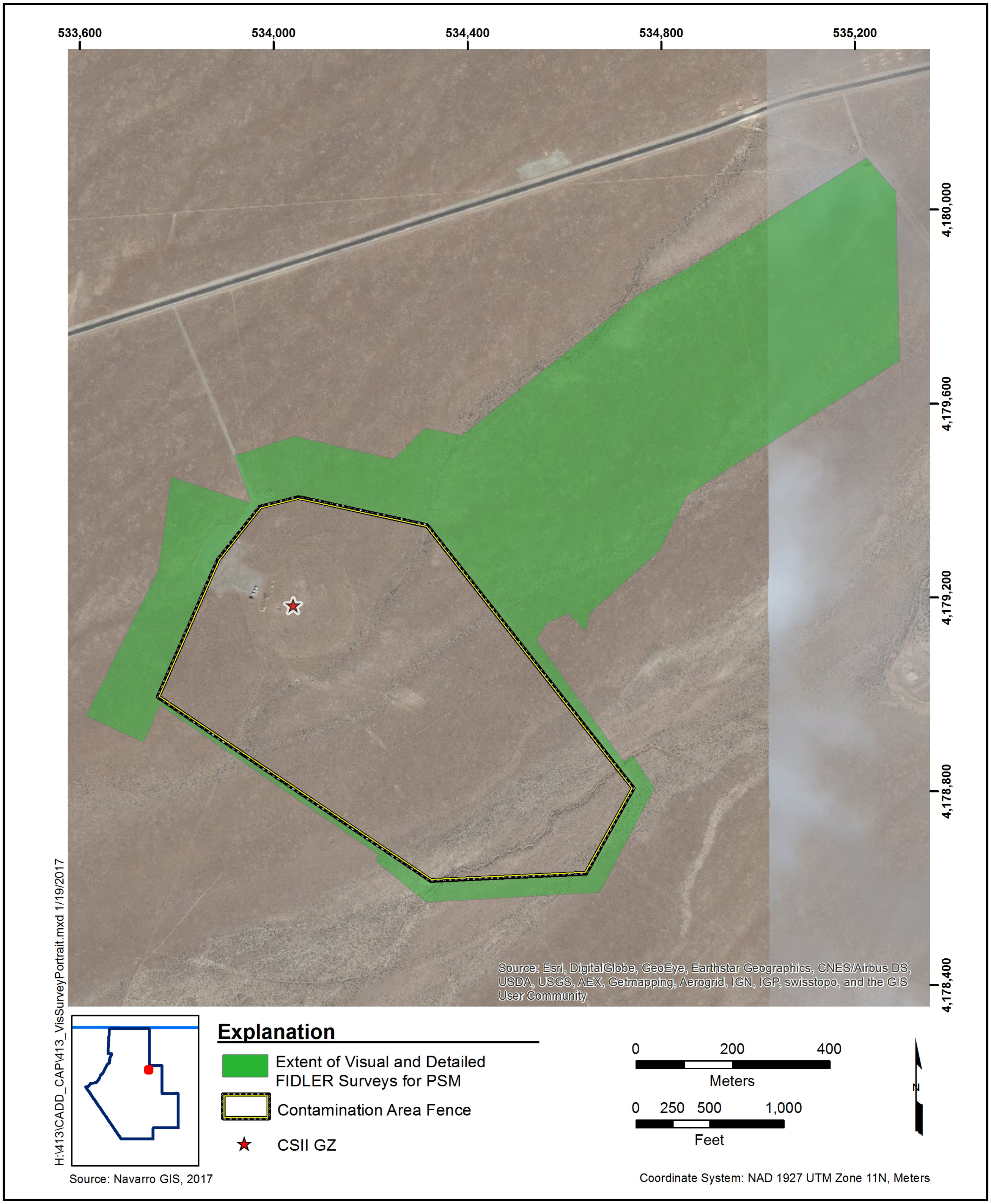

Figure A.8-1
SG6, Visual and Radiological Survey Areas

material at the time of the test as described in Section 3.1.3 of the CAIP (NNSA/NFO, 2016). The visual survey identified a pattern of distribution of bunker debris scattered to the east of the original test bunker. The radiological survey identified that some of the debris showed anomalously high radioactivity (i.e., hot spots) associated with the liquid phase of test material that was coated on part of the surface of the debris at the time of the test (see Figure A.8-2 for survey results). The radiological survey also showed a distribution pattern of elevated radioactivity associated with the atmospheric deposition of the gaseous phase of test material. To evaluate these two distributions separately, the radiation survey data points associated with the hot spots were separated from the remaining data before creating an interpolative surface from the FIDLER survey data using a modification of the process outlined in Section A.2.2.1. The interpolative surface generated after removal of the hot spot data represents the distribution of the gaseous phase of airborne contaminants from the CSII test and were used in the evaluation of the extent of COCs for SG1. The separate distribution of the hot spots was used to evaluate the need for corrective action for SG6 releases. This FIDLER interpolated surface and the GPS locations of hot spots are shown in Figure A.8-2.

In order to determine whether SG6 debris or soil could cause a receptor to receive a dose in excess of the 25-mrem/CW-year FAL, FIDLER data were compared to soil and debris hot spot criteria. As explained in Appendix J, these hot spot criteria are based on different RRMGs than the area-based RRMGs described in the Soils RBCA document (NNSA/NFO, 2014) and used in SG1. The development of separate criteria for PSM was necessary because the contaminated debris and relatively small, isolated areas of soil contamination in SG6 are not comparable to the large areas of wide-spread contamination evaluated in SG1. The hot spot RRMGs are based on a 1-m^2 area of contamination. An approximately 120-m^2 area of soil with elevated FIDLER readings was also identified. Due to its size, this area is too large for evaluation as a hot spot. Therefore, this area was investigated as part of SG1 using the area-based RRMGs to determine whether the 25-mrem/CW-yr FAL was exceeded. One soil sample plot and one TLD were established at the location of the highest radiation survey values (sample location C29). The results are discussed with SG1 in Section A.3.2. Any debris in SG6 that exceed the debris hot spot criteria (FIDLER readings of 177 MOB) or hot spot locations of soil that exceed the soil hot spot criteria (FIDLER readings of 28 MOB) are considered PSM for which corrective action is required. Further explanation of the hot spot criteria is found in Appendix J.

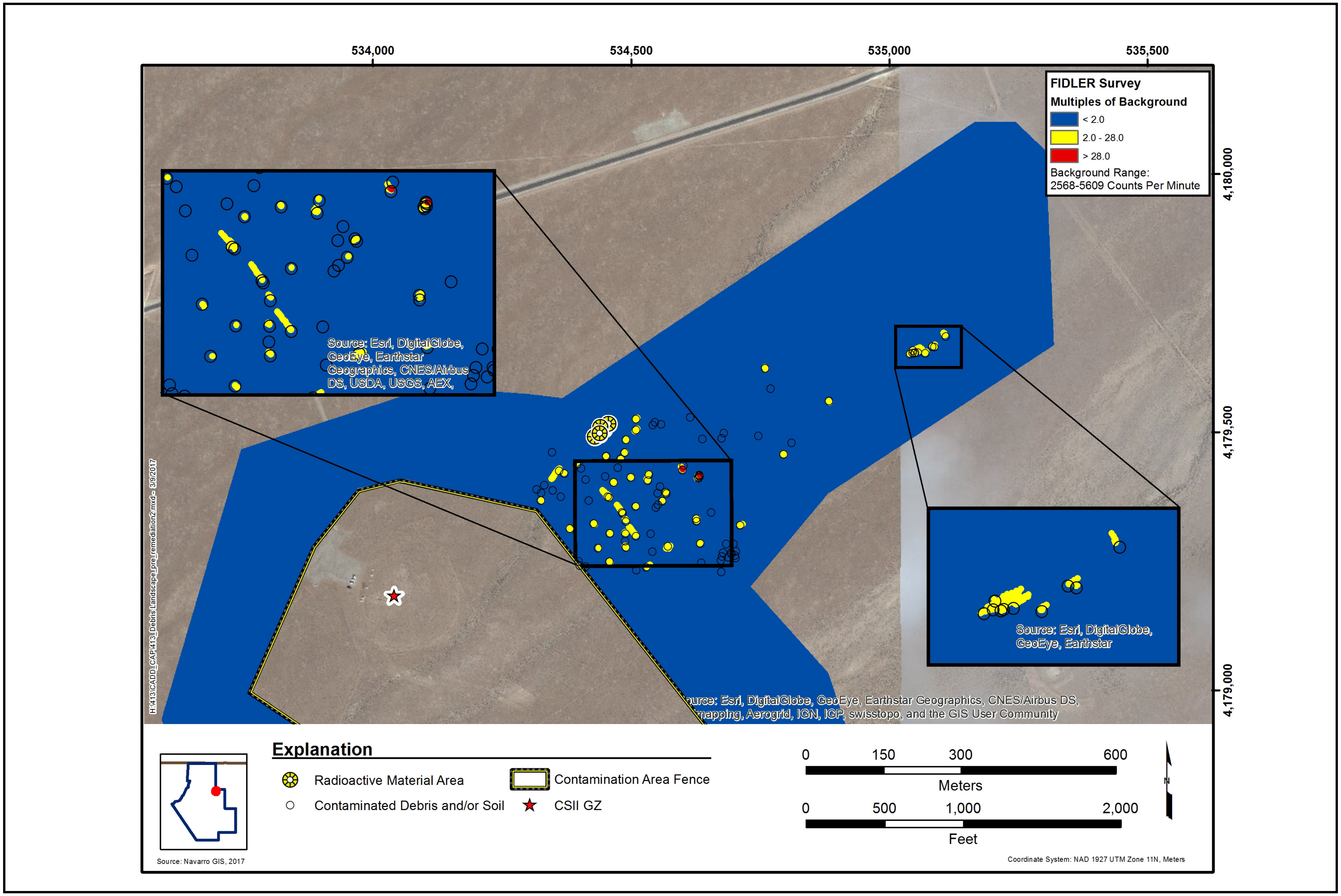

Figure A.8-2
Pre-removal FIDLER Survey Results and Visible Debris

A.8.3 Debris Removal

No debris exceeded the debris hot spot criterion of 177 MOB. However, all debris exceeding the hot spot criterion for soil of 28 MOB was removed as a BMP.

A.8.4 Nature and Extent of COCs

After debris was removed, removable contamination swipes were collected from the ground surface to ensure that the remaining soil did not present HCA conditions (i.e., alpha removable contamination at levels above 2,000 dpm/100 cm^2). Any remaining radiological contamination will be managed in compliance with all applicable DOE requirements. A FIDLER survey was also conducted to verify that remaining soil was below the soil hot spot criterion. Figure A.8-3 presents the FIDLER survey data after the debris was removed. Because no hot spots remain that exceed the soil hot spot criterion, no further corrective action is required for SG6.

A.8.5 Deviations/Revised CSM

The CAIP requirements (NNSA/NFO, 2016) were met at SG6 with one deviation. The CAIP stated that PSM sample results would be compared to the criteria listed in the Soils RBCA document (NNSA/NFO, 2014) to determine the need for corrective action. The approach to evaluating PSM hot spots in the CAIP was not followed. That approach was superseded by a recently adopted hot spot evaluation approach developed and implemented at two other Soils CAUs (CAU 573 and CAU 414). This revised approach is presented in Appendix J. The approach describes the development of a hot spot criterion that allows for the estimation of dose associated with PSM used to make a conservative assumption of when a hot spot may provide a dose exceeding the radiological FAL. This deviation did not adversely impact the evaluation of DQO decisions and provides more appropriate criteria for determining the need for corrective action for PSM at CAU 413.

The information gathered during the CAI supports the CSM as presented in the CAIP. Therefore, no revisions were necessary to the CSM.

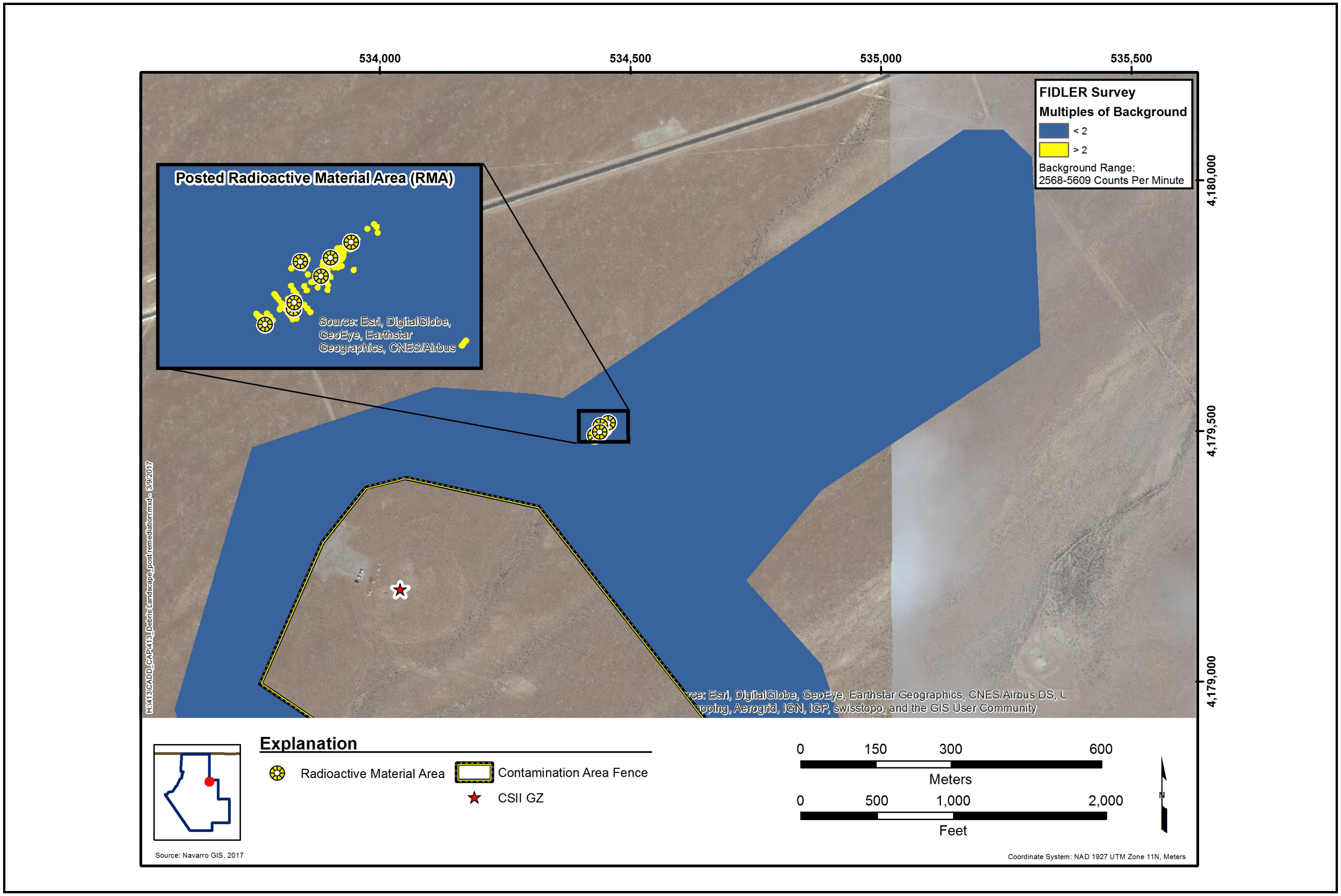

Figure A.8-3
Post-removal FIDLER Survey Results

A.9.0 SG7, Soil Mounds

This study group includes 10 visible soil mounds identified during previous investigations at the CSII site (Figure A.9-1). Eight of the mounds are believed to be associated with a technology demonstration project conducted at the site in 1998; the other two are believed to be topsoil reserved for use in site revegetation.

A.9.1 CAI Activities

CAI activities specific to SG7 included soil and TLD sampling.

A.9.1.1 Soil Samples

Two grab samples consisting of six subsamples were collected at each soil mound, one from the surface of the mound (0 to 15 cm) and the other from the mound interior (15 to 30 cm from the mound surface), in accordance with the sampling methodology specified in the CAIP (NNSA/NFO, 2016). All soil mound samples were submitted for gamma spectroscopy; Pu-241; and isotopic U, Pu, and Am analyses. A summary of the soil mound sample results is provided in Table A.9-1; sample locations are shown on Figure A.9-1.

A.9.1.2 TLD Samples

One TLD was installed in the center of each mound at a height of 1 m above the mound surface. All TLDs were measured by the NNSS environmental TLD monitoring program. Table A.9-2 provides information for the TLDs placed at SG7 sample locations.

A.9.2 Investigation Results

The following subsections present the internal, external, and TED results for soil and TLD samples collected in SG7. The internal dose calculated from soil sample results and the external dose calculated from TLD measurements were combined to determine TED at each sample location. The radiological results are reported as doses that are comparable to the dose-based FAL of 25 mrem/CW-yr.

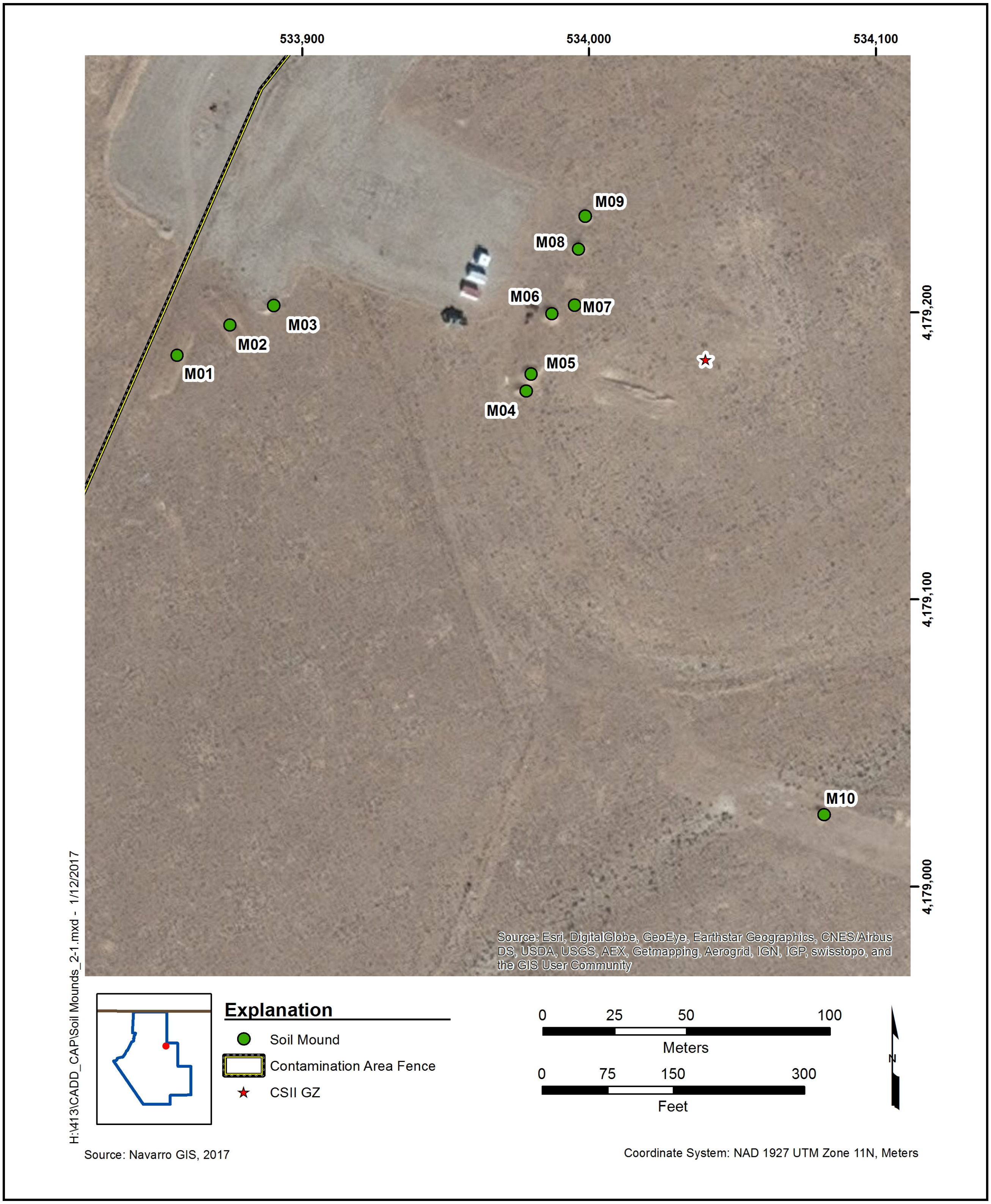

Figure A.9-1
SG7 Sample Locations

Table A.9-1
SG7 Soil Mound Samples

Sample Location	Sample Number	Depth (cm bgs)
M01	AB3A003	0 - 15
	AB3A004	15 - 30
M02	AB3A005	0 - 15
	AB3A006	15 - 30
M03	AB3A007	0 - 15
	AB3A008	15 - 30
M04	AB3A009	0 - 15
	AB3A010	15 - 30
M05	AB3A011	0 - 15
	AB3A012	15 - 30
M06	AB3A013	0 - 15
	AB3A014	15 - 30
M07	AB3A015	0 - 15
	AB3A016	15 - 30
M08	AB3A017	0 - 15
	AB3A018	15 - 30
M09	AB3A019	0 - 15
	AB3A020	15 - 30
M10	AB3A037	0 - 15
	AB3A038	15 - 30

A.9.2.1 Internal Radiological Dose Calculations

Estimates for the internal dose that a receptor would receive at SG7 sample locations were determined as described in Section A.2.3.1. The internal doses for each exposure scenario are presented in Table A.9-3.

Table A.9-2
SG7 TLDs

Location	TLD Number	Date Placed	Date Removed
M01	4457	07/01/2015	12/08/2015
M02	4632	07/01/2015	12/08/2015
M03	5087	07/01/2015	12/08/2015
M04	1834	07/01/2015	12/08/2015
M05	4711	07/01/2015	12/08/2015
M06	4921	07/01/2015	12/08/2015
M07	4427	07/01/2015	12/08/2015
M08	3538	07/01/2015	12/08/2015
M09	4776	07/01/2015	12/08/2015
M10	4489	07/28/2015	12/08/2015

Table A.9-3
Average Internal Dose at Sample Locations in SG7 [a]
(Page 1 of 2)

Sample Location	Sample Depth (cm)	Number of Samples	Construction Worker (mrem/CW-yr)	Industrial Area (mrem/IA-yr)
M01	0 - 15	1	0	0
	15 - 30	1	0	0
M02	0 - 15	1	0	0
	15 - 30	1	0	0
M03	0 - 15	1	0	0
	15 - 30	1	0	0
M04	0 - 15	1	1	1
	15 - 30	1	1	1
M05	0 - 15	1	3	4
	15 - 30	1	4	6
M06	0 - 15	1	3	4
	15 - 30	1	5	6
M07	0 - 15	1	4	5
	15 - 30	1	4	6

Table A.9-3
Average Internal Dose at Sample Locations in SG7 [a]
(Page 2 of 2)

Sample Location	Sample Depth (cm)	Number of Samples	Construction Worker (mrem/CW-yr)	Industrial Area (mrem/IA-yr)
M08	0 - 15	1	3	4
	15 - 30	1	3	4
M09	0 - 15	1	2	3
	15 - 30	1	2	2
M10	0 - 15	1	2	2
	15 - 30	1	2	3

[a] A 95% UCL internal dose for SG7 sample locations was not calculated because there were fewer than 3 samples collected at each location.

A.9.2.2 External Radiological Dose Calculations

Estimates for the external dose that a receptor would receive at SG7 sample locations were determined as described in Section A.2.3.2. External dose was calculated for the CW scenario. The standard deviation, number of elements, minimum sample size, and 95 percent UCL values of external dose for each exposure scenario are presented in Table A.9-4.

Table A.9-4
Average and 95% UCL External Dose at Sample Locations in SG7
(Page 1 of 2)

Sample Location	Standard Deviation (CW Scenario)	Number of Elements	Minimum Sample Size (CW Scenario)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
				Average	95% UCL	Average	95% UCL
M01	0.4	3	3	0	1	0	1
M02	0.3	3	3	0	1	0	1
M03	0.0	3	3	0	0	0	0
M04	0.2	3	3	1	2	3	3
M05	0.5	3	3	0	1	1	2
M06	0.1	3	3	0	0	0	0
M07	0.3	3	3	1	1	1	2

Table A.9-4
Average and 95% UCL External Dose at Sample Locations in SG7
(Page 2 of 2)

Sample Location	Standard Deviation (CW Scenario)	Number of Elements	Minimum Sample Size (CW Scenario)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
				Average	95% UCL	Average	95% UCL
M08	0.4	3	3	0	1	1	2
M09	0.2	3	3	0	0	0	1
M10	1.0	3	3	1	2	2	5

A.9.2.3 Total Effective Dose

The TED for each soil mound sample location was calculated by adding the external dose values and the internal dose values. The average TED and the 95 percent UCL of the TED for the CW and IA exposure scenarios are presented in Table A.9-5. The 95 percent UCL of the average TED is shown at each SG7 sample location in Figure A.9-2. All TED results were less than the radiological FAL.

Table A.9-5
Average and 95% UCL TED at Sample Locations in SG7
(Page 1 of 2)

Sample Location	Sample Depth (cm)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
		Average	95% UCL	Average	95% UCL
M01	0 - 15	0	1	1	2
	15 - 30	0	0	1	1
M02	0 - 15	0	1	0	1
	15 - 30	0	0	0	1
M03	0 - 15	0	0	0	0
	15 - 30	0	0	0	0
M04	0 - 15	2	2	4	4
	15 - 30	1	1	2	2
M05	0 - 15	3	4	5	6
	15 - 30	5	5	7	7

Table A.9-5
Average and 95% UCL TED at Sample Locations in SG7
(Page 2 of 2)

Sample Location	Sample Depth (cm)	Construction Worker (mrem/CW-yr)		Industrial Area (mrem/IA-yr)	
		Average	95% UCL	Average	95% UCL
M06	0 - 15	3	3	4	4
	15 - 30	5	5	7	7
M07	0 - 15	5	5	7	7
	15 - 30	5	5	7	7
M08	0 - 15	3	4	4	5
	15 - 30	3	3	5	5
M09	0 - 15	2	2	3	3
	15 - 30	2	2	3	3
M10	0 - 15	3	4	4	7
	15 - 30	3	3	3	3

A.9.3 Nature and Extent of COCs

Based on historical documents presented in the CAIP (NNSA/NFO, 2016), it was surmised that three of the soil mounds (M01 through M03) consisted of surface soil that had been scraped in preparation of the construction of the former staging area (SG4). The average TED for these three locations is less than 1 mrem/CW-yr (Table A.9-5). The average TED for the mound surface (less than 1 mrem/CW-yr) and interior (less than 1 mrem/CW-yr) at each mound were very similar, suggesting the mounds are homogenous. The low doses associated with these three mounds are consistent with the location of the former staging area which was built on the outer edge of the contamination plume where radioactivity levels were low.

The other seven soil mounds are thought to be associated with a technology demonstration project conducted at the site in 1998. The average TED for mounds M04 through M10 was 3 mrem/CW-yr. The difference in dose between the average mound surface and interior was less than 1 mrem/CW-yr. This difference in dose is not considered significant and does not alter the CSM assumption that the mounds are homogeneous. Historical records indicate surface soil from areas with varying levels of contamination within the contamination plume was removed for testing during the demonstration

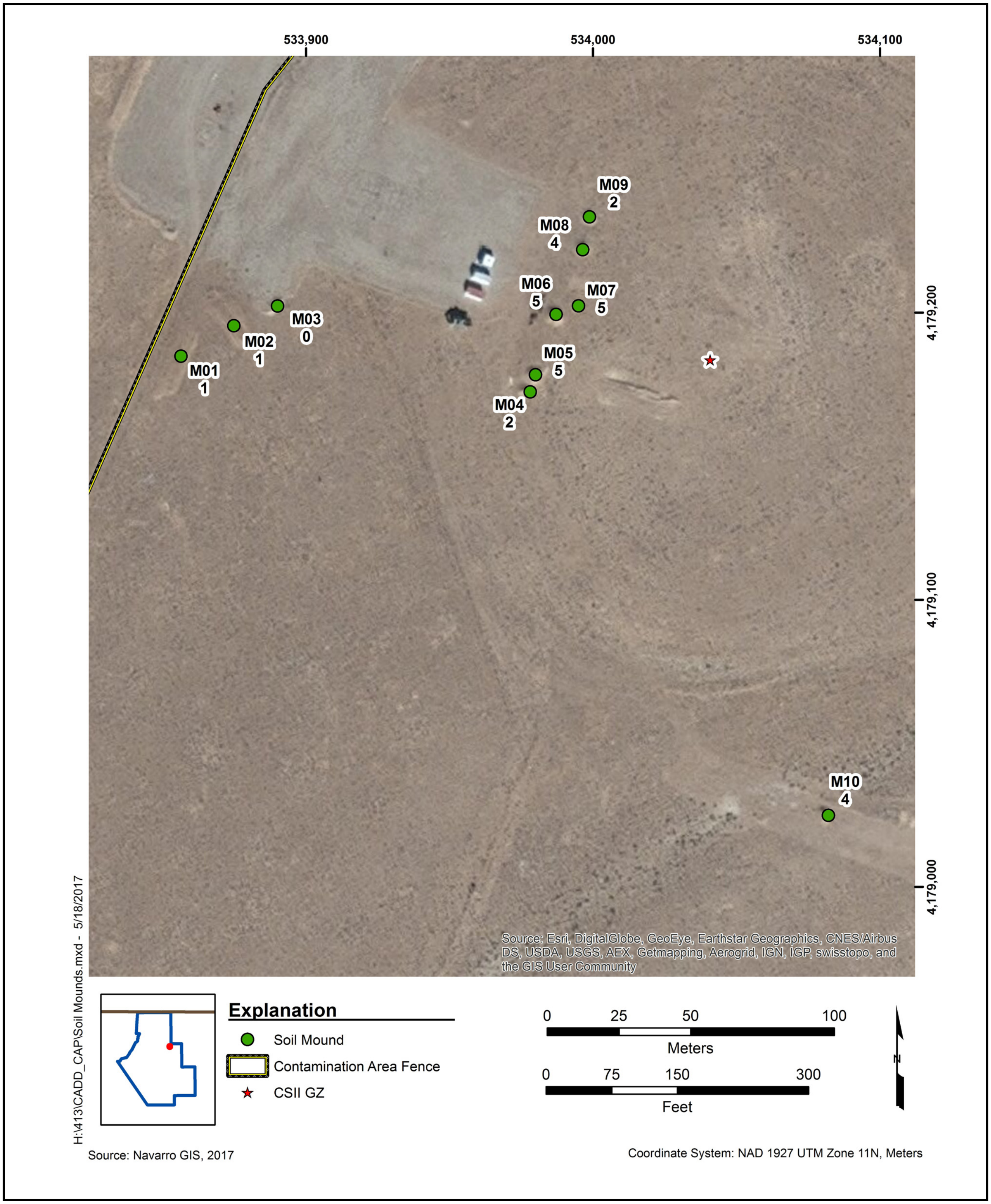

Figure A.9-2
95% UCL TED (mrem/CW-yr) at SG7 Sample Locations

project (NNSA/NFO, 2016). Thus, it was expected that the doses at these seven mounds would be greater than the doses for M01 through M03 because the soil from the other seven mounds originated in areas of higher radioactivity.

The 95 percent UCL of the average TED did not exceed the FAL of 25 mrem/CW-yr at any sampled location within SG7. Therefore, no corrective action is required.

A.9.4 Deviations/Revised CSM

The information gathered during the CAI supports the CSM as presented in the CAIP (NNSA/NFO, 2016). Although the calculated dose for the mound interior was, in some cases, slightly higher than the mound surface, the doses were very similar (Table A.9-5). Thus, the CSM element of mound homogeneity was confirmed, and no revisions to the CSM were necessary.

A.10.0 Waste Management

This section addresses the characterization and management of investigation and remediation wastes. Waste management activities were conducted as specified in the CAIP (NNSA/NFO, 2016).

A.10.1 Generated Wastes

The wastes listed in Table A.10-1 were generated during the CAI. Wastes were segregated to the greatest extent possible, and waste minimization techniques were integrated into the field activities to reduce the amount of waste generated. Controls were in place to minimize the use of hazardous materials and the unnecessary generation of hazardous and/or mixed waste. The amount, type, and source of waste placed into each container were recorded in waste management logbooks that are maintained in the CAU 413 file.

Approximately 6 cubic yards (yd^3) of PPE and disposable sampling equipment was generated during the CAI at CAU 413. In addition, the removal of debris at the debris investigation area in SG6 (Section A.8.3) generated 37 5-gal plastic buckets of pieces of concrete and metal debris.

A.10.2 Waste Characterization and Disposal

Waste characterization and disposition was determined using information from process knowledge, review of analytical results from associated samples, direct radiation survey readings, and radiological swipe results. This information was compared to federal and state regulations, permit limitations, and disposal facility acceptance criteria. This resulted in the two waste streams being characterized as LLW that meets the waste acceptance criteria for disposal at the Area 5 RWMC.

These wastes were consolidated with wastes generated at CAUs 411, 412, and 414 for storage at TTR before disposal. The consolidated waste was characterized as low level radioactive waste and transported to the NNSS Area 5 RWMC for disposal. The waste shipping and disposal documentation for CAU 413 is in Attachment D-1.

Table A.10-1
Waste Summary Table

Waste Items	Waste Characterization				Waste Disposition			
	Hazardous	Hydrocarbon	PCBs	Radioactive	Disposal Facility	Waste Volume	Disposal Date	Disposal Doc [a]
PPE and disposable sampling equipment	No	No	No	Yes	Area 5 RWMC	6 yd^3	08/16/2016	CD [a]
Concrete pieces and metal debris	No	No	No	Yes	Area 5 RWMC	37 5-gal buckets	08/16/2016	CD [a]

[a] Copies of waste disposal documents are located in Attachment D-1 of this document.

CD = Certificate of Disposal
PCB = Polychlorinated biphenyl

A.11.0 Quality Assurance

This section contains a summary of QA/QC measures implemented during the sampling and analysis activities conducted in support of the CAU 413 CAI. The following subsections discuss the data validation process, QC samples, and nonconformances. A detailed evaluation of the DQIs is presented in Appendix B.

Laboratory analyses were conducted for samples used in the decision-making process to provide a quantitative measurement of any COPCs present. Rigorous QA/QC was implemented for all laboratory sample data, including documentation, verification and validation of analytical results, and affirmation of DQI requirements related to laboratory analysis. Detailed information regarding the QA program is contained in the Soils QAP (NNSA/NSO, 2012).

A.11.1 Data Validation

Data were validated in accordance with the Soils QAP (NNSA/NSO, 2012) and approved protocols and procedures. All laboratory data from samples collected and analyzed for CAU 413 were evaluated for data quality in a tiered process. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results were evaluated using validation criteria. Documentation of the data qualifications resulting from these reviews is retained in CAU 413 files as electronic media.

All laboratory data were subjected to Tier I and Tier II evaluations. Laboratory data packages were reviewed for completeness. The analytical data contained within the packages were evaluated for correctness, compliance, precision, and accuracy. Where issues were encountered within the data, validation-qualifiers were assigned with descriptions of why the qualifiers were added.

A Tier III evaluation was performed on the analytical results for four samples, which represents 5 percent of the samples collected for site characterization. This review was performed by Analytical Quality Associates, Inc., of Albuquerque, New Mexico. The Tier III data validation review was in general agreement with the Tier II data validation, and no corrections to the Tier II validation were necessary.

A.11.2 QC Samples

During the CAI, three FDs were sent as blind samples to the laboratory to be analyzed for the investigation parameters listed in the CAIP (NNSA/NFO, 2016). The results from these samples were evaluated for precision (see Section B.1.1.1.1).

Laboratory QC samples used to measure precision and accuracy were analyzed by the laboratory with each batch of samples submitted for analysis. When QC criteria were exceeded, qualifying flags were added to sample results, along with the reason for estimation or rejection. Documentation of data qualifications is retained in the Analytical Services database and in the data packages located in Navarro Central Files.

A.11.3 Field Nonconformances

There were no field nonconformances identified for the CAI.

A.11.4 Laboratory Nonconformances

The analytical laboratories report data quality issues such as fluctuations in analytical instrumentation operations, sample preparations, missed holding times, spectral interferences, high or low chemical yields/matrix spikes, and precision that do not fall within the limits of their QC parameters. These analytical data evaluations show that some of the data were identified as having quality issues associated with accuracy, completeness, precision, and/or sensitivity. These data were flagged accordingly and factored into the DQA (see Appendix B).

A.12.0 Summary

Radionuclide contaminants detected in environmental samples during the CAI were used to calculate conservative estimates of maximum potential dose for FFACO decision-making purposes only. These estimates were evaluated against the radiological FAL to determine the presence and extent of COCs at the site. Releases within SG1 and SG5 exceed the FAL; therefore, corrective action is required at CAU 413. The extent of the areas in SG1 and SG5 that exceed the FAL are presented in Figure A.12-1. A summary of CAI results is presented in Table A.12-1.

Table A.12-1
CAU 413 Summary of CAI Results

CAS	Study Group	SG Description	CAI Results	Potential Waste Types and Volumes
TA-23-02CS	1	Undisturbed Areas	FAL exceeded	1,400 m^3 of LLW
	2	Disturbed Areas	FAL not exceeded	None
	3	Sedimentation Areas		
	4	Former Staging Area		
	5	Buried Debris	FAL assumed to be exceeded	430 m^3 of LLW
	6	Potential Source Material	FAL not exceeded	None
	7	Soil Mounds	FAL not exceeded	

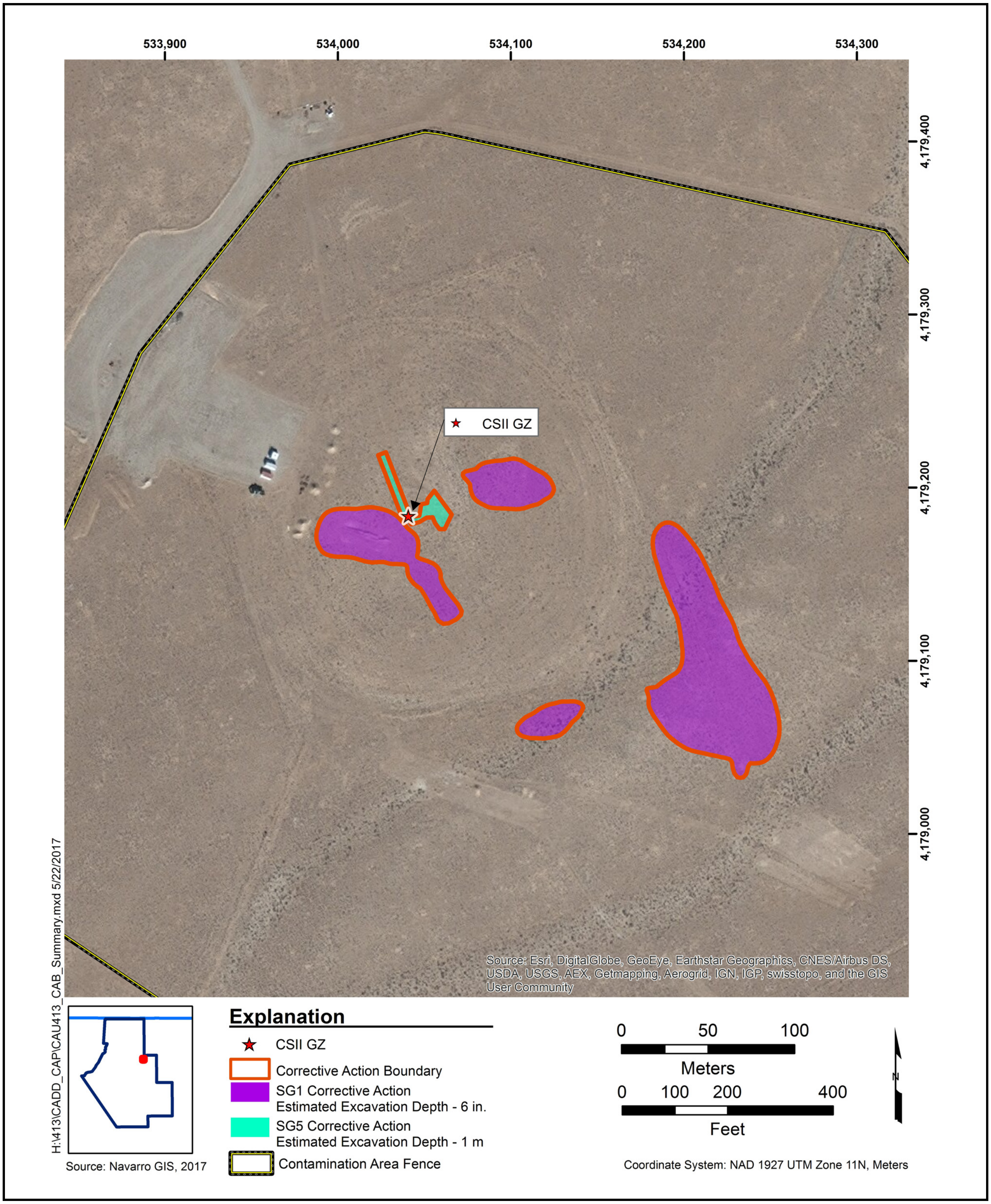

Figure A.12-1
Corrective Action Boundaries at CAU 413

A.13.0 References

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Appendix B

Data Assessment

B.1.0 Data Assessment

The DQA process is the scientific evaluation of the investigation results to determine whether the DQO criteria established in the CAU 413 CAIP (NNSA/NFO, 2016) were met and whether DQO decisions can be resolved at the desired level of confidence. The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence. Using both the DQO and DQA processes helps to ensure that DQO decisions are sound and defensible.

The DQA involves five steps that begin with a review of the DQOs and end with an answer to the DQO decisions. These steps are briefly summarized as follows:

1. *Review DQOs and Sampling Design.* Review the DQO process to provide context for analyzing the data. State the primary statistical hypotheses; confirm the limits on decision errors for committing false-negative (Type I) or false-positive (Type II) decision errors; and review any special features, potential problems, or deviations to the sampling design.

2. *Conduct a Preliminary Data Review.* Review QA reports and inspect the data both numerically and graphically, validating and verifying the data to ensure that the measurement systems performed in accordance with the criteria specified, and using the validated dataset to determine whether the quality of the data is satisfactory.

3. *Select the Test.* Select the test based on the population of interest, population parameter, and hypotheses. Identify the key underlying assumptions that could cause a change in one of the DQO decisions.

4. *Verify the Assumptions.* Perform tests of assumptions. If data are missing or are censored, determine the impact on DQO decision error.

5. *Draw Conclusions from the Data.* Perform the calculations required for the test.

B.1.1 Review DQOs and Sampling Design

This section contains a review of the DQO process presented in Appendix A of the CAIP (NNSA/NFO, 2016). The DQO decisions are presented with the DQO provisions to limit false-negative or false-positive decision errors. Special features, potential problems, or any deviations to the sampling design are also presented.

B.1.1.1 Decision I

The Decision I statement as presented in the CAIP (NNSA/NFO, 2016) is as follows: "Does any location exceed the FALs?" For judgmental sampling design, any analytical result for a COPC above the FAL will result in that COPC being designated as a COC. For probabilistic (unbiased) sampling design, any COPC that has a 95 percent UCL of the average concentration above the FAL will result in that COPC being designated as a COC. A COC may be assumed to be present based on the presence of wastes that have the potential to release COC concentrations in the future (i.e., PSM) or the presence of removable contamination at levels exceeding the criteria for defining an HCA. A COC may also be defined as a contaminant that, in combination with other like contaminants, is determined to jointly pose an unacceptable risk based on a multiple contaminant analysis (NNSA/NFO, 2014). If a COC is detected, then Decision II must be resolved.

B.1.1.1.1 DQO Provisions To Limit False-Negative Decision Error

A false-negative decision error (when it is concluded that contamination exceeding FALs is not present when it actually is) was controlled by meeting the following criteria:

1a) For Decision I, having a high degree of confidence that sample locations selected will identify COCs if present anywhere within the study group (judgmental sampling).

1b) Maintaining a false-negative decision error rate of 0.05 (probabilistic sampling).

2) Having a high degree of confidence that analyses conducted will be sufficient to detect any COCs present in the samples.

3) Having a high degree of confidence that the dataset is of sufficient quality and completeness.

Criteria 1b, 2, and 3, were assessed based on the entire dataset. Therefore, these assessments apply to both Decision I and Decision II.

Criterion 1a (Confidence Judgmental Sample Locations Identify COCs)

Decision I for SG1 and SG5 was resolved during the DQO process with the assumption that locations within SG1 and the buried debris and soil in SG5 exceeded the radiological FAL and required corrective action. Therefore, Decision I sampling only applied to SG2, SG3, SG4, SG6, and SG7. A judgmental sampling approach was used to resolve Decision I in all of these study groups except SG7. A probabilistic approach was used to resolve Decision I in SG7.

Judgmental sample locations were selected using biasing factors such as radiological survey results and/or the presence of debris. Soil samples were collected from the initial locations identified in the CAIP (NNSA/NFO, 2016). These locations were then modified as necessary according to Section A.8.2.1 of the CAIP:

> "The judgmental sample locations may need to be modified during the CAI based on field conditions, but only if the modified locations meet the decision needs and criteria stipulated in these DQOs."

And Section 4.2.4.2 of the CAIP:

> "At each location, additional FIDLER surveys will be conducted to determine whether elevated radioactivity (i.e., above background levels) is present. Soil samples will be collected in the areas of highest radioactivity."

SG2, Disturbed Areas

The five disturbed areas in SG2 were identified through historical records and aerial photographs (NNSA/NFO, 2016). Initial sample locations were identified in the CAIP within each area that were biased to the highest radiological readings detected in the 1996 KIWI and 2012 FIDLER surveys (NSTec, 2009), and/or FIDLER surveys conducted during the CAI.

SG3, Sedimentation Areas

Sample locations were selected based on the presence of sedimentation areas within the three identified drainages at CAU 413. The sedimentation areas were identified visually. The sampling location within each sedimentation area was then selected as the location of the highest FIDLER readings in the individual sedimentation area.

SG4, Former Staging Area

The former staging area is a distinct feature visible in aerial photographs of the site and is constructed of materials readily distinguishable from surrounding soil. The two grab sample locations in SG4 were selected within the footprint of the feature on the edge closest to GZ, as these areas would be expected to have the highest levels of contamination.

SG6, Potential Source Material

PSM was identified through visual and FIDLER surveys. The only PSM identified during the CAI were metal and concrete pieces from the CSII test structure. The PSM was concentrated in the area outside the CA fence to the east of GZ. This eastern area was targeted for comprehensive visual and FIDLER surveys during the CAI based on (1) historical information presented in the CAIP (NNSA/NFO, 2016) that suggested that debris ejected from the CSII test was thrown out in an eastward direction from GZ, (2) isolated areas of detected radioactivity in the 2006 aerial radiation survey, and (3) the observation of radioactively contaminated metal fragments in the area during previous investigations.

The analytical suite selected for samples collected using a judgmental or probabilistic approach was sufficient to identify any COCs present in the samples. The analytical methods were chosen during the DQO process as the analyses required to detect any of the COPCs listed in the CAIP that were defined as the contaminants that could reasonably be expected at the site that could contribute to a dose or risk exceeding FALs. The COPCs were identified based on operational histories, waste inventories, release information, investigative background, contaminant sources, release mechanisms, and migration pathways as presented in the CAIP. This provides assurance that the analyses conducted for each sample has the capability of identifying any COPC present in the sample. All Decision I samples were analyzed using the analytical methods listed in the CAIP.

Criterion 1b (Confidence in Probabilistic False-Negative Decision Error Rate)

Control of the false-negative decision error for the probabilistic samples was accomplished by ensuring the following:

- The samples are collected from unbiased locations.

- A sufficient sample size was collected (see Section B.1.1.1.1).
- A false rejection rate of 0.05 was used in calculating the 95 percent UCLs and minimum sample size.

The probabilistic sampling approach was used at sample plots and for soil mound sampling in SG7. Within each sample plot and at each SG7 soil mound location, a composite soil sample was collected from six aliquot locations. Selection of the sample aliquot locations was accomplished using a random start, systematic triangular grid pattern for sample placement. This permitted that any given location within the boundaries of the sampling area would have an equal probability of being chosen as any other location. Because only two samples were collected from each mound, sample statistics and a minimum sample size were not calculated for these locations.

The minimum number of samples required for each probabilistic sample plot location was calculated for both the internal (soil samples) and external (TLD elements) dose samples. The minimum number of samples was also calculated for the TLDs placed at SG7 soil mound locations. The minimum sample size (n) was calculated using the following EPA sample size formula (EPA, 2006):

$$n = \frac{s^2(z_{.95} + z_{.80})^2}{(\mu - C)^2} + \frac{z^2_{.95}}{2}$$

where

s = standard deviation
$z_{.95}$ = z score associated with the false-negative rate of 5 percent
$z_{.80}$ = z score associated with the false-positive rate of 20 percent
μ = dose level where false-positive decision is not acceptable (12.5 mrem/yr)
C = FAL (25 mrem/yr)

The use of this formula requires the input of basic statistical values associated with the sample data. Data from a minimum of three samples are required to calculate these statistical values and, as such, the least possible number of samples required to apply the formula is three. Therefore, in instances where the formula resulted in a value fewer than three, three is adopted as the minimum number of samples required. The results of the minimum sample size calculations and the number of samples collected at SG1 sample plot locations are presented in Table B.1-1. The minimum sample size calculations were conducted for probabilistic samples as stipulated in the CAIP (NNSA/NFO, 2016) based on the following parameters:

- A false rejection rate of 0.05
- A false acceptance rate of 0.20
- The maximum acceptable gray region set to one-half the FAL (12.5 mrem/yr)
- The calculated standard deviation

Table B.1-1
Input Values and Determined Minimum Number of Samples for Sample Plots in SG1

Sample Plot Location	Standard Deviation (CW Scenario)	Minimum Sample Size	Number of Samples Collected
C08	0.3	3	4
C09	0.1	3	4
C10	0.1	3	4
C11	18.6	15	4
C12	7.5	3	4
C13	1.5	3	4
C14	1.5	3	4
C15	0.9	3	4
C16	0.9	3	4
C29	0.6	3	4

Sample plot C11 was the only SG1 location that failed the minimum number of samples requirement. As stated in the Soils RBCA document, if the minimum sample size requirement is not met, either additional samples may be collected, or it may be conservatively assumed that the result exceeds the FAL. Because this location is close to GZ and contains elevated levels of radiation as evidenced by the aerial, KIWI, and FIDLER radiation surveys, it is assumed that this location exceeds the radiological FAL and corrective action is required.

TLDs were placed at the center of each sample plot in SG1, at judgmental sample locations in SG3, and on each soil mound in SG7. Although the TLD locations were not established at random locations, they provided three independent measurements of dose per TLD, that integrate unbiased measurements from the area of the sample plot. The minimum sample size for the environmental TLDs placed at CAU 413 are provided in Table B.1-2. All TLD locations met the required minimum sample size.

Table B.1-2
Input Values and Determined Minimum Number of Samples for CAU 413 TLDs
(Page 1 of 2)

Study Group	TLD Location	Standard Deviation (CW Scenario)	Minimum Sample Size	Number of Samples Collected
SG1, Undisturbed Areas	C08	0.1	3	3
	C09	0.0	3	3
	C10	0.3	3	3
	C11	2.5	3	3
	C12	1.8	3	3
	C13	1.2	3	3
	C14	1.7	3	3
	C15	0.9	3	3
	C16	0.5	3	3
	C29	0.6	3	3
SG3, Sedimentation Areas	C17	0.5	3	3
	C19	0.2	3	3
	C21	0.4	3	3
	C22	0.3	3	3
	C23	0.0	3	3
	C24	0.1	3	3
	C25	1.2	3	3
	C26	1.0	3	3
	C27	0.4	3	3
	C28	1.6	3	3

Table B.1-2
Input Values and Determined Minimum Number of Samples for CAU 413 TLDs
(Page 2 of 2)

Study Group	TLD Location	Standard Deviation (CW Scenario)	Minimum Sample Size	Number of Samples Collected
SG7, Soil Mounds	M01	0.4	3	3
	M02	0.3	3	3
	M03	0.0	3	3
	M04	0.2	3	3
	M05	0.5	3	3
	M06	0.1	3	3
	M07	0.3	3	3
	M08	0.4	3	3
	M09	0.2	3	3
	M10	1.0	3	3

Note: The actual required minimum number of samples calculated for TLDs by the one-sample t-test (EPA, 2006; PNNL, 2007) was fewer than 3. The minimum number of samples required to calculate statistics is 3.

Criterion 2 (Confidence in Detecting COCs Present in Samples)

Sample results were assessed against the acceptance criterion for the DQI of sensitivity as defined in the Soils QAP (NNSA/NSO, 2012). The sensitivity acceptance criterion for radionuclides is that all detection limits are less than their corresponding CW internal dose RRMGs. All of the analytical detection limits for radionuclides were less than their corresponding RRMGs. Therefore, the DQI for sensitivity has been met for all contaminants, and no data were qualified for sensitivity.

Criterion 3 (Confidence that Dataset is of Sufficient Quality and Complete)

To satisfy the third criterion, the dataset was assessed against the acceptance criteria for the DQIs of precision, accuracy, comparability, completeness, and representativeness, as defined in the Soils QAP (NNSA/NSO, 2012). The DQI acceptance criteria are presented in Table 6-1 of the CAIP (NNSA/NFO, 2016). The individual DQI results are presented in the following subsections.

Precision

Precision was evaluated as described in Section 4.2 of the Soils QAP (NNSA/NSO, 2012). No data quality issues were identified for the analytical results that resulted in their being qualified for precision, so this criterion was met by the CAU 413 analytical dataset.

Accuracy

Accuracy was evaluated as described in Section 4.2 of the Soils QAP (NNSA/NSO, 2012). No data quality issues were identified for the analytical results that resulted in them being qualified for accuracy, so this criterion was met by the CAU 413 analytical dataset.

Representativeness

The DQO process as identified in Appendix A of the CAIP (NNSA/NFO, 2016) was used to address sampling and analytical requirements for CAU 413. During this process, appropriate locations were selected that enabled the samples collected to be representative of the population parameters identified in the DQO (the most likely locations to contain contamination [judgmental sampling] or that represent contamination of the sample plot [probabilistic sampling] and locations that bound COCs) (Section A.2.1). The sampling locations identified in the Criterion 1a discussion meet this criterion.

Special consideration is needed for Am and Pu isotope concentrations related to representativeness. This is due to the nature of these contaminants in soil (Bernhardt, 1976). These isotopes may be present in soil in the form of small particles that may or may not be captured in a small soil sample of 1 to 2 grams. As individual particles of these radionuclides can make a significant impact on analytical results, small soil samples taken from the same site can produce analytical results that are very different (i.e., poor accuracy). However, the Am and Pu isotopes are co-located (e.g., Am-241 is a daughter product of Pu-241), and the relative concentrations between different samples from the same site (i.e., the ratio of Am to Pu isotope concentrations) should be equal. Based on process knowledge and demonstrated by analytical results from previously sampled Soils sites, the ratios between Am and Pu isotopes in soil contamination from any given source is expected to be the same throughout the contaminant plume at any given time. Therefore, if the ratios are known and one of these isotopic concentrations is known, the concentrations of the other isotopes can be estimated.

Am-241 is reported by the gamma spectrometry method as well as the isotopic Am method. As the gamma spectrometry measurement is based on a much larger soil sample (usually 1 liter), the particle distribution problem discussed above is greatly diminished and the probability of the result being representative of the sampled site is much improved. Therefore, the ratios between the Am and Pu isotopes will be established using the isotopic analytical results and these ratios will be used to infer concentrations of Pu isotopes using the gamma spectrometry results for Am-241. These inferred Pu values will be more representative of the sampled area than the isotopic results. For CAU 413, the isotopic ratios of Am-241 to Pu-238, Pu-239/240, and Pu-241 are 0.0995, 12.671, and 1.7622, respectively.

Based on the methodical selection of sample locations, the use of Am and Pu concentrations that are more representative of the sampled area, the analytical data acquired during the CAU 413 CAI adequately represents contaminant concentrations of the sampled population and the dataset is determined to be acceptable for the criterion of representativeness.

Comparability

Field sampling, as described in the CAIP (NNSA/NFO, 2016), was performed and documented in accordance with approved procedures that are comparable to standard industry practices. Approved analytical methods and procedures were used to analyze, report, and validate the data. These are comparable to other methods used not only in industry and government practices, but most importantly are comparable to other investigations conducted for the NNSS. Therefore, CAU 413 datasets are considered comparable to other datasets generated using these same standardized DOE procedures, thereby meeting DQO requirements. In addition, standard approved field and analytical methods ensured that data were appropriate for comparison to the investigation action levels specified in the CAIP.

Completeness

The CAIP (NNSA/NFO, 2016) defines acceptable criteria for completeness to be that the dataset is sufficiently complete to be able to make the DQO decisions. This is initially evaluated as 80 percent of release-specific analytes identified in the CAIP having valid results. Data that were qualified as rejected are listed in Table B.1-3. Although these data were not used in the resolution of DQO decisions and are not counted toward meeting the completeness acceptance criterion, these

Table B.1-3
Completeness Measurements

Constituent	Analyses	Number of Measurements Qualified	Number of Measurements Performed	Percent within Criteria
Eu-152	Gamma Spectroscopy	4	85	95.3
Eu-155	Gamma Spectroscopy	7	85	91.8
Np-239	Gamma Spectroscopy	8	85	90.6
Cm-243	Gamma Spectroscopy	13	85	84.7

Cm = Curium
Eu = Europium
Np = Neptunium

radionuclides were not present in any CAU 413 sample that provided a measurable dose. As shown in Table B.1-3, the 80 percent criteria was met for completeness for the CAU 413 dataset. Additionally, as presented in Criterion 2 above, no data failed sensitivity. Therefore, the dataset for CAU 413 has met the general completeness criteria as sufficient information is available to make the DQO decisions.

B.1.1.1.2 DQO Provisions To Limit False-Positive Decision Error

The false-positive decision error was controlled by assessing the potential for false-positive analytical results. QA/QC samples such as method blanks were used to determine whether a false-positive analytical result may have occurred. This provision is evaluated during the data validation process and appropriate qualifiers are applied to the data when applicable. There were no data qualifiers that would indicate a potential false-positive analytical result.

The use of disposable sampling equipment also minimized the potential for cross contamination that could lead to a false-positive analytical result.

B.1.1.2 Decision II

Decision II as presented in the CAIP (NNSA/NFO, 2016) is as follows: "Is there sufficient information to evaluate potential CAAs?" Sufficient information is defined to include the following:

- The lateral and vertical extent of contamination at levels exceeding the FAL
- The information needed to estimate potential remediation waste types and volumes

COCs were detected or assumed to be present above the radiological FAL at SG1, and SG5. Therefore, Decision II must be resolved at these study groups. The lateral and vertical extent of contamination at SG1, SG5, and SG6 was determined through radiological surveys, geophysical surveys, and soil and TLD sampling.

SG1, Undisturbed Areas

It was assumed in the CAU 413 DQOs that TED exceeded the radiological FAL. Thus, only Decision II needed to be addressed at this study group. The lateral and vertical extent of contamination above the FAL was determined through the correlation of FIDLER survey surface (Section A.2.2.2) with TED from sample plot locations (Section A.3.3). Sample plot locations were selected at locations with varying levels of contamination (i.e., high to low) using available KIWI and FIDLER survey data. A total of 10 soil sample plot locations were used to establish the correlation. The extent of the corrective action boundary for SG1 was then established as the isopleth of the FIDLER survey surface value correlated to a 95 percent UCL TED of 25 mrem/CW-yr.

SG5, Buried Debris

It was assumed in the CAU 413 DQOs that the dose from debris and soil buried after the CSII test exceeded the radiological FAL. Thus, only Decision II needed to be addressed at this study group. The lateral and vertical extent of the buried debris was determined through geophysical surveys, using electromagnetic instruments. These data were compared to existing geophysical data collected in the 1990s to confirm the extent of the buried debris/soil.

The information required to predict potential remediation waste types for all study groups was provided by the analytical results from soil samples. The information needed to evaluate the feasibility of remediation alternatives was provided by the potential waste volumes and the potential waste types.

B.1.1.3 Sampling Design

The CAIP (NNSA/NFO, 2016) stipulated that the following sampling processes would be implemented:

SG1, Undisturbed Areas

- A minimum of 9 soil sample plots (each with a TLD) will be established in areas of varying contamination levels to determine the extent of contamination (Decision II).

  Result. A total of 10 sample plots were sampled. The location of the plots were selected judgmentally, and sample aliquots were collected within each plot probabilistically as described in Section A.2.0. A TLD was placed at the center of each sample plot.

- Removable contamination data will be collected from random locations at the soil sample plots inside the CA fence.

  Result. Removable contamination surveys were completed at each sample plot located inside the CA fence. Sixty-six additional removable contamination surveys were also completed to determine HCA conditions within the inner fences (Section A.3.2).

SG2, Disturbed Areas

- One sample location will be evaluated in each of the five disturbed areas. Each location will be field screened to a depth of 30 cm. A surface soil sample will be submitted for analysis from each location. If screening criteria are exceeded at depth, a sample from the depth interval with the most elevated readings will be submitted for analysis.

  Result. A total of five surface and one subsurface soil samples were collected from the disturbed areas in SG2.

SG3, Sedimentation Areas

- A minimum of two areas in each drainage channel within the CA fence and two areas in each drainage channel outside the fence will be sampled. A TLD will be placed at each drainage sample location.

  Result. A total of fourteen surface soil samples and one subsurface sample were collected from 12 sample locations within the three drainages at CAU 413. A TLD was placed at each sample location, with one exception (Section A.5.2). The minimum sample requirements were met and one additional sample location within each of the two northernmost drainages was evaluated for buried contamination and sampled. Additional FIDLER surveys were completed within the northernmost drainage.

SG4, Former Staging Area

- Two soil samples will be collected within the former staging area footprint inside the CA fence.

  Result. Two grab soil samples were collected within the former staging area footprint at SG4.

SG6, Potential Source Material

- Samples of PSM or soil potentially impacted by PSM may be collected based on visual and/or radiological biasing factors.

  Result. Samples of PSM or soil impacted by PSM were not collected during the CAI. Comprehensive FIDLER surveys and visual surveys were conducted to identify PSM and soil with elevated activity.

SG7, Soil Mounds

- Six random subsamples will be collected from the surface (0 to 5 cm) of each soil mound and from each mound interior (15 to 30 cm).

  Result. The samples at the soil mounds were collected, as planned. Removable contamination surveys of the soil mound surfaces were also completed.

B.1.2 Conduct a Preliminary Data Review

A preliminary data review was conducted by reviewing QA reports and inspecting the data. The contract analytical laboratories generate a QA nonconformance report when data quality does not meet contractual requirements. All data received from the analytical laboratories met contractual requirements, and a QA nonconformance report was not generated. Data were validated and verified to ensure that the measurement systems performed in accordance with the criteria specified in the Soils QAP (NNSA/NSO, 2012). The validated dataset quality was found to be satisfactory.

B.1.3 Select the Test and Identify Key Assumptions

The test for making DQO decisions for radiological contamination was the comparison of the TED to the FAL of 25 mrem/CW-yr. The radiological FAL is based on an exposure duration to a site worker using the CW exposure scenario. The key assumptions that could impact a DQO decision are listed in Table B.1-4.

Table B.1-4
Key Assumptions

Exposure Scenario	Construction Worker
Affected Media	Surface and subsurface soil and debris; drainage sediments
Location of Contamination/Release Points	Surface soil surrounding and downwind of GZ; subsurface soil and debris buried near GZ.
Transport Mechanisms	Lateral transport of contamination through drainage channels and overland flow is a major driving force for migration of surface contaminants. Wind may also contribute to lateral transport through resuspension and redistribution of windborne contaminants; however, this transport mechanism is less likely to cause migration of contamination at levels exceeding the FAL. Mechanical disturbance during post-test operations may also serve to displace or redistribute contaminants. Percolation/infiltration of precipitation through soil is a minor force for contaminant migration.
Preferential Pathways	Lateral transport is the major force for migration; wind and percolation/infiltration are minor forces for migration.
Lateral and Vertical Extent of Contamination	Contamination is expected to have been initially contiguous to the release points. Concentrations are expected to generally decrease with distance and depth from the source. Lateral and vertical extent of contamination exceeding the FAL is assumed to be within the spatial boundaries.
Groundwater Impacts	None; groundwater contamination is not expected.
Future Land Use	Military.
Other DQO Assumptions	N/A

B.1.4 Verify the Assumptions

The results of the investigation support the key assumptions identified in the CAU 413 DQOs and Table B.1-4. All data collected during the CAI supported the CSM, and no revisions to the CSM were necessary.

B.1.4.1 Other DQO Commitments

In addition to the commitments discussed in Section B.1.1.3, the following commitments were made in the CAIP (NNSA/NFO, 2016):

- Perform geophysical surveys at the area in SG5 where contaminated debris and soil was buried after the CSII test.

  Result. Geophysical surveys were conducted in the area surrounding GZ. The survey results confirmed the extent of buried debris/disturbed soil suggested by previous geophysical surveys completed in the 1990s.

- Conduct a visual survey of CAU 413 to determine whether potential releases are present based on biasing factors such as stains, spills, radioactivity levels, or debris.

  Result. Visual surveys of CAU 413 identified an area east of GZ outside the CA fence where contaminated debris and isolated areas of soil with elevated radioactivity were concentrated (see Section B.1.1.3). No other PSM was identified at the site.

B.1.5 Draw Conclusions from the Data

The following subsections resolve the two DQO decisions for each of the CAU 413 study groups.

B.1.5.1 Decision Rules for Both Decision I and II

Decision rule. If COC contamination is found that is inconsistent with the CSM or extends beyond the spatial boundaries identified in the CAIP, then work will be suspended and the investigation strategy will be reconsidered, else the decision will be to continue sampling.

- **Result.** The COC contamination is consistent with the CSM and does not extend beyond the spatial boundaries.

B.1.5.2 Decision Rules for Decision I

Decision rule. If the population parameter of any COPC in the Decision I population of interest exceeds the corresponding FAL, then Decision II will be resolved and a corrective action will be determined, else no further investigation is needed for that COPC in that population.

- **Result.** Because COCs were assumed to be present within SG1 and SG5, resolution of Decision II is required. Contaminants were not detected above the FAL at any of the other study groups.

Decision rule. If a waste is present that, if released, has the potential to cause the future contamination at levels exceeding a FAL, then a corrective action will be determined, else no further corrective action will be necessary.

- **Result.** No contaminated debris or soil in SG6 exceeded the hot spot criteria defined in Appendix J.

B.1.5.3 Decision Rules for Decision II

Decision rule. If the spatial extent of any COC has not been defined, then additional samples will be collected, else no further investigation will be necessary. If sufficient information is not available to determine potential remediation waste types and evaluate the feasibility of remediation alternatives, additional waste characterization samples will be collected, else no further investigation will be necessary.

- **Results.** Decision II was resolved for SG1 by the defined area that exceeds 25 mrem/CW-yr and the defined area where removable contamination is present at levels exceeding HCA criteria. Decision II for SG5 was resolved by the lateral and vertical extent of buried material defined by the geophysical surveys.

- Potential remediation waste types were identified sufficiently by the analytical results collected during the CAI.

- Data collected from sampling, geophysical surveys, radiological surveys, and visual surveys are sufficient to support the evaluation of CAAs for CAU 413.

B.1.6 Decision-Supporting Data Quality

B.1.6.1 FIDLER Surveys for Contaminant Distribution

The intended use of the FIDLER data is to depict the spatial distribution of a contaminant when used in conjunction with a GPS unit. The data must provide radiologic instrument relative response sufficient to differentiate areas of high and low instrument response in a reliable and repeatable fashion. The data also must be spatially representative of the distribution and therefore should have spatial accuracy of 1 to 2 m.

FIDLER surveys are conducted according to specific procedures that invoke the quality checks necessary to ensure that the data are usable for their intended use, as follows:

- The FIDLERs are subject to a daily response check to a controlled source to ensure that they are operating as expected.
- Operational guidance is given as to instrument configuration and speed of survey.
- The GPS units are configured so that data of undesirable spatial quality are not recorded.

The survey post-processing invokes additional quality controls that address the following:

- Daily background signatures, collected in the field at a single location, are reviewed for histogram normality and response levels.
- Processed surveys are verified for correctness by those who originally performed the survey.
- Surveys adjacent to or overlapping area where previous surveys have been performed are inspected as to their agreement with the existing data.

FIDLER radiological surveys produce quality data with well-documented pedigrees in accordance with rigorous procedures that guide how they are conducted. Those data meet quality checks designed to ensure that they are suitable for their intended use. The FIDLER survey, once processed into a continuous surface as described in the RBCA document (NNSA/NFO, 2014), can then be correlated with the decision-supporting TED values to create an isopleth delineating a conservative estimate of where the FAL is exceeded.

B.1.6.2 Removable Contamination HCA Criterion

The instruments that generated the removable contamination levels used to compare to the HCA criteria were managed under processes fully compliant with the requirements listed in 10 CFR 835 (CFR, 2017). Specifically, instruments and equipment used for monitoring met the following requirements under 10 CFR 835.401(b):

- Periodically maintained and calibrated on an established frequency.
- Appropriate for the type(s), levels, and energies of the radiation(s) encountered.
- Appropriate for existing environmental conditions.
- Routinely tested for operability.

Data generated under these conditions are sufficient to inform stakeholders to make the decision (i.e., assumption) that the removable contamination could be present at levels that could potentially cause a dose exceeding the radiological FAL. Although the determination of HCA conditions is imprecise, it is only used as an indicator of when an assumption that dose exceeds the FAL may be appropriate in the absence of dose information associated with removable contamination.

B.1.6.3 Visual Surveys

Visual surveys were used to determine the biasing of sample locations by determining the depth of fill material, extent of the soil mounds, identification of PSM, identification of major drainage channels, and identification of sedimentation areas. The CAU 413 DQOs specify criteria for the visual survey to be indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination. This information does not have inherent data quality properties but was agreed to in the DQOs as the identification of the listed biasing criteria by the field personnel.

B.1.6.4 Surface Electromagnetic Survey Data

The instruments that generated the electromagnetic survey values used to delineate probable locations of buried debris are operated according to specific procedures that invoke the quality checks necessary to ensure that the resultant data are usable for their intended use. The operating procedures invoke processes whereby the instruments are as follows:

1. Calibrated pre- and post-survey.
2. Periodically checked during the course of a survey.

3. Appropriate for the type(s), levels, and energies of the debris encountered.
4. Appropriate for existing environmental conditions.
5. Routinely tested for operability.

Data generated under these conditions are sufficient to inform stakeholders to make the decision (i.e., assumption) that the buried debris could be present.

B.2.0 References

Bernhardt, D.E. 1976. *Evaluation of Sample Collection and Analysis Techniques for Environmental Plutonium,* USEPA Report ORP/LV-76-5. Las Vegas, NV.

CFR, see *Code of Federal Regulations*.

Code of Federal Regulations. 2017. Title 10 CFR, Part 835, "Occupational Radiation Protection." Washington, DC: U.S. Government Printing Office.

EPA, see U.S. Environmental Protection Agency.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

NSTec, see National Security Technologies, LLC.

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PNNL, see Pacific Northwest National Laboratory.

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U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2014. *Soils Risk-Based Corrective Action Evaluation Process*, Rev. 1, DOE/NV--1475-Rev. 1. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2016. *Corrective Action Investigation Plan for Corrective Action Unit 413: Clean Slate II Plutonium Dispersion (TTR), Tonopah Test Range, Nevada*, Rev. 1, DOE/NV--1542. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012. *Soils Activity Quality Assurance Plan*, Rev. 0, DOE/NV--1478. Las Vegas, NV.

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Appendix C

Cost Estimates

C.1.0 Cost Estimates

Table C.1-1 contains the information on the cost estimates of clean closure and closure in place with administrative controls for CAU 413. These costs were developed based on the scope and assumptions for each CAA as described in Section 3.3.

Table C.1-1
CAU 413, Clean Closure and Closure in Place Estimates

CAS	Clean Closure Actions	Clean Closure ROM	Closure in Place Actions	Closure in Place ROM
TA-23-02CS	Consists of excavating soil and debris that exceed the FAL of 25 mrem/CW-yr. This includes (1) removal of surface soil to a depth up to 15 cm from SG1 locations that exceed the FAL, (2) removal of soil that exceeds HCA conditions, and (3) removal of all subsurface soil and debris in SG5. Contaminated soil and debris would be disposed of at an offsite facility, and excavated areas would be returned to surface conditions compatible with the intended future use of the site.	$3,200,000	Consists of establishing FFACO URs at locations that exceed, or are assumed to exceed, the FAL of 25 mrem/CW-yr. Specifically, the locations within SG1 that exceed the FAL and the buried debris and soil in SG5.	$35,000

ROM = Rough order of magnitude

ROM estimates are developed before the scope is fully defined. A ROM estimate will have an accuracy of about plus or minus 50 percent. These estimates are based on the principles of the Earned Value Management System as outlined in American National Standards Institute/Electronics Industry Alliance Standard EIA-748-C, *Earned Value Management System* (ANSI/EIA, 2013), and in *A Guide to the Project Management Body of Knowledge (PMBOK Guide)* (PMI, 2013).

C.2.0 References

ANSI/EIA, see American National Standards Institute/Electronics Industry Alliance.

American National Standards Institute/Electronics Industry Alliance. 2013. *Earned Value Management Systems*, EIA-748-C. New York, NY.

PMI, see Project Management Institute.

Project Management Institute. 2013. *A Guide to the Project Management Body of Knowledge (PMBOK Guide),* 5th Edition. Newtown Square, PA.

Appendix D

Evaluation of Risk

D.1.0 Risk Evaluation

The RBCA process used to establish FALs is described in the Soils RBCA document (NNSA/NFO, 2014). This process conforms with NAC Section 445A.227, which lists the requirements for sites with soil contamination (NAC, 2014a). For the evaluation of corrective actions, NAC Section 445A.22705 (NAC, 2014b) requires the use of ASTM Method E1739 (ASTM, 1995) to "conduct an evaluation of the site, based on the risk it poses to public health and the environment, to determine the necessary remediation standards or to establish that corrective action is not necessary." For the evaluation of corrective actions, the FALs are established as the necessary remedial standard.

The ASTM Method E1739 defines three tiers (or levels) of evaluation involving increasingly sophisticated analyses:

- **Tier 1 evaluation.** Sample results from source areas (highest concentrations) are compared to Tier 1 action levels based on generic (non-site-specific) conditions (i.e., the PALs established in the CAU 413 CAIP [NNSA/NFO, 2016]). The FALs may then be established as the Tier 1 action levels, or the FALs may be calculated using a Tier 2 evaluation.
- **Tier 2 evaluation.** Conducted by calculating Tier 2 action levels using site-specific information as inputs to the same or similar methodology used to calculate Tier 1 action levels. The Tier 2 action levels are then compared to individual sample results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis.
- **Tier 3 evaluation.** Conducted by calculating Tier 3 action levels on the basis of more sophisticated risk analyses using methodologies described in Method E1739 that consider site-, pathway-, and receptor-specific parameters.

The RBCA decision process stipulated in the Soils RBCA document (NNSA/NFO, 2014) is summarized in Figure D.1-1.

D.1.1 Scenario

CAU 413, Clean Slate II Plutonium Dispersion (TTR), comprises one CAS, TA-23-02CS, Pu Contaminated Soil. This CAS consists of a release of radionuclides to the surrounding soil from a storage–transportation test conducted on May 31, 1963 (NNSA/NFO, 2016).

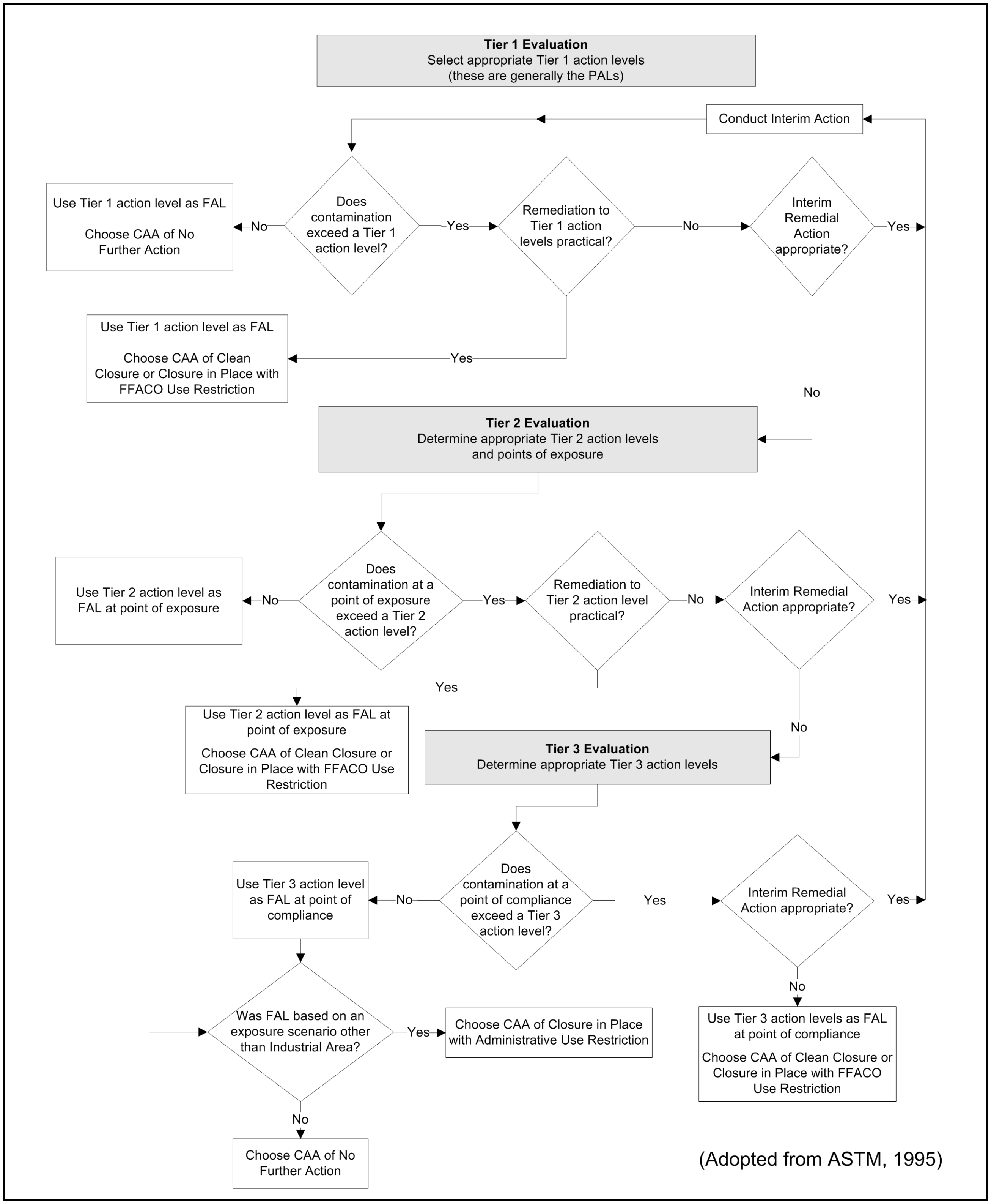

Figure D.1-1
RBCA Decision Process

D.1.2 Site Assessment

The site includes the area affected by the surface release of radioactivity associated with the CSII nuclear test. Scattered testing related debris is present throughout the area. Removable contamination was identified on the debris. Investigation activities at CAU 413 included visual surveys, ground-based radiation surveys, collection of surface and subsurface soil samples, and placement of TLDs. The CAI results are presented in Appendix A.

The CW scenario based FAL was established in this appendix (25 mrem/CW-yr) as it is more protective than the actual current and projected site use. The maximum estimated TED for decision-making purposes (based on the CW scenario) was 55 mrem/yr in a surface soil sample. Buried contamination exists at the site that was not sampled and could potentially provide a higher dose if exposed.

D.1.3 Site Classification and Initial Response Action

The four major site classifications listed in Table 3 of the ASTM Standard are (1) Classification 1, immediate threat to human health, safety, and the environment; (2) Classification 2, short-term (0 to 2 years) threat to human health, safety, and the environment; (3) Classification 3, long-term (greater than 2 years) threat to human health, safety, and the environment; and (4) Classification 4, no demonstrated long-term threats.

Based on the CAI, surface and subsurface contamination is present that could potentially pose a short-term threat to human health, safety, and the environment. Therefore, CAU 413 has been determined to be a Classification 2 site as defined by ASTM Method E1739 (ASTM, 1995).

D.1.4 Development of Tier 1 Action Level Lookup Table

Tier 1 action levels are defined as the PALs listed in the CAIP (NNSA/NFO, 2016) as established during the DQO process. The PALs represent a very conservative estimate of risk, are preliminary in nature, and are generally used for site screening purposes. Although the PALs are not intended to be used as FALs, FALs may be defined as the Tier 1 action level (i.e., PAL) value if implementing a corrective action based on the Tier 1 action level is appropriate.

The radiological dose-based PAL was based on the CW exposure scenario, which assumes that a construction worker is present on a temporary basis at the site for 8 hr/day, 120 day/yr. This results in a total of 960 hours per year (hr/yr) of potential exposure. The 25-mrem/yr dose-based Tier 1 action level for radiological contaminants is determined by calculating the dose a site worker would receive if exposed to the site contaminants over an annual exposure period of 960 hours.

Chemical PALs were defined in the CAIP (NNSA/NFO, 2016); however, no chemical contamination biasing factors were identified at CAU 413 and no chemical analyses was completed on CAI samples. Therefore, the establishment of chemical action levels for CAU 413 was not necessary.

D.1.5 Exposure Pathway Evaluation

For all releases, the DQOs stated that site workers could be exposed to COCs through oral ingestion, inhalation, or dermal contact (absorption) of soil due to inadvertent disturbance of these materials or irradiation by radioactive materials. The potential exposure pathways would be through worker contact with the contaminated soil or debris currently present at the site. The limited migration demonstrated by the analytical results, elapsed time since the releases, and depth to groundwater support the selection and evaluation of only surface and shallow subsurface contact as the complete exposure pathways. Ingestion of groundwater is not considered to be a significant exposure pathway.

D.1.6 Comparison of Site Conditions with Tier 1 Action Levels

An exposure time based on the CW scenario (960 hr/yr) was used to calculate the Tier 1 action levels (i.e., PALs). This scenario was established by the USAF as applicable to CAU 413 (Cornish, 2014). For radiological contaminants, dose values were calculated for comparison to the Tier 1 action level based on an exposure time of 960 hr/yr.

The sample locations at each CAU 413 release that exceed a Tier 1 action level (i.e., PAL) are listed in Table D.1-1. Based on the unrealistic but conservative assumption that a site worker would be exposed to the maximum dose calculated at any sampled location, this site worker would receive a 25-millirem (mrem) dose at each of these locations in the exposure times listed in Table D.1-2.

Table D.1-1
Locations Where 95% UCL of the TED Exceeds the Tier 1 Action Level (mrem/CW-yr)

Study Group	Location	Average TED	95% UCL TED
1	C11	48	74
	C12	55	67
	C14	23	28

Table D.1-2
Minimum Exposure Time to Receive a 25-mrem/CW-yr Dose

Location	Average TED (mrem/CW-yr)	Minimum Exposure Time (hours)
C11	48	496
C12	55	432
C14	23	1,023

D.1.7 Evaluation of Tier 1 Results

The CW exposure scenario was established by the USAF as the appropriate land use scenario for the CAU 413 site (Cornish, 2014). Although the types of work activities that are currently conducted or planned to be conducted at the site are not consistent with the CW scenario used in the development of the Tier 1 PAL, it was determined that potential remediation to the Tier 1 action level is practical and appropriate.

D.1.8 Tier 1 Remedial Action Evaluation

Remedial actions are required based on CAU 413 data compared to the Tier 1 action level. As corrective actions are practical for these releases, the Tier 1 action level is established as the FAL, and corrective actions are proposed.

As the radiological FAL was established as the Tier 1 action level, a Tier 2 evaluation is not necessary.

D.2.0 Summary

The Tier 2 action levels are typically compared to results from reasonable points of exposure (as opposed to the source areas as is done in Tier 1) on a point-by-point basis. Points of exposure are defined as those locations or areas at which an individual or population may come in contact with a COC originating from a release. However, for CAU 413, the Tier 2 action levels were conservatively compared to the 95 percent UCL of the maximum estimate doses from single point locations. These conservative estimated maximum potential doses were used for FFACO decision-making purposes only.

Of the releases considered in this risk assessment, only radiological dose exceeded a FAL. The FAL for radiological dose was established at the Tier 2 level of 25 mrem/CW-yr.

The corrective action for CAU 413 is based on the assumption that activities on the TTR will be limited to those that are industrial in nature and that the TTR will maintain controlled access (i.e., restrict public access and residential use). The FALs were based on an exposure time of 960 hr/yr of site worker exposure to the contaminated surface soils. If the land use at the site changes to a more intensive use where a site worker could be potentially exposed to site contamination for longer exposure times, the worker could potentially receive an unacceptable level of risk. Should the future land use of the TTR change such that these assumptions no longer are valid, additional evaluation may be necessary.

D.3.0 References

ASTM, see ASTM International.

ASTM International. 1995 (reapproved 2015). *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739-95(2015). West Conshohocken, PA.

Cornish, Col. B.R., U.S. Air Force, 99 ABW/CC. 2014. Letter to R. Boehlecke (NNSA/NFO) titled "Air Force Response to DOE Request to Close Five Radiological Sites on the NTTR," 2 May. Nellis AFB, NV.

NAC, see *Nevada Administrative Code.*

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Nevada Administrative Code. 2014a. NAC 445A.227, "Contamination of Soil: Order by Director for Corrective Action; Factors To Be Considered in Determining Whether Corrective Action Required." Carson City, NV. As accessed at http://www.leg.state.nv.us/nac on 2 December 2015.

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Attachment D-1

Waste Disposal Documentation

(7 Pages)

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 15, shipment number ITL12005, with container number TTRA01 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Heser	NI	Waste Coordinator
Shipped by	Organization	Title
/s/ Mark Heser		9/20/12
Signature		Date
Stephen E. Wolf	NStec	Waste Specialist
Received by	Organization	Title
/s/ Stephen E. Wolf		09-20-2012
Signature		Date

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number ITL15003 with container number 413A02 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Shipped by	Organization	Title
Mark Heser	NI	Waste Coordinator

Signature		Date
/s/ Mark Heser		12/2/14

Received by	Organization	Title
Stephen E Wolf	NSTec	Waste Specialist

Signature		Date
/s/ Stephen E. Wolf		12-03-14

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number ITL15004 with container number 413A03 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Heser	NI	Waste Coordinator
Shipped by	Organization	Title
/s/ Mark Heser		12/2/14
Signature		Date
Stephen E Wolf	NSTec	Waste Specialist
Received by	Organization	Title
/s/ Stephen E. Wolf		12-03-14
Signature		Date

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number ITL15005 with container number 413A04 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Shipped by	Organization	Title
Mark Heser	NI	Waste Coordinator

Signature	Date
/s/ Mark Heser	12/2/04

Received by	Organization	Title
Stephen E Wolf	NSTec	Waste Specialist

Signature	Date
/s/ Stephen E. Wolf	12-03-14

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number ITL15006 with container number 413A05 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Heser	NI	Waste Coordinator
Shipped by	Organization	Title
/s/ Mark Heser		12/2/14
Signature		Date
Stephen E. Wolf	NSTec	Waste
Received by	Organization	Title
/s/ Stephen E. Wolf		12-03-14
Signature		Date

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number ITL15007 with container number 413A06 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Mark Heser	NI	Waste Coordinator
Shipped by	Organization	Title
/s/ Mark Heser		12/2/14
Signature		Date
Stephen E. Wolf	NSTec	Waste Specialist
Received by	Organization	Title
/s/ Stephen E. Wolf		12-03-14
Signature		Date

COPY

Certificate of Disposal

This is to certify that the Waste Stream No. LITN-000000006, Revision 16, shipment number **ITL16022** with container numbers 412B01 was shipped and received at the Nevada National Security Site Radioactive Waste Management Complex in Area 5 for disposal as stated below.

Shipped by	Organization	Title
Mark Heser	Navarro	LL Waste Coordinator

Signature	Date
/s/ Mark Heser	8/15/16

Received by	Organization	Title
Stephen E Wolf	NSTec	Waste Specialist

Signature	Date
/s/ Stephen E. Wolf	08/16/16

Appendix E

Engineering Specifications and Drawings

E.1.0 Engineering Specifications and Drawings

This section does not apply to this document.

Appendix F

Sampling and Analysis Plan

F.1.0 Sampling and Analysis Plan

The DQO process described in this appendix is a systematic planning method used to plan data collection activities and define performance criteria for the post-remediation confirmation sampling at CAU 413, Clean Slate II Plutonium Dispersion (TTR). These DQOs are designed to ensure that the data collected will provide sufficient and reliable information to confirm implementation of clean closure at CAU 413. The seven steps of the DQO process presented in Sections F.2.0 through F.8.0 were developed in accordance with *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA, 2006).

F.2.0 Step 1 - State the Problem

Step 1 of the DQO process defines the problem that requires study and develops a conceptual model of the environmental hazard to be investigated.

F.2.1 Problem Statement

The problem statement for CAU 413 clean closure is as follows: "Verification information is required to determine whether COCs are present after implementation of corrective action at CAU 413."

F.2.2 Conceptual Site Model

The CSM is used to organize and communicate information about site characteristics. It reflects the best interpretation of available information at a point in time. The CSM is a primary vehicle for communicating assumptions about release mechanisms, potential migration pathways, or specific constraints. The CSM describes the most probable scenario for current conditions at the site and defines the assumptions that are the basis for identifying appropriate sampling strategy and data collection methods. An accurate CSM is important as it serves as the basis for all subsequent inputs and decisions throughout the DQO process.

The CSM presented in the CAU 413 CAIP (NNSA/NFO, 2016) was updated using data collected during the CAI and assuming complete implementation of the corrective action of clean closure, as defined in this CADD/CAP. The CSM presented in the CAU 413 CAIP contained the seven study group elements evaluated during the CAI. Based on the data collected during the CAI, the CSM presented in the CAIP was validated and no revisions were necessary. As the releases in SG2, SG3, SG4, SG6, and SG7 have been determined not to present a dose above the FAL, the CSM presented in this appendix is limited to the post-remediation state of the remediated areas. The post-remediation CSM assumes the physical setting of the site, contaminant sources, release information, historical background information, and physical and chemical properties of the potentially affected media are unchanged from what was presented in the CAIP DQOs. A diagram of the CSM is presented in Figure F.2-1.

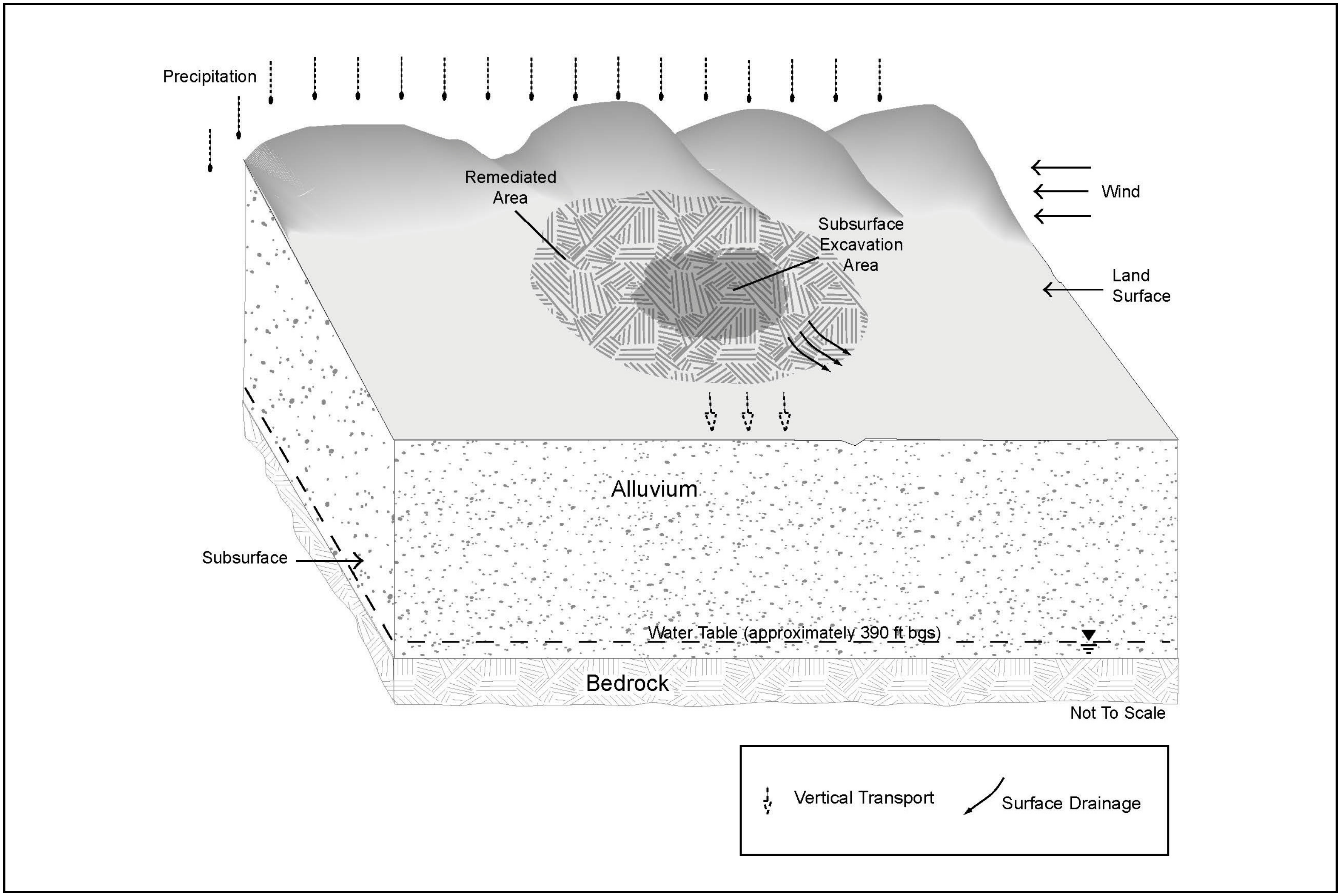


Figure F.2-1
Corrective Action CSM

F.2.2.1 Release Sources

The potential release source at CAU 413 is radionuclide contamination originally dispersed and/or buried as a result of the CSII test that is not removed during the corrective action.

F.2.2.2 Potential Contaminants

The release-specific COPCs are defined as the contaminants reasonably expected at the site that could contribute to a dose or risk exceeding FALs based on the nature of the releases identified in Section 2.2.1. Based on the evaluation of dose from 85 samples collected during the CAI, no detected radionuclide other than Am-241 and Pu-239/240 was attributed to more than 1.2 percent of TED. Therefore, the only radionuclides considered to be COPCs for the post-remediation DQOs are Am-241 and Pu-239/240.Based on the evaluation of dose from 85 samples collected during the CAI, no detected radionuclide other than Am-241 and Pu-239/240 was attributed to more than 1.2 percent of TED. Therefore, the only radionuclides considered to be COPCs for the post-remediation DQOs are Am-241 and Pu-239/240.

F.2.2.3 Contaminant Characteristics

The contaminant characteristics of the radionuclide contaminants include, but are not limited to, solubility, density, and adsorption potential. As the contaminant characteristics are unchanged from the CAIP (NNSA/NFO, 2016), refer to Section A.2.2.3 of the CAIP for information on contaminant characteristics for CAU 413.

F.2.2.4 Site Characteristics

CAU 413 is located in the Cactus Flat valley between two mountain ranges on the TTR. The topography at the site is gently sloping with surface water runoff flow to the southwest toward the Antelope Lake dry lake bed. As the site characteristics are unchanged from the CAIP (NNSA/NFO, 2016), refer to Section 2.2.4 of the CAIP for additional information.

F.2.2.5 Migration Pathways and Transport Mechanisms

As evidenced by the CAI data, the migration pathways and transport mechanisms are unchanged from that presented in the CAIP (NNSA/NFO, 2016); and vertical and lateral transport of contamination is limited, as the contaminants are relatively immobile. This provides the potential for a much greater lateral transport of contaminants compared to vertical flow.

F.2.2.6 Exposure Scenarios

The exposure scenarios are unchanged from the CAIP (NNSA/NFO, 2016). Human receptors may be exposed to COPCs through oral ingestion or inhalation of, or dermal contact (absorption) with soil or debris due to inadvertent disturbance of these materials, or external irradiation by radioactive materials. As presented in Appendix D, the most appropriate exposure scenario for CAU 413 was conservatively established as the CW exposure scenario.

F.3.0 Step 2 - Identify the Goal of the Study

Step 2 of the DQO process states how environmental data will be used in meeting objectives and solving the problem, identifies study questions or decision statements, and considers alternative outcomes or actions that can occur upon answering the questions.

F.3.1 Decision Statements

The decision statement is as follows: "Do COCs remain following completion of the corrective action removal activities?"

F.3.2 Alternative Actions to the Decision

If COCs are not present in the remaining material following completion of the corrective action removal activities, further corrective action is not required. If COCs are present, additional contaminated material will be removed.

F.4.0 Step 3 - Identify Information Inputs

Step 3 of the DQO process identifies the information needed, determines sources for information, and identifies methods that will allow reliable comparisons with corrective action criteria.

F.4.1 Information Needs

To resolve the DQO decision (determine whether COCs remain), soil samples will be collected and analyzed following these two criteria:

- Samples must be collected in areas most likely to contain a COC (judgmental sampling).
- The method must be sufficient to identify any COCs present.

The resolution of DQO Decision I for each excavated area will be based on analytical soil sample results. Therefore, the analytical data will be considered decisional data. To ensure samples are collected in the areas most likely to contain a COC (if present), sample locations will be selected from the most elevated radiological readings using relative readings from a radiological survey. This use of the FIDLER radiological survey data for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). To additionally ensure that samples are collected in the areas most likely to contain a COC (if present), visual and geophysical surveys will be conducted to ensure that all buried debris is removed before collecting the verification samples. These surveys meet the definition of decision-supporting data as defined in the Soils QAP.

As the dose to a potential receptor cannot be estimated for removable contamination, the decision to require corrective action for removable contamination will be based on an assumption that removable contamination exceeds the radiological FAL when the HCA criterion is exceeded. The HCA criterion does not represent dose and is not a basis for determining whether COCs are present. It is an additional consideration for making the conservative assumption of the need for corrective action where it cannot be determined whether COCs are present. This use of removable contamination information meets the definition of decision-supporting data as defined in the Soils QAP.

F.4.2 Sources of Information

Information to satisfy the DQO decision will be generated by collecting and analyzing soil samples from the area of highest radiological readings in and adjacent to the remediated area. Information to support the DQO decision for all excavated areas will be generated by performing a radiological survey of the remediated areas and of the adjacent undisturbed soil. Additional information to support the DQO decision for SG5 will be generated by performing visual and geophysical surveys.

F.5.0 Step 4 - Define the Boundaries of the Study

Step 4 of the DQO process defines the target population of interest and its relevant spatial boundaries, specifies temporal and other practical constraints associated with survey/data collection, and defines the sampling units on which decisions or estimates will be made.

F.5.1 Target Populations of Interest

The population of interest to resolve the DQO decision (determine whether COCs remain in or adjacent to remediated area) is the presence of PSM or a dose above FALs.

F.5.2 Spatial Boundaries

Spatial boundaries are the maximum lateral and vertical extent of expected contamination that can be supported by the CSM. The spatial boundaries are as follows:

- **Vertical.** 2 m below original ground surface for the buried debris, and 10 cm for surface contaminated soil.
- **Lateral.** 10 m beyond the corrective action boundary defined in Appendix A.

COCs found beyond these boundaries may indicate a flaw in the CSM and in earlier analytical results, and may require reevaluation of the CSM before the investigation can continue.

F.5.3 Practical Constraints

Practical constraints may be activities by other organizations, utilities, threatened or endangered animals and plants, unstable terrain, and/or access restrictions that may affect the ability to investigate this site. The only practical constraints that have been identified specific to CAU 413 are the potential impacts from other organizations, and site access restrictions.

F.5.4 Define the Sampling Units

The scale of decision making refers to the smallest, most appropriate area or volume for which decisions will be made. The scale of decision making was defined as each of the corrective action excavations.

F.6.0 Step 5 - Develop the Analytic Approach

Step 5 of the DQO process specifies appropriate population parameters for making decisions, defines action levels, and generates a decision rule.

F.6.1 Population Parameters

Population parameters are the parameters compared to action levels. The population parameters are defined for judgmental and probabilistic sampling designs in the CAIP (NNSA/NFO, 2016).

F.6.2 Action Levels

The FALs are established in Appendix D.

F.6.3 Decision Rules

The decision rules applicable to the DQO decision are as follows:

- If contamination levels are inconsistent with the CSM or extend beyond the spatial boundaries identified in Section F.5.2, then work will be suspended and the corrective action strategy will be reconsidered, else the decision will be to continue the corrective action.
- If the TED in the population of interest (defined in Step 4) exceeds the radiological FAL, then additional corrective action will be implemented, else no further corrective action is needed.

F.7.0 Step 6 - Specify Performance or Acceptance Criteria

Step 6 of the DQO process defines the decision hypotheses, specifies controls against false rejection and false acceptance decision errors, examines consequences of making incorrect decisions from the test, and places acceptable limits on the likelihood of making decision errors. The performance and acceptance criteria presented in this section will be evaluated in the DQA section of the CR.

F.7.1 Decision Hypotheses

The baseline condition (i.e., null hypothesis) and alternative condition for the DQO decision are as follows:

- **Baseline condition.** A COC is present.
- **Alternative condition.** A COC is not present.

Decisions and/or criteria have false-negative or false-positive errors associated with their determination. The impact of these decision errors and the methods that will be used to control these errors are discussed in the following subsections. In general terms, confidence in the DQO decision will be established qualitatively by the following:

- Developing a CSM (based on process knowledge).
- Testing the validity of the CSM based on corrective action results.
- Evaluating the quality of data.

F.7.2 False-Negative Decision Error

The false-negative decision error would mean deciding that a COC is not present when it actually is. The potential consequence is an increased risk to human health and environment. Refer to Section A.7.2 of the CAIP (NNSA/NFO, 2016) for additional detail on false-negative decision errors.

F.7.3 False-Positive Decision Error

The false-positive decision error would mean deciding that a COC is present when it is not, resulting in increased costs for unnecessary corrective action activities. Refer to Section A.7.3 of the CAIP (NNSA/NFO, 2016) for additional detail on false-positive decision errors.

F.8.0 Step 7 - Develop the Plan for Obtaining Data

Step 7 of the DQO process selects and documents a design that will produce data that exceeds performance or acceptance criteria. A judgmental scheme will be implemented to select survey and sample locations within the remediated areas at CAU 413. A probabilistic sampling scheme will be implemented to select sample locations within the sample plot and evaluate the analytical results.

A radiological survey of the remediated areas and of the adjacent undisturbed soil (minimum of 2 m from the excavation boundary) will be performed to identify the location of the highest remaining radioactivity. Surveys will be conducted using vehicle-mounted and/or hand-held FIDLER instruments connected to a GPS instrument. The results of the FIDLER survey will be used to bias soil sample locations to locations within each remediation area with the most elevated readings. For SG1, a minimum of one soil sample plot will be established at the location of the highest radiological survey value in each of the four areas identified by the 25-mrem/CW-yr boundary shown in Figure A.3-4. For SG5, the excavation area will be visually assessed to ensure that all visible debris has been removed, geophysical surveys will be completed to verify that all debris has been removed from the subsurface excavation area, and a minimum of one soil sample plot will be established at the location of the highest radiological survey value. The remaining dose at these sample plots will be calculated using the analytical results from the soil samples (TLDs will not be used to estimate external dose).

For removable contamination, removable contamination surveys will be conducted at the confirmation sample locations where HCA conditions were identified in the CAI to verify that HCA conditions no longer exist.

All samples collected for corrective action confirmation will be analyzed for gamma spectroscopy. The activity of the Pu isotopes will be inferred using the ratios established from the CAI sample results.

F.9.0 References

EPA, see U.S. Environmental Protection Agency.

NNSA/NFO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office.

NNSA/NSO, see U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office.

U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office. 2016. *Corrective Action Investigation Plan for Corrective Action Unit 413: Clean Slate II Plutonium Dispersion (TTR), Tonopah Test Range, Nevada*, Rev. 1, DOE/NV--1542. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2012. *Soils Activity Quality Assurance Plan,* Rev. 0, DOE/NV--1478. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, EPA/240/B-06/001. Washington, DC: Office of Environmental Information.

Appendix G

Activity Organization

G.1.0 Activity Organization

The Environmental Management (EM) Nevada Program Soils Activity Lead is Tiffany Lantow. She can be contacted at 702-295-7645.

The identification of the activity Health and Safety Officer and the Quality Assurance Officer can be found in the appropriate plan. However, personnel are subject to change, and it is suggested that the EM Nevada Program Soils Activity Lead be contacted for further information. The Task Manager will be identified in the FFACO Monthly Field Activity Report prior to the start of field activities.

Appendix H

Sample Location Coordinates

H.1.0 Sample Location Coordinates

Sample location coordinates were collected during the CAI using a GPS instrument. These coordinates identify the field sampling locations (e.g., easting, northing) at CAU 413 and are listed in Table H.1-1.

Table H.1-1
Sample Location Coordinates for CAU 413
(Page 1 of 2)

Sample Location	Northing [a]	Easting [a]
B01	4178882.0	533273.3
B02	4179571.7	534734.2
B03	4177918.5	534211.3
C01	4178791.3	534260.1
C02	4178918.4	534195.2
C03	4178987.3	534278.5
C05	4179046.0	534029.0
C06	4179200.5	533953.2
C07	4179239.1	533973.1
C08	4178561.0	534918.1
C09	4178597.8	534454.7
C10	4178975.1	534102.8
C11	4179159.1	534007.4
C12	4179077.4	534217.1
C13	4179073.2	534080.8
C14	4179038.6	534198.1
C15	4179015.5	534336.2
C16	4178991.9	534147.8
C17	4178614.6	534344.1
C18	4178597.1	534329.1
C19	4178884.9	533923.9
C20	4178869.6	533915.5
C21	4179027.6	534064.9

Table H.1-1
Sample Location Coordinates for CAU 413
(Page 2 of 2)

Sample Location	Northing [a]	Easting [a]
C22	4178960.3	533956.0
C23	4178903.3	533936.6
C24	4178998.2	534227.6
C25	4178945.3	534157.6
C26	4178894.3	533988.7
C27	4178800.3	534658.7
C28	4178752.4	534586.7
C29	4179497.9	534438.8
M01	4179184.0	533852.0
M02	4179194.5	533868.6
M03	4179200.3	533884.3
M04	4179170.0	533973.0
M05	4179179.2	533975.5
M06	4179196.6	533981.4
M07	4179201.6	533989.6
M08	4179221.7	533990.4
M09	4179231.4	533993.5
M10	4179023.6	534076.8

[a] UTM, NAD27, Zone 11N, Meters

NAD = North American Datum
UTM = Universal Transverse Mercator

Appendix I

Geophysical Survey Report

I.1.0 Background

Geophysical surveys were conducted by the Navarro Geophysics group in 2015 and 2016 at the debris burial area addressed under SG5 to determine whether buried metallic materials are present within the area of the suspected disposal trenches. The surveys were conducted both within the HCA and CA on July 14 and 15, 2015. Additional surveys were conducted on May 17 and 18, 2016, within the CA to provide supplemental information. The Navarro Geophysics group submitted the results, and an interpretation of the results of the geophysical surveys in the report is presented in Attachment I-1.

All of the EM31 runs were accomplished with the unit suspended from a shoulder harness. All of the EM61 runs were conducted with the coils mounted to the wheels except for the survey conducted in the HCA, which was conducted with the coils suspended from a harness worn by the operator. With the wheels attached, the bottom coil is about 40 cm above the ground surface. When the coils are suspended from the harness (rather than being mounted on the wheels), the bottom coil is about 20 cm from the land surface.

Surface metallic debris and man-made structures/materials that might be detected by the instruments and interfere with the interpretation of results were visually identified.

The data acquisition, processing, and reduction software described in Attachment I-1 are considered commercial off-the-shelf items that were used for the intended purpose without modification. All data transcriptions, reductions, and conversions were verified using a checkprint process.

I.2.0 Errata for Attachment I-1

- Page 4 of 28: Change antennae to antenna.
- Page 7 of 28: “CS2” refers to CSII.
- Page 15 of 28: “CS2” refers to CSII.

Attachment I-1

Technical Memorandum: Conduct of Geophysical Surveys at the Nevada Test and Training Range Corrective Action Unit 413

(28 Pages)

Technical Memorandum: Conduct of Geophysical Surveys at the Nevada Test and Training Range Corrective Action Unit 413

Document Date: October 28, 2016

Introduction

Geophysical surveys were conducted at the Clean Slate II Corrective Action Site (CAS) TA-23-02CS belonging to Corrective Action Unit (CAU) 413. The surveys were conducted both within the High Contamination Area (HCA) and Contamination Area (CA) July 14-15, 2015. Additional surveys were conducted May 17-18, 2016 in the CA to improve upon the coverage provided by the previous surveys. The objective of the surveys was to detect whether or not there are buried metallic materials indicating the potential for back-filled disposal trenches at the site.

Equipment Used

Two instruments were used to conduct the surveys. The first was an EM31-MK2 earth conductivity meter. The second was an EM61-MK2A time domain metal detector. Both instruments are produced by Geonics Limited of Mississauga, Ontario, Canada.

The EM31-MK2 Earth Conductivity Meter

Figure 1 shows an EM31-MK2 in use on a survey. The instrument measures the conductivity of the materials (soil) interrogated as well as detecting the presence of metal. A transmitter coil located at one end induces circular eddy current loops in the earth. Under certain conditions, the magnitude of any one of these current loops is directly proportional to the terrain conductivity in the vicinity of that loop. Each one of the current loops generates a magnetic field which is proportional to the value of the current flowing within that loop. A part of the magnetic field from each loop is intercepted by the receiver coil on the opposite end of the instrument which results in an output voltage which is linearly related to the terrain conductivity.

Figure 1 Photo of the EM31-MK2 in Use (Geonics, 2012)

Both the quadrature-phase and in-phase signals were recorded. The quadrature-phase signal is the conductivity measurement and the instrument records this response in units of milli-Siemens/meter (mS/m). The in-phase measurement is recorded in units of parts per thousand (ppt). The quadrature-phase signal detects both metallic objects as well as the conductivity of the soil. Because it measures the conductivity of the soil, it can indicate areas of disturbed soil where there are significant differences in conductivity caused by the disturbance. The in-phase signal is most sensitive to the presence of metallic objects.

The instrument was carried as shown in Figure 1. An Archer 14802 Field personal computer (PC) with integrated Hemisphere XF101 global positioning system (GPS) receiver from Juniper Systems, Inc. of Logan, Utah was used to collect the data produced by the EM31-MK2.

The data was reduced using the DAT31W software (Version 2.08, 2001-2012) provided by Geonics. This software allows the user to reduce the "raw" data files saved in the data-logger to files containing the Universal Transverse Mercator (UTM) coordinates of the data points, in meters, and the response values (quadrature-phase and in-phase) generated by the EM31-MK2. All location data was converted to the project standard UTM 11 North American Datum (NAD) 27 coordinate system using ArcMap Version 10 (ArcMap) by esri (esri, 2012). The EM31-MK2 response data, matched to the UTM11 NAD27 coordinates, was then imported into ArcMap for contouring and visualization.

The EM61-MK2A Four Channel Time Domain Metal Detector

The EM61-MK2A detects both ferrous and non-ferrous conductive objects with excellent spatial resolution. Each system includes a single transmitter coil and two receiver coils. The coils are one meter by one-half meter in size. Figure 2 is a photo of the equipment with the coils mounted on wheels.

A primary magnetic field, generated by current supplied to the transmitter coil, induces eddy currents in nearby metallic objects. The induced eddy currents decay with time at a rate that is dependent on the characteristics of the object, producing a secondary magnetic field with the same rate of decay. The time-decay of the secondary magnetic field generates a signal within each of the two receiver coils, thereby detecting the presence of metal. Four time gates (channels) of data are collected. The earlier time gates (channels) improve the detection of smaller targets (Geonics, 2012). The instrument response is recorded in units of millivolts (mV). With the coils mounted on wheels, as shown in Figure 2, the lowermost coil is approximately 40 centimeters (cm) above the ground surface. The lowermost coil doubles as both a transmitter and receiver with the transmission occurring at 75 Hertz. When not transmitting, the same coil acts as a receiver. The uppermost coil is only used to receive the mV signals generated in nearby metallic objects.

Figure 2: Photo of the EM61-MK2A with Wheels Supporting Coils (Geonics, 2012)

The field PC, with integrated GPS receiver, used with the EM31-MK2 was also used to collect the data produced by the EM61-MK2A. To improve positioning accuracy, a model 150-1013-00 patch antennae was connected to the integrated GPS receiver and mounted on the top coil of the EM61-MK2A.

The survey data accompanies this technical memorandum. The data were reduced using the DAT61MK2 software (Version 2.40, 2011) provided by Geonics. This software allows the user to reduce the “raw” data files saved in the data-logger to files containing the UTM coordinates of the data points, in meters, and the four time gate response values (channels of data) generated by the EM61-MK2A. All location data was converted to the project standard UTM11 North American Datum (NAD) 27 coordinate system using ArcMap Version 10 by ESRI (ESRI, 2012). The EM61-MK2A response data, matched to the UTM11 NAD27 coordinates, was then imported into ArcMap for contouring and visualization.

General Information Regarding the EM31-MK2 and EM61-Mk2A Instrument Response Data

The strength of the instrument response is relative. It is a function of the ability of the field generated by the coils to excite a response in an object. The instrument response is affected by the size of the object, its conductivity and iron content, and the distance of the object from the coils (i.e., depth of burial). As such, a small piece of highly ferrous material at ground surface would yield a stronger response than a larger non-ferrous but conductive object also on the surface. In addition, the same piece of highly ferrous material will yield a stronger instrument response on the surface than it will if buried and, is consequently, further from the coils.

The data logger and Hemisphere XF101 GPS unit recorded the survey data while the GPS unit was in motion during the conduct of the surveys. The locations of surface debris were recorded with a Trimble GEO Explorer 2008 series GPS unit running ArcPad held stationary at each location. Although it is not generally the case, differences between the locations reported for the surface debris measured with the Trimble and the survey response data may be different by as much as a few meters due to the difference in the manner with which the GPS data were collected (i.e., stationary versus in motion).

The Trimble collected the data directly in UTM 11 NAD 27 (m). The survey data using the Archer field PC were collected in UTM 11 World Geodetic System (WGS) 84 coordinates, in meters. As noted above, the data were converted to the project standard of UTM 11 NAD 27 coordinates, in meters, prior to use.

Conduct of the Geophysical Surveys

The geophysical surveys were completed in both the HCA and CA. The EM31-MK2 was used only in the HCA. The EM61-MK2A was used to refine the EM31-MK2 survey results inside the HCA and for the surveys conducted in the CA. The focus at each site was the search for potential disposal areas containing metallic debris.

As part of the survey process, surficial metallic debris and man-made structures/materials which might be detected by the instruments were identified. The locations of these items were recorded using a Trimble GEO Explorer 2008 series GPS unit running ArcPad. In addition to the locations, short descriptions of the items found were recorded as well. These data are stored in the file: CSII_GPS.xlsx.

Survey Results

The EM31-MK2 was used on July 14, 2015 to survey within the HCA. A total of six files were collected. These files and the types of data collected are shown in Table 1. Figure 3 is an aerial view of the site showing the area surveyed using the EM31-MK2. The surveys were conducted entirely within the HCA. The projection of the surveyed area across the HCA/CA fence line is due to a discrepancy in the original survey locations for the fence posts that are reflected in the figure. The north arrows appearing on all figures in the report represent grid north, not magnetic.

Table 1 – Files Collected Using the EM31-MK2

Raw Data Filename	Date Collected	Comment
071407A.R31	7/14/2015	Pre-survey static check
071407B.R31	7/14/2015	Pre-survey instrument response check
071408A.R31	7/14/2015	Surveyed area in the HCA walking principally north-south
071409A.R31	7/14/2015	Surveyed portion of area in the HCA walking principally east-west
071411A.R31	7/14/2015	Completed survey in the HCA walking principally east-west
071415A.R31	7/14/2015	Post-survey instrument response check
CAU413_EM31_14JUL15_WGS84_NAD27_m	7/14/2015	Excel workbook containing worksheets for each of the EM31-MK2 survey files collected in July 2015
CSII_GPS.xlsx	Various	Table of locations/objects surveyed-in

Files 071407A, 071407B, and 071415A are the pre and post-survey instrument check files for July 14, 2015. The pre-survey and post-survey static and instrument response checks are done to verify instrument response under set conditions. For the static checks, the instrument was moved to an area free of interference and a data file collected to record the instrument response. The point where this check was performed as well as the orientation of the instrument boom were noted so that they could be repeated during the post-survey check. The instrument response

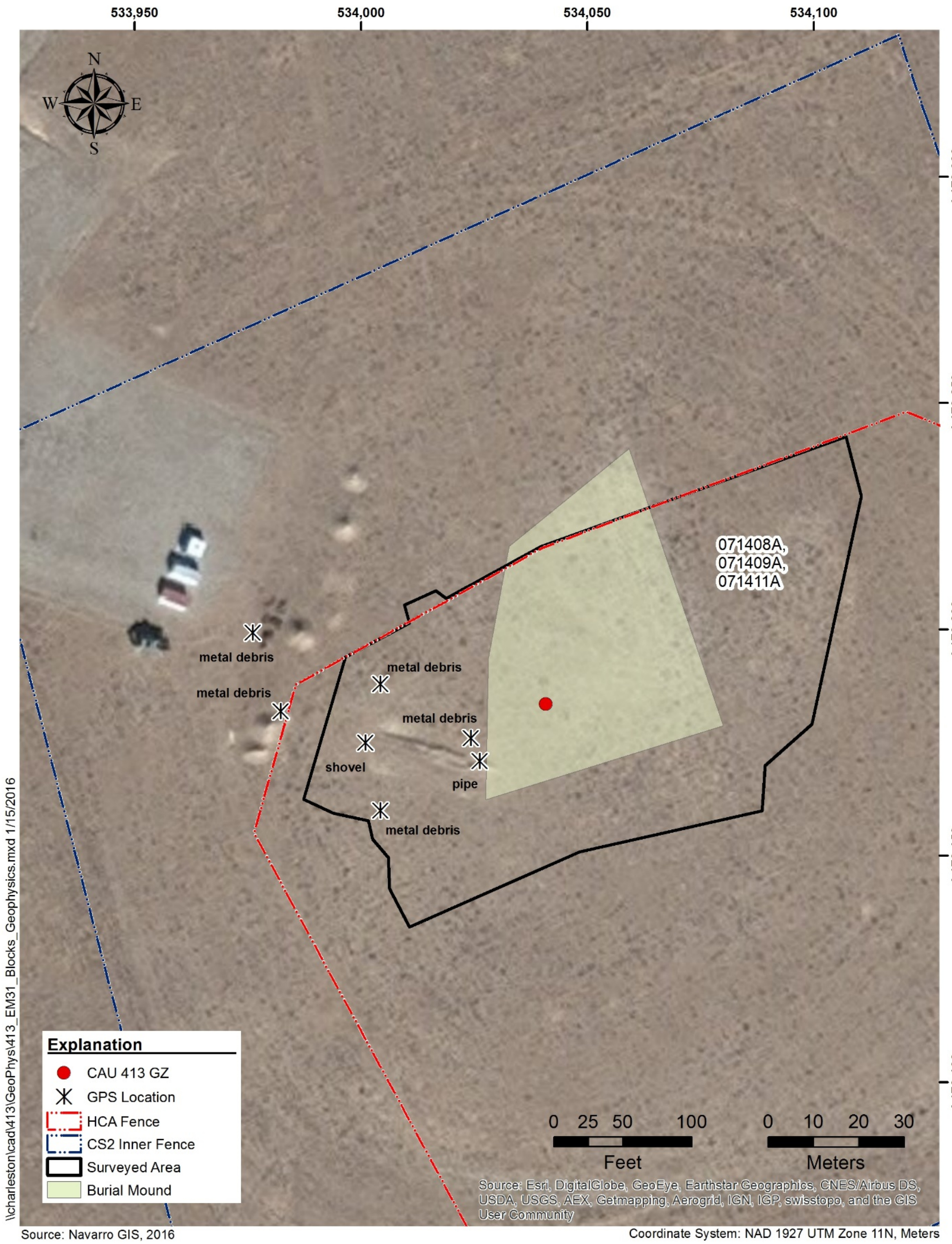


FIGURE 3 Aerial Showing the Area Surveyed Using the EM31-MK2

check consisted of walking across a length of carbon steel pipe while recording the instrument response. For this check, the instrument was passed over the middle of the pipe with the boom oriented perpendicular to the pipe.

A post-survey static check was not performed this day because the power on the Archer data logger was nearly exhausted. However, a post-survey instrument response check was completed. Plots of the pre and post-survey instrument response check data are given in the file CAU413_EM31_14JUL15_WGS84_NAD27_m.xlsx that accompanies this memorandum. Reference to the file shows very similar instrument responses for both the pre and post-survey instrument response checks indicating the instrument response was consistent.

Attachment 1 is a list of all the electronic files included with this memorandum. The Attachment shows the filenames as well as provides brief comments describing the content of the files. The R31 extension files (e.g. listed in Table 1) are the raw data files from the EM31-MK2 instrument as recorded by the Archer data logger. The DAT31W software by Geonics, Inc. was used to convert these files to first G31 extension files and then to XYZ extension files. The XYZ extension files contain the instrument response data as well as the GPS location of each data point in UTM 11 WGS 84 coordinates in meters. The data in the XYZ extension files was imported into Excel® workbooks. The data in the XYZ extension files for each of the survey files (excluding the instrument static and response checks) and was further processed using ArcMap 10.3.1 software to convert the WGS 84 coordinates to the project standard NAD 27 coordinate system. Both the WGS 84 and NAD 27 coordinates, in meters, are included in the Excel® workbooks for the survey files.

Results Using the EM31-MK2 Earth Conductivity Meter

Files 071408A, 071409A, and 071411A represent the EM31-MK2 survey files collected in the HCA. File 071408A was walked generally north-south with the lines of survey approximately 10 feet (ft) apart. Files 071409A and 071411A were walked generally east-west with the lines of survey approximately 10 ft apart. Files 071409A and 071411A combined generally covered the same area as file 071408A. This portion of the survey was split into two segments to allow the operator to rest.

Figure 4 shows the combined paths walked for the EM31-MK2 surveys, as well as the in-phase instrument response at each data point. The results presented in Figure 4 show two areas of elevated readings near the center of the area surveyed. These readings do not correspond to metal debris observed at the surface. However, overall, the instrument responses were low and do not indicate significant amounts of buried metal. A measure of this can be seen along the northern edge of the area surveyed. The “elevated” readings at the northernmost end of the lines of survey represent instrument response to the metal t-posts and barbed wire of the HCA/CA boundary fence.

Figure 5 shows the combined paths walked for the EM31-MK2 surveys, as well as the quadrature-phase instrument response at each data point. The results presented in Figure 5 show the areas of elevated readings near the center of the area surveyed are at the same locations indicated by the in-phase data in Figure 4. In addition, a linear trend of disturbed earth/metallic debris is noted. Once again, the instrument responses were low and do not indicate significant amounts of buried metal. This can be seen comparing the instrument response due to the metal fence posts and barbed wire along the northern edge of the area surveyed to the readings near the center of the area surveyed.

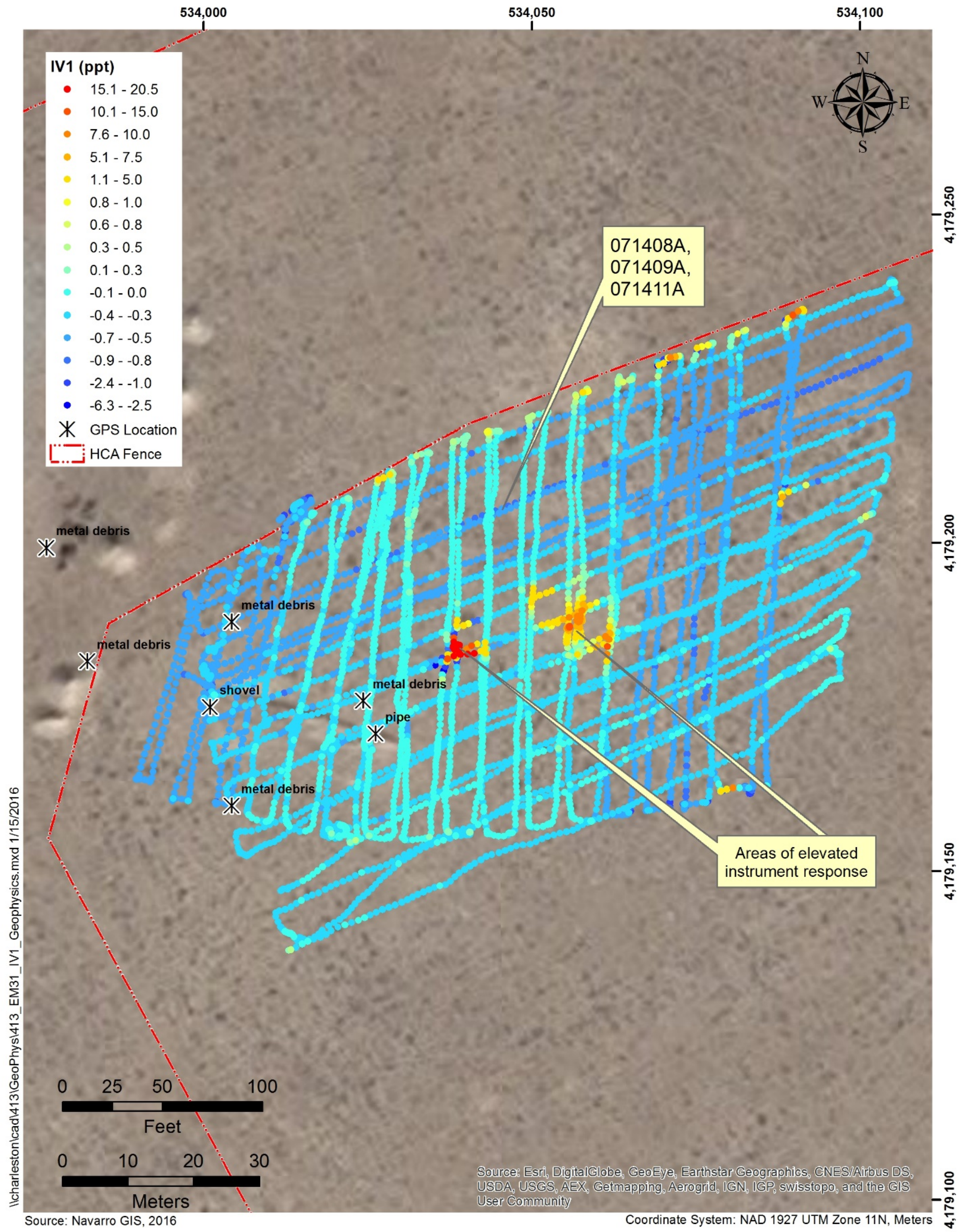


FIGURE 4 – In-Phase Point Data from the EM31-MK2 Surveys

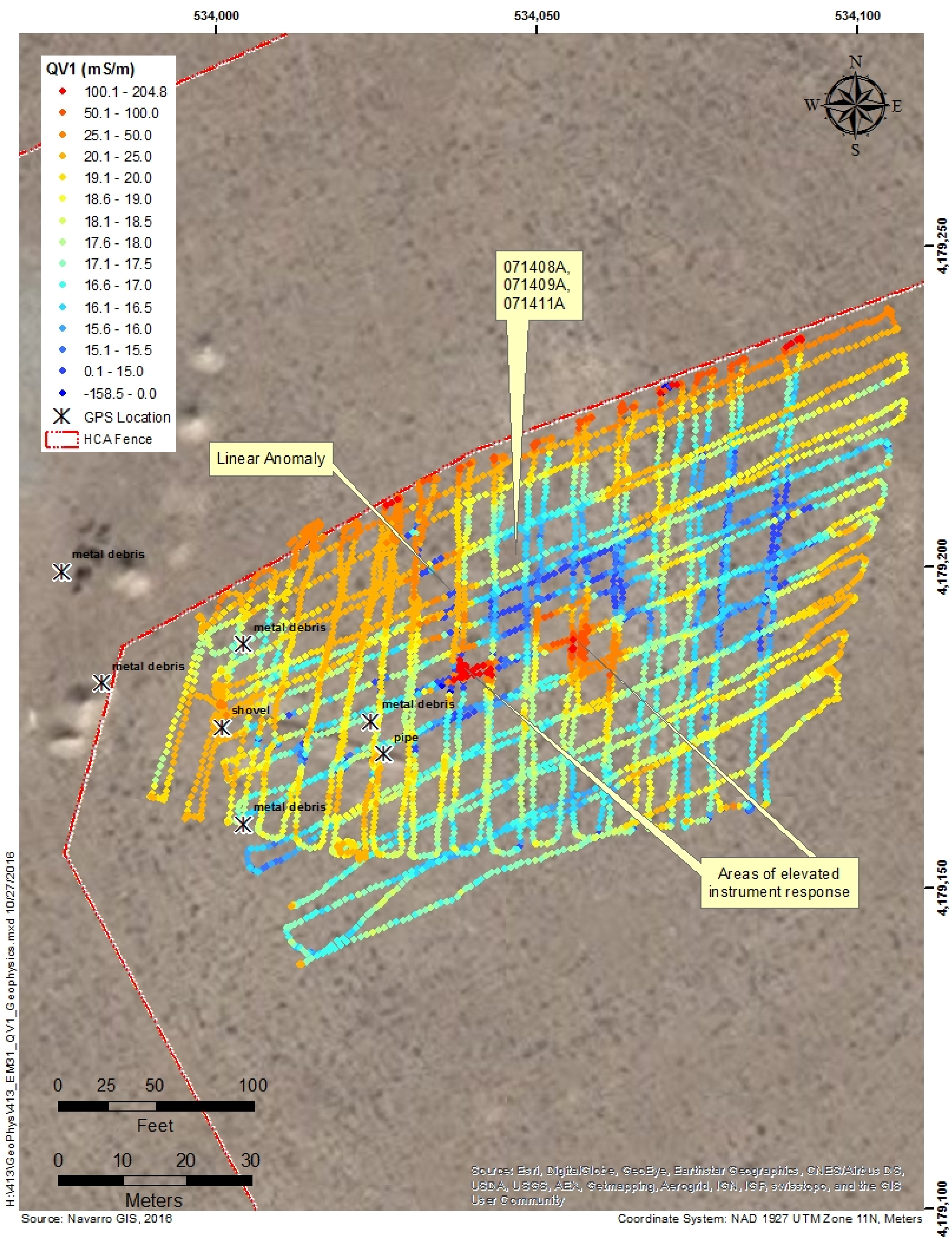


FIGURE 5 – Quadrature-Phase Point Data from the EM31-MK2 Surveys

Results Using the EM61-MK2A Four Channel Time Domain Metal Detector

Surveys were completed with the EM61-MK2A on July 15, 2015 and May 17-18, 2016. Table 2 lists the survey files collected and provides comment. Figure 6 is an aerial of the site showing the locations of the EM61-MK2A surveys presented in this memorandum.

Two areas were surveyed in the CA on July 15, 2015 using the EM61-MK2A (files 071513A and 071513B). However, the areas surveyed did not completely cover the area of interest in the CA. To address this data gap, three additional surveys were completed in the CA using the EM61-MK2A on May 17-18, 2016 (files 051708C, 051710A, and 051809C). In combination, these surveys cover the entire area of interest.

The results of the instrument check runs were normal. Plots of the pre and post-survey instrument check runs are included in the CAU413_EM61_JUL2015_WGS84_NAD27_m_all chan_rpt-data.xlsx and CAU413_EM61_MAY2016_WGS84_NAD27_m_all chan_rpt-data.xlsx workbooks included with this report. No post-survey instrument checks were conducted on May 17, 2016 due to rain.

Attachment 1 is a listing of all the electronic files included with this report. The Attachment shows the filenames as well as provides brief comments describing the content of the files. The R61 extension files (e.g. listed in Table 2) are the raw data files from the EM61-MK2A instrument as recorded on the Archer data logger. The DAT61MK2 software by Geonics, Inc. was used to convert these files to first M61 extension files and then to XYZ extension files. The XYZ extension files contain the data collected by the instrument as well as the GPS location of each data point in UTM 11 WGS 84 coordinates in meters. The data in the XYZ extension files was imported directly into Excel® workbooks. The data in the XYZ extension files for each of the survey files (excluding the instrument static and response checks) was further processed using ArcMap 10.3.1 software to convert the WGS 84 coordinates to the project standard NAD 27 coordinate system. Both the WGS 84 and NAD 27 coordinates, in meters, are included in the Excel® workbooks for the survey files.

Table 2 – Survey Files Collected Using the EM61-MK2A

Raw Data File	Date Collected	Comment
071507A.R61	7/15/2015	Pre-survey static check
071507B.R61	7/15/2015	Pre-survey instrument response check
071509A.R61	7/15/2015	Survey walked generally east-west refining results of the EM31-MK2 survey within the HCA
071513A.R61	7/15/2015	Survey walked generally east-west in the CA
071513B.R61	7/15/2015	Survey walked generally east-west in the CA
071515A.R61	7/15/2015	Post-survey static check
071515B.R61	7/15/2015	Post-survey instrument response check
CAU413_EM61_JUL2015_WGS84_NAD27_m_all chan_rpt-data.xlsx	NA	Excel workbook containing worksheets for each of the EM61-MK2A survey files collected in July 2015
051708A.R61	5/17/2016	Pre-survey static check
051708B.R61	5/17/2016	Pre-survey instrument response check
051708C.R61	5/17/2016	Survey walked generally south-southeast to north-northwest in the CA
051710A.R61	5/17/2016	Survey walked generally south-southeast to north-northwest in the CA
051809A.R61	5/18/2016	Pre-survey static check
051809B.R61	5/18/2016	Pre-survey instrument response check
051809C.R61	5/18/2016	Survey walked generally southwest-northeast in the CA
051813A.R61	5/18/2016	Post-survey static check
051813B.R61	5/18/2016	Post-survey instrument response check
CAU413_EM61_MAY2016_WGS84_NAD27_m_all chan_rpt-data.xlsx	NA	Excel workbook containing worksheets for each of the EM61-MK2A survey files collected in May 2016
CSII_GPS.xlsx	Various	Table of locations/objects surveyed-in

The first EM61-MK2A survey (file 071509A) was conducted in the HCA to investigate anomalies detected using the EM31-MK2. The surveys captured in files 071513A and 071513B were conducted in the CA north of the HCA. The lines of survey were generally walked east-west with approximately five feet between lines for each of these surveys. The spacing between lines varied due to the presence of vegetation and, in one case, a mound of earth, obstructing the intended line of survey. The survey conducted in the HCA (file 071509A) was conducted with the coils suspended from a harness worn by the operator. In this configuration, the bottom coil was some 20 cm above the ground surface. The coils were attached to the wheels for the surveys conducted in the CA May 17-18, 2016. In this configuration, the bottom coil was some 40 cm above the ground surface.

Figure 7 shows the paths of the EM61-MK2A survey inside the HCA (071509A) as well as one of the surveys in the CA (051809C). The survey in the CA was walked in a southwest to northeast pattern generally parallel to the HCA fence. The Channel 2 instrument response at each data point is indicated in Figure 7 by the color of the markers. The survey within the HCA, captured in file 071509A, concentrated on the two areas of elevated readings detected using the EM31-MK2 as well as a linear anomaly proceeding north-northwest from the westernmost area of elevated readings. Figure 7 shows the same areas of elevated instrument response as detected using the EM31-MK2 as well as a linear trend extending from the westernmost area of elevated readings. This linear anomaly suggests the presence of disturbed soil and metallic debris. The figure shows some mildly elevated instrument responses in the CA where the linear anomaly in the HCA appears to continue. Although the areas of elevated instrument response shown are readily apparent, the magnitudes of the responses are not great and no significant quantities of buried metal are indicated. By way of example, there are a number of “elevated” readings along the trend of the HCA fence line. These values, which range between 319 to 4,125 mV, are due to the instrument detecting the metal posts in the HCA fence line.

Figure 8 shows the path of the EM61-MK2A survey inside the HCA (071509A) as well as two of the surveys in the CA (051708C and 051710A). The surveys in the CA were walked in a south-southeast to north-northwest pattern generally perpendicular to the HCA fence. The Channel 2 instrument response at each data point in Figure 8 is indicated by the color of the markers. Figure 8 shows the anomalies in the HCA noted earlier as well as the extension of the linear anomaly in the HCA into the CA some 9 meters (m). However, the instrument responses observed in the CA are relatively low.

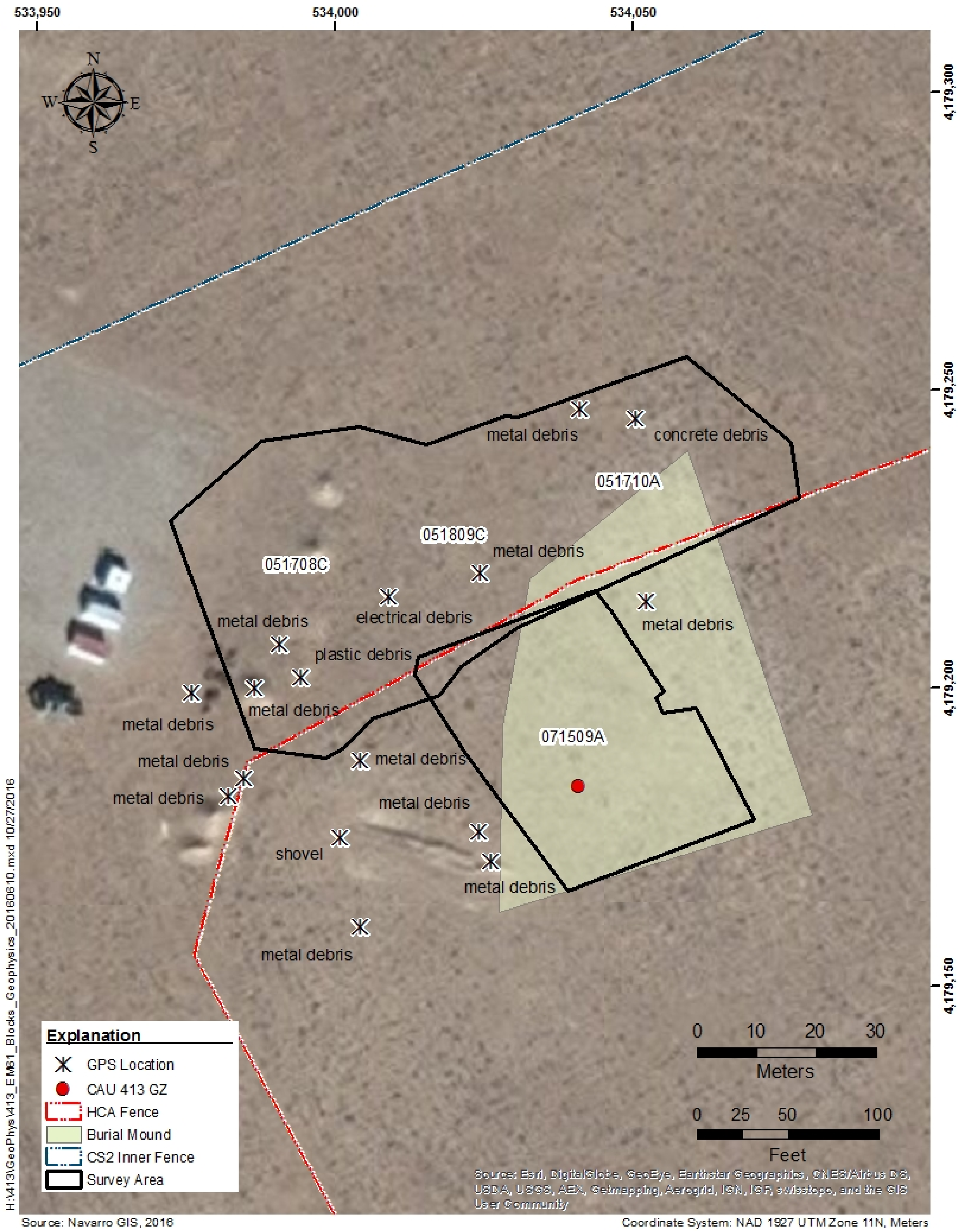


FIGURE 6 Aerial Showing the Areas Surveyed Using the EM61-MK2A

Estimates of Potential Excavation Volumes

The EM61-MK2A data yields a detailed picture of the potential buried metallic debris. In order to estimate potential volumes of buried debris that may be excavated during cleanup of CAU 413, these data were used to estimate the depth of burial of the debris.

The EM61-MK2A yields a Channel 1 response of around 150 mV for the single test bolt used to measure the pre and post-survey instrument response. A cutoff of a 1,500 mV Channel 1 response (approximately equivalent to ten test bolts) was chosen to represent “significant” accumulations of metal for the purpose of defining potential areas of excavation.

Figure 9 shows the Channel 1 contoured data with values of 1,500 mV and greater. In addition, the figure shows potential areas for excavation to remove the buried metal objects detected. Depths to the objects were estimated by processing the instrument response data using the DAT61MK2 software. In addition to the circles surrounding the numbered anomalies, a dashed rectangle appears on Figure 9 surrounding Points 1, 9, and 11. This represents the potential excavation area assuming the anomalies detected represent continuous or nearly continuous metal objects in a backfilled trench.

The anomalies numbered 1, 9, and 11 may represent manifestations of a backfilled trench containing more metal than is indicated by the anomalies themselves. Excavation at these anomalies will indicate whether or not there is additional metal present. The estimated depths to the metal producing anomalies 1, 9, and 11 are between 0.4 and 0.7 m. The length of the potential excavation, based on the linear anomaly observed in the EM61-MK2A data described above, is approximately 38 m. The width of a standard backhoe bucket is around 0.6 m. Taking the maximum depth of the objects detected (i.e. 0.7 m) as the depth of excavation, a length of 38 m, and a width of 0.6 m leads to an estimated in-place excavation volume of some 16 m^3. This value does not include an expansion multiplier to account for an increase in the total volume of loose excavated soil as compared to the compacted soil in place.

Table 3 lists the potential areas for excavation shown in Figure 9. For each point, the UTM 11 NAD 27 coordinates, in meters, on which the potential areas for excavation are centered, the estimated radii and depths of excavation, and estimated excavation volumes are shown as well. The estimated excavation volumes do not include an expansion multiplier to account for an increase in the total volume of loose excavated soil as compared to the compacted soil in place. If excavation is undertaken, it is suggested that the EM61-MK2A be taken to each location and used to find the peak instrument response. Excavation should then proceed focused on the location of the peak instrument response. Once a metallic object is uncovered and removed, the EM61-MK2A should be passed over the area again to verify that no metal objects remain. Proceeding in this manner, it is likely that the volumes requiring excavation to remove the buried metallic objects will be minimized.

Table 3 – Potential Excavation Areas and Estimates of Volumes

Anomaly Number	Easting (m)*	Northing (m)*	Estimated Radius (m)	Estimated Potential Excavation Depth (m)	Estimated Potential Excavation Volume (m^3)
1	534,030.1	4,179,207.7	2	0.7	8.8
2	534,056.2	4,179,194.9	1	1.0	3.1
3	534,055.7	4,179,193.3	1	.4	1.3
4	534,049.8	4,179,187.9	1	.7	2.2
5	534,060.0	4,179,186.9	1	.4	1.3
6	534,060.1	4,179,184.7	1.5	.4	2.8
7	534,062.1	4,179,183.7	1.5	.7	4.9
8	534,043.5	4,179,181.0	1	.4	1.3
9	534,039.7	4,179,184.2	1	.4	1.3
10	534,059.4	4,179,178.9	1	.4	1.3
11	534,034.9	4,179,195.4	1	.4	1.3
12	534,054.6	4,179,186.9	1	.7	2.2
				Subtotal	31.7
Trench**	See Figure 9	See Figure 9	NA	0.7	4.6
ESTIMATED TOTAL					**36.3**

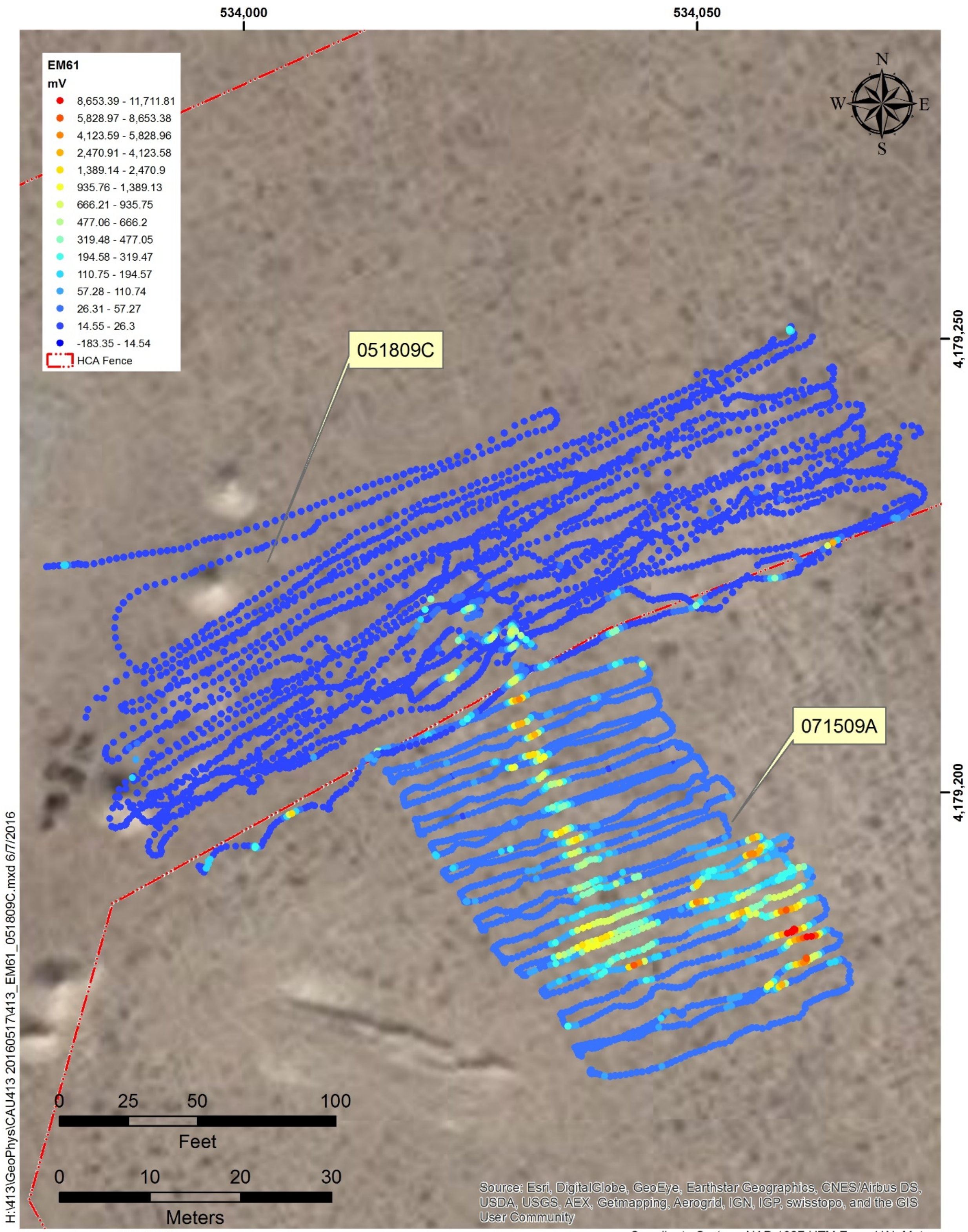
*Coordinates in UTM 11 NAD 27 coordinate system, in meters

** Trench volume excludes point volumes estimated for anomalies 1, 9, and 11

Conclusions

Geophysical surveys were conducted in the HCA and CA at the Clean Slate II Corrective Action Site (CAS) TA-23-02CS. The surveys were conducted using both an EM31-MK2 earth conductivity meter and EM61-MK2A four channel time domain metal detector produced by Geonics Limited of Mississauga, Ontario, Canada. The pre and post-survey calibration runs were normal indicating that both instruments were functioning properly.

Although minor amounts of buried metal are indicated within the HCA, no significant accumulations of buried metal were detected. Nor was any significant amount of metal indicated by the surveys conducted in the CA.



Source: Navarro GIS, 2016

Coordinate System: NAD 1927 UTM Zone 11N, Meters

FIGURE 7 – EM61-MK2A Channel 2 Response Data – View 1

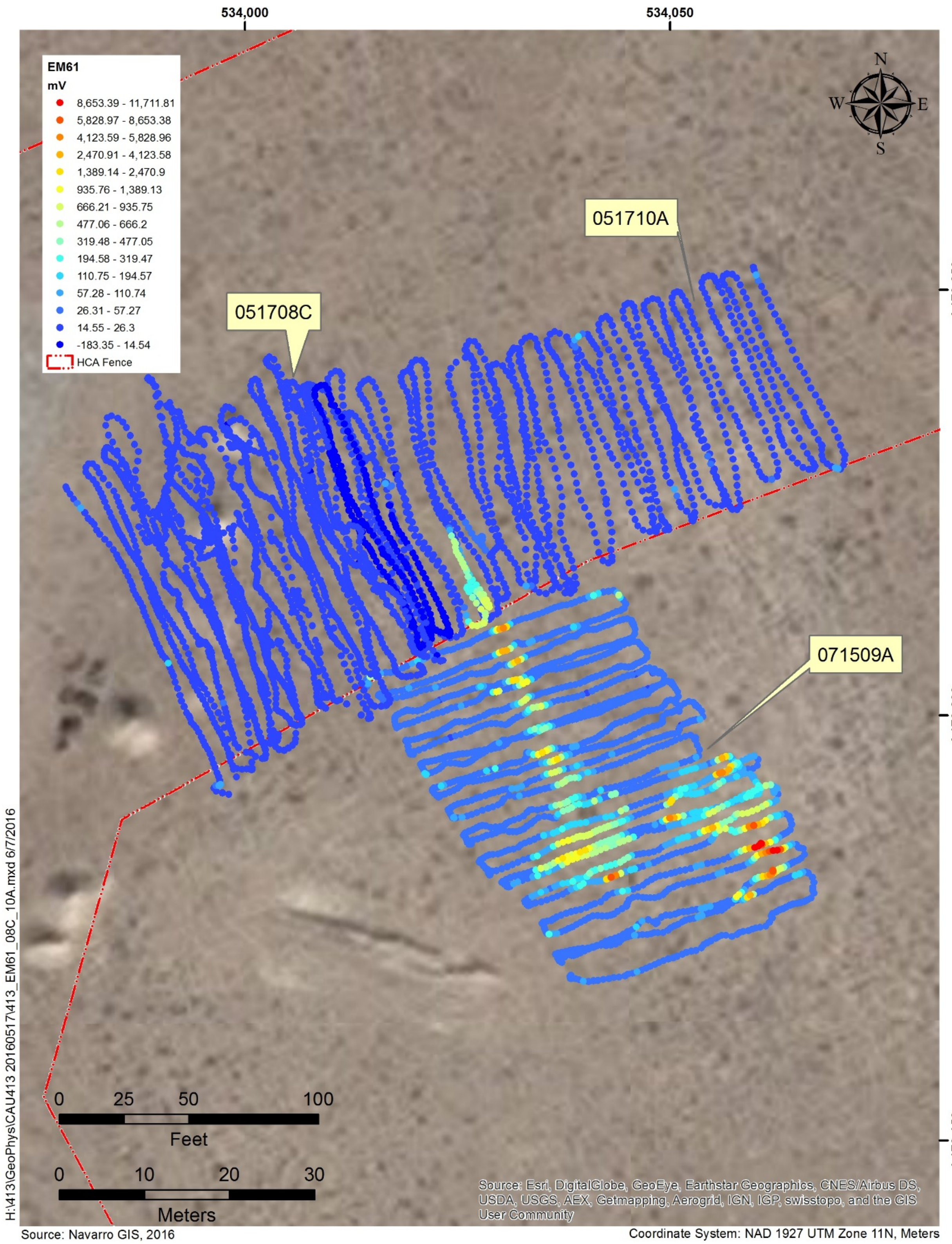


FIGURE 8 – EM61-MK2A Channel 2 Response Data – View 2

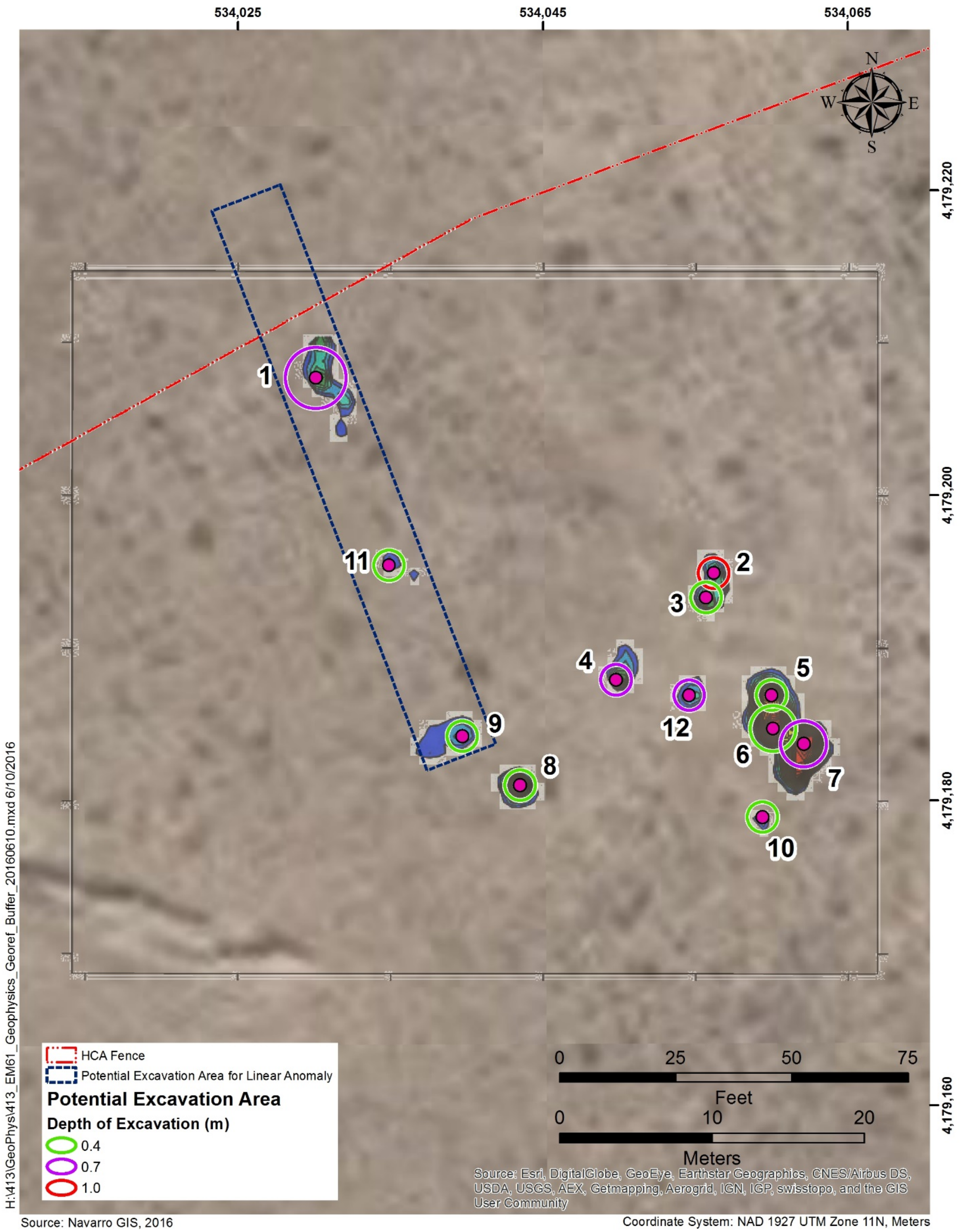


Figure 9 - Potential Excavation Areas

References

DAT31W Software, 2001-2012, Version 2.08
http://geonics.com/

DAT61MK2 Software, 2011, Version 2.40
http://geonics.com/

ESRI, 2012. ArcMap Version 10.
http://www.esri.com/software/arcgis

Geonics, 2012.
http://geonics.com/

Golden Software, 2012. Surfer Version 11.6.1159 (64-bit)
http://www.goldensoftware.com/products/surfer/surfer.shtml

ATTACHMENT 1

EM31-MK2 Files

071407A.R31	EM31-MK2 raw data file containing pre-survey static check
071407B.R31	EM31-MK2 raw data file containing pre-survey instrument response check
071408A.R31	EM31-MK2 raw data file containing survey in the HCA walking principally north-south
071409A.R31	EM31-MK2 raw data file containing survey in the HCA walking principally east-west
071411A.R31	EM31-MK2 raw data file containing survey in the HCA walking principally east-west
071415A.R31	EM31-MK2 raw data file containing post-survey instrument response check
071407A.G31	Intermediate process file produced using the DAT31W software
071407B.G31	Intermediate process file produced using the DAT31W software
071408A.G31	Intermediate process file produced using the DAT31W software
071409A.G31	Intermediate process file produced using the DAT31W software
071411A.G31	Intermediate process file produced using the DAT31W software
071415A.G31	Intermediate process file produced using the DAT31W software
071407A.XYZ	Final process file produced using the DAT31W software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071407B.XYZ	Final process file produced using the DAT31W software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071408A.XYZ	Final process file produced using the DAT31W software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071409A.XYZ	Final process file produced using the DAT31W software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071411A.XYZ	Final process file produced using the DAT31W software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).

ATTACHMENT 1 (Continued…)

EM31-MK2 Files	
CAU413_EM31_14JUL15_WGS84_NAD27_m	Excel workbook containing worksheets for each of the EM31-MK2 survey files collected in July 2015
CSII_GPS	Excel workbook containing the locations of metallic surface debris noted on the surface within the areas surveyed
EM61-MK2A Files	
071507A.R61	EM61-MK2A raw data file containing pre-survey static check
071507B.R61	EM61-MK2A raw data file containing pre-survey instrument response check
071509A.R61	EM61-MK2A raw data file containing survey in the HCA walking principally east-west
071513A.R61	EM61-MK2A raw data file containing survey in the CA walking principally east-west
071513B.R61	EM61-MK2A raw data file containing survey in the CA walking principally east-west
071515A.R61	EM61-MK2A raw data file containing post-survey static check
071515B.R61	EM61-MK2A raw data file containing post-survey instrument response check
051708A.R61	EM61-MK2A raw data file containing pre-survey static check
051708B.R61	EM61-MK2A raw data file containing pre-survey instrument response check
051708C.R61	EM61-MK2A raw data file containing survey in the CA walking principally south-southeast to north-northwest
051710A.R61	EM61-MK2A raw data file containing survey in the CA walking principally south-southeast to north-northwest
051809A.R61	EM61-MK2A raw data file containing pre-survey static check
051809B.R61	EM61-MK2A raw data file containing pre-survey instrument response check
051809C.R61	EM61-MK2A raw data file containing survey in the CA walking principally southwest to northeast
051813A.R61	EM61-MK2A raw data file containing post-survey static check
051813B.R61	EM61-MK2A raw data file containing post-survey instrument response check

ATTACHMENT 1 (Continued…)	
EM61-MK2A Files	
071507A.M61	Intermediate process file produced using the DAT61MK2 software
071507B.M61	Intermediate process file produced using the DAT61MK2 software
071509A.M61	Intermediate process file produced using the DAT61MK2 software
071513A.M61	Intermediate process file produced using the DAT61MK2 software
071513B.M61	Intermediate process file produced using the DAT61MK2 software
071515A.M61	Intermediate process file produced using the DAT61MK2 software
071515B.M61	Intermediate process file produced using the DAT61MK2 software
051708A.M61	Intermediate process file produced using the DAT61MK2 software
051708B.M61	Intermediate process file produced using the DAT61MK2 software
051708C.M61	Intermediate process file produced using the DAT61MK2 software
051710A.M61	Intermediate process file produced using the DAT61MK2 software
051809A.M61	Intermediate process file produced using the DAT61MK2 software
051809B.M61	Intermediate process file produced using the DAT61MK2 software
051809C.M61	Intermediate process file produced using the DAT61MK2 software
051813A.M61	Intermediate process file produced using the DAT61MK2 software
051813B.M61	Intermediate process file produced using the DAT61MK2 software
071507A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071507B.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071509A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071513A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).

ATTACHMENT 1 (Continued…)

EM61-MK2A Files

071513B.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071515A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
071515B.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051708A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051708B.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051708C.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051710A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051809A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051809B.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051809C.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).

ATTACHMENT 1 (Continued…)	
EM61-MK2A Files	
051813A.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
051813B.XYZ	Final process file produced using the DAT61MK2 software. File contains the instrument response as well as the location data for each data point. Coordinates in UTM11 WGS 84 (m).
CAU413_EM61_JUL2015_WGS84_NAD27_m_all chan_rpt-data	Excel workbook containing the EM61-MK2A data from July 2015. Coordinates are provided in UTM 11 WGS 84 (m) and UTM 11 NAD 27 (m).
CAU413_EM61_MAY2016_WGS84_NAD27_m_all chan_rpt-data	Excel workbook containing the EM61-MK2A data from May 2016. Coordinates are provided in UTM 11 WGS 84 (m) and UTM 11 NAD 27 (m).
CSII_GPS	Excel workbook containing the locations of metallic surface debris noted on the surface within the areas surveyed

Appendix J

Radiological Hot Spot Criteria

J.1.0 Radiological Hot Spot Criteria

J.1.1 Background

The radiological hot spot criterion was developed to address corrective action decisions for small areas that may contain unacceptably high activities of residual radioactive material (i.e., hot spots), even though the areas do not cause a dose that exceeds the area-based FAL. Hot spots may be identified by FIDLER surveys that detect radioactivity nominally above a value correlated to the FAL and anomalous to the surrounding area. This approach is based on the "Hot Spot Criterion for Field Application" in Section 3.3.2 of the *User's Manual for RESRAD Version 6* (Yu et al., 2001), which states the following:

> *"The derivation of remedial action criteria generally assumes homogeneous contamination of large areas (several hundred square meters or more), and the derived concentration guide is stated in terms of concentrations averaged over a 100-m^2 area. Because of this averaging process, hot spots can exist within these 100-m^2 areas that contain radionuclide concentrations significantly higher than the authorized limit. Therefore, the presence of hot spots could potentially pose a greater risk of exposure to individuals using the site than the risk associated with homogeneous contamination. To ensure that individuals are adequately protected and to ensure that the ALARA process is satisfied, the following hot spot criterion must be applied, along with the general criterion for homogeneous contamination."*

This approach is used by MARSSIM to comply with radiation protection requirements, and is fully evaluated and described in the *User's Manual for RESRAD Version 6* (Yu et al., 2001) and *Dose Modeling and Statistical Assessment of Hot Spots for Decommissioning Applications* (Abelquist, 2008). The hot spot RRMGs are based on the exact computations as the area-based RRMGs (based on an area of contamination of 1,000 m^2) that have been used throughout the Soils Activity with the only exception being that the area of contamination was reduced to 1 m^2.

J.1.2 Hot Spot Criterion for Soil

This process produces a hot spot criterion that will conservatively protect potential receptors from an unacceptable dose due to a small area of elevated radioactive contamination (i.e., hot spot). The hot spot criterion is a FIDLER survey value expressed in terms of counts per minute (cpm) that corresponds to a dose of 25 mrem/yr calculated using the CW exposure scenario hot spot RRMGs. Hot spot RRMGs were developed using RESRAD by changing the area of contaminated zone parameter to represent the area of the hot spot (i.e., 1 m^2). To maintain conservatism in the process, the *User's Manual for RESRAD Version 6* stipulates that the minimum hot spot area to be used for development of the hot spot RRMGs will be 1 m^2 (Yu et al., 2001). When calculating the hot spot RRMGs, all other RESRAD parameters are not changed from those used to produce the area-based RRMGs in accordance with the Soils RBCA document (NNSA/NFO, 2014). The area-based RRMGs (based on 1,000 m^2) and the resulting hot spot RRMGs (based on 1 m^2) for the CW exposure scenario are presented in Table J.1-1. Based on the average relative abundance of radionuclides at the CSII site, the calculated activities of each radionuclide that would result in a dose of 25 mrem/CW-yr are presented in Table J.1-1 for both the area-based and hot spot RRMGs. Of the radionuclides present at the CSII site, Pu-239/240 and Am-241 provide more than 98 percent of TED. As Am-241 is the more readily detectable by field instrumentation, it was used to develop a FIDLER field screening criterion for hot spots based on an Am-241 activity of 877 pCi/g. To maintain conservatism in the process, the *User's Manual for RESRAD Version 6* stipulates that any hot spot exceeding 30 times the area-based FAL will be assumed to require corrective action (Yu et al., 2001). As 30 times the area-based Am-241 activity of 358 pCi/g is greater than the hot spot Am-241 activity of 877 pCi/g, the 30 times limit does not apply.

Table J.1-1
Hot Spot Contaminant Activities at 25 mrem/CW-yr

Contaminant	Area-Based			Hot Spot		
	RRMG (pCi/g)	Activity (pCi/g)	Dose (mrem/yr)	RRMG (pCi/g)	Activity (pCi/g)	Dose (mrem/yr)
Am-241	3,270	358	3	11,900	877	2
Am-243	394	3.9	0	4,130	9.5	0
Cs-137	147	0.8	0	2,230	2.0	0
Pu-238	5,820	35.6	0	13,300	87.3	0
Pu-239/240	5,310	4,540	21	12,200	11,100	23
Pu-241	263,000	631	0	622,000	1,550	0
Th-232	1,060	10.3	0	7,980	25.2	0
U-234	56,600	4.3	0	152,000	10.5	0
U-235	513	0.2	0	7,450	0.4	0
U-238	2,920	6.5	0	35,400	16.0	0
		Total [a]	25		Total	25

[a] All numbers are rounded to significant digits for reporting purposes, but unrounded numbers are used in calculations, thus causing an apparent discrepancy in the total.

Th = Thorium

The Am-241 hot spot limit of 877 pCi/g was applied to the CSII hot spots by converting the Am-241 activity into FIDLER count rates. This was achieved by calculating the FIDLER cpm associated with the gamma emissions of Am-241 in terms of gamma disintegrations per minute (gamma dpm) per pCi/g. This required determining detector efficiencies for each FIDLER instrument and gamma attenuation rates through soil using an Am-241 button source in a controlled environment. This method was applied to the specific FIDLER instruments named Charlie and Nero.

J.1.3 Relationship between Gamma Disintegrations and FIDLER Counts

Efficiencies are used to convert gamma disintegrations of Am-241 per minute (dpm) to net counts per minute (net cpm) (gross cpm minus background cpm) from the FIDLER instruments. The efficiencies for the FIDLER detectors were determined by using an 11.03E6-pCi Am-241 button source that was centered 15 inches (in.) away from the face of the detector. This distance represents the approximate distance from the detector to the ground during radiation surveys.

$$efficiency\ (cpm/dpm) = \frac{net\ cpm}{4\pi\ gamma\ activity\ (dpm)} \qquad Eq.\ 1$$

The 4π gamma activity is calculated by using the standard conversion of 2.22 total dpm per pCi and converting total dpm to gamma dpm by applying the 59.5 kiloelectron volt gamma yield of Am-241 (0.36) (the fraction of total Am-241 disintegrations that produce a gamma emission) as follows:

$$4\pi\ gamma\ dpm = 11{,}030{,}000\ pCi * \frac{2.22\ total\ dpm}{pCi} * \frac{0.36\ gamma\ dpm}{1\ total\ dpm} = 8.82E6 \qquad Eq.\ 2$$

Using the 11.03E6-pCi Am-241 button source, the FIDLER instrument efficiencies are shown in Table J.1-2.

The FIDLER instruments were calibrated on 06/23/2016. The differences in the efficiencies before and after this date are largely due to changes in the high voltage/gain at the time of calibration. The high voltage/gain settings resulted in pre-calibration readings that were much higher than post-calibration readings.

Table J.1-2
FIDLER Instrument Efficiencies

	Net cpm	Efficiency
Charlie before 06/23/2016	39,668	0.0045
Nero before 06/23/2016	43,194	0.0049
Charlie after 06/23/2016	8,891	0.00101
Nero after 06/23/2016	10,931	0.0012

However, using a single-point derived efficiency is unrealistic because the detector will detect gammas from its field of view, not just directly underneath the detector. For this reason, an integrated efficiency is needed. The integrated efficiency was determined by using an Am-241 button source at various offsets from the center of the detector and determining the efficiency of the source at each location. The efficiencies at each offset were weighted based on the portion of counts at the offset compared to the total counts recorded for all offsets. The weighted efficiencies at each offset were then summed to yield an integrated efficiency (Alecksen and Whicker, 2016; Farr et al., 2010).

$$\begin{matrix} integrated \\ efficiency \end{matrix} = \sum_{n=0\ cm}^{40\ cm} \left(\frac{(net\ cpm_n)}{\sum_{n=0\ cm}^{40\ cm}(net\ cpm_n)} \times efficiency_n \right) \qquad Eq.\ 3$$

To calculate the integrated efficiency, the gross counts, background counts, and efficiency at a certain distance would need to be known. This was done for each detector. Table J.1-3 contains the results for Charlie after 06/23/2016.

Table J.1-3
Example Efficiencies for Charlie after 06/23/2016

cm	Gross Counts	Net Counts	Fraction of Total Counts	Efficiency	Weighted Efficiency
	Gamma cpm		None		
0	9,014	8,891	50.6%	0.00101	0.00051
20	6,207	6,084	34.6%	0.00069	0.00024
40	2,735	2,612	14.9%	0.00030	0.00004
	Sum	17,587		Sum	0.00079

The following explains the data contained in each of the table columns in Table J.1-3:

- **cm.** The distance from the center of the detector in centimeters.
- **Gross Counts.** Gross counts at the distance listed in the row.
- **Net Counts.** Gross counts – background counts at the distance listed in the row.
- **Fraction of Total Counts.** The fraction of the total net counts at the listed distance.
- **Efficiency.** The efficiency at the listed distance.
- **Weighted Efficiency.** The "Efficiency" column multiplied by the "Fraction of Total Counts" column. The last row is the sum of all the weighted efficiencies and is the integrated efficiency for the detector.

This was done for each of the detectors resulting in the following integrated efficiencies:

- Charlie before 06/23/2016 = 0.0037 (cpm/dpm)
- Nero before 06/23/2016 = 0.0040 (cpm/dpm)
- Charlie after 06/23/2016 = 0.00079 (cpm/dpm)
- Nero after 06/23/2016 = 0.00099 (cpm/dpm)

The net cpm readings of the FIDLER instruments can be divided by these integrated efficiencies to convert the net cpm readings to gamma dpm.

J.1.3.1 Conversion of Gamma DPM to Am-241 Activity Concentration

The conversion of gamma dpm to an activity concentration in pCi/g can be calculated using the mass of Am-241-contaminated soil in the FIDLER field of view and the standard conversion of 2.22 dpm per pCi. It was experimentally determined that the FIDLER will detect about 97 percent of the normalized activity within a 100-cm radius of the FIDLER in a uniformly contaminated area. This means that 3 percent of the normalized activity is detected by the FIDLER from a distance greater than 100 cm. For the calculations, the assumption is made that the FIDLER has an effective field of view with a 100-cm radius. The mass of soil in the FIDLER field of view with a 1-in. (2.54-cm) thickness of was calculated as follows:

- Field of view area (100-cm radius) = 31,416 cm^2
- Volume of the field of view area (2.54-cm depth) = 79,796 cm^3
- Mass per 79,796 cm^3 of soil volume (1.6-g/cm^3 soil density) = 127,674 g

The following equation was used to determine the conversion factor from gamma dpm to Am-241 activity in pCi/g:

$$\frac{gamma\ dpm}{pCi/g} = \frac{2.22\ total\ dpm}{pCi} * \frac{0.36\ gamma\ dpm}{total\ dpm} * \frac{Soil\ mass\ (g)}{2.54\ cm\ of\ depth} * depth\ (cm) \qquad Eq.\ 4$$

As shown in the following equation for a depth of contamination of 2.54 cm, this results in 102,037.3 gamma dpm for each pCi/g of Am-241.

$$\frac{gamma\ dpm}{pCi/g} = \frac{2.22\ total\ dpm}{pCi} * \frac{0.36\ gamma\ dpm}{total\ dpm} * \frac{127{,}674.3\ g}{2.54\ cm} * 2.54\ cm = 102{,}037.3 \qquad Eq.\ 5$$

However, this relationship must be modified, as it does not account for attenuation of the gamma activity through the soil. Gamma emissions are attenuated exponentially in the desert soil. Some of the Am-241 gamma emissions are scattered and/or absorbed in the soil while others do not interact with the soil. An Am-241 button source was used to determine the attenuation coefficient of typical desert soil and the transmission fraction through various soil depths and offsets to 30 cm. The following equation is used for determining the transmission of photons through a target:

$$I_x = I_o e^{-\mu x} \qquad Eq.\ 6$$

where
I_x = the photons that do not interact with the soil
I_o = the photons emitted from the source
μ = the linear attenuation coefficient
x = the thickness of the soil

The μ is determined by solving for μ in Equation 6. Experimentally, I_o is the gamma activity of the source, and I_x is the activity detected by the FIDLER. The distance from the source to the surface of the soil, x, is variable depending on the soil depth and the offset used. The distance from source to surface soil, x, was calculated for each soil thickness and offset. The average attenuation coefficient from a series of offsets and soil thicknesses was determined to be 0.6 cm^{-1}.

The transmission fraction is the portion of emitted gammas that could be detected after traveling through a soil thickness. This was determined by placing the source 15 in. away from the detector on the surface of the soil (as well as offsets of 10, 20, and 30 cm) and recording the count rate. Then the source was placed underneath 1 in. of soil (still with the detector 15 in. away from the soil surface) and the count rate recorded (at offsets also). This process was repeated for a soil depth of 2 and 3 in. An integrated efficiency was determined (as discussed in the previous section) for the surface and each soil depth. The integrated efficiency for each soil depth was then compared to the integrated efficiency of the surface. The fraction of the integrated efficiency at soil depth to the integrated efficiency at the soil surface will be known as the transmission fraction. The two FIDLER detectors yielded results that were not distinguishably different. Therefore, the derived transmission fractions will be used for both instruments.

The integrated efficiency was determined for each soil depth using the Charlie detector. The transmission percentages for each soil depth were then calculated, as shown in Table J.1-4.

Table J.1-4
Transmission Percentages at Soil Depths

Soil Depth	Transmission Percentage
Surface	100.0%
2.54 cm	17.5%
5.08 cm	4.4%
7.62 cm	1.2%

With the inclusion of a soil mass, the attenuation of the Am-241 gamma ray through the soil becomes an important factor in the estimation of soil concentration. The soil concentration can be better estimated by applying the corresponding transmission fraction to the gamma dpm to Am-241 activity (pCi/g) previously calculated.

$$\frac{dpm}{pCi/g} attenuated = \frac{dpm}{pCi/g} * \frac{1}{F_t} \qquad \textit{Eq. 7}$$

Using a transmission fraction associated with the bottom of the contaminated soil layer would represent that all of the Am-241 contamination is at that depth and attenuated through an overlying layer of uncontaminated soil. Using a transmission fraction associated with the top of the contaminated soil layer would be more representative of site conditions, because the contamination is concentrated at or near the surface and decreases rapidly with depth. However, to be conservative, it was determined to use a transmission fraction associated with a soil depth of one-half of the estimated total depth of contamination, even though this would result in an overestimation of Am-241 activities.

Using a total soil contamination depth of 5 cm, the corresponding transmission fraction would be 0.175. As shown in the following equation, this would result in 17,856.5 gamma dpm for each pCi/g of Am-241.

$$\frac{dpm}{pCi/g} attenuated = \frac{102{,}037.3\ gamma\ dpm}{pCi/g} * 0.175 = 17{,}856.5 \qquad \textit{Eq. 8}$$

Putting the various equations together to get the relationship between the FIDLER net cpm readings and the Am-241 activity in pCi/g results in the following equation:

$$\frac{net\ cpm}{pCig} = (Ew) * \left(\frac{dpm\ to\ pCi}{conversionfactor}\right) * \left(\frac{Am241}{gamma\ yield}\right) * (soil\ mass) * \left(\frac{transmission}{factor}\right) \qquad \textit{Eq. 9}$$

where
Ew = The integrated efficiency of the FIDLER instrument

Populating the non-FIDLER-specific parameters results in the following:

$$\frac{net\ cpm}{pCi/g} = Ew\left(\frac{net\ cpm}{gamma\ dpm}\right) * \frac{2.22\ total\ dpm}{pCi} * \frac{0.36\ gamma\ dpm}{total\ dpm} * 127{,}674.3\ g * 0.175 \qquad \textit{Eq. 10}$$

Consolidating terms results in the following conversion factor:

$$\frac{net\ cpm}{pCi/g} = Ew\left(\frac{net\ cpm}{gamma\ dpm}\right) * \frac{17{,}856.5\ gamma\ dpm}{pCi/g} \qquad \textit{Eq. 11}$$

Applying the integrated efficiency of the Charlie FIDLER instrument (0.00079) to Equation 11 results in a conversion factor of 14.11. Applying the integrated efficiency of the Nero FIDLER instrument (0.00099) to Equation 11 results in a conversion factor of 17.68. Applying these conversion factors to the hot spot Am-241 activity of 877 pCi/g with results in hot spot criteria for the Charlie and Nero FIDLER instruments of 12,400 cpm and 15,500 cpm, respectively. .

J.2.0 References

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Appendix K

Analytical Test Results

K.1.0 Analytical Test Results

This appendix presents the analytical results for the soil samples collected at CSII. The analytical results of the investigation samples that were used to calculate doses are presented in Tables K.1-1 and K.1-2. The calculations to convert the analytical results to dose are contained in the Soils RBCA document (NNSA/NFO, 2014).

Table K.1-1
Results for Gamma-Emitting Radionuclides Detected above MDCs
(Page 1 of 4)

Sample Location	Sample Number	COPCs (pCi/g)				
		Am-241	Cs-137	Cm-243	Th-232	U-238
C17	AB3A001	1.6	0.0	0.0	2.1	2.0
C18	AB3A002	2.7	0.0	0.0	2.0	0.0
M01	AB3A003	3.3	0.2	0.0	1.9	0.0
	AB3A004	2.4	0.3	0.0	2.0	0.0
M02	AB3A005	1.5	0.3	0.0	2.1	0.0
	AB3A006	2.2	0.3	0.0	2.0	0.0
M03	AB3A007	0.0	0.0	0.0	1.9	0.0
	AB3A008	0.0	0.0	0.0	2.0	0.0
M04	AB3A009	10.5	0.2	0.0	2.1	0.0
	AB3A010	13.3	0.2	0.0	1.9	0.0
M05	AB3A011	48.6	0.1	0.0	2.1	0.0
	AB3A012	67.4	0.1	0.0	2.0	0.0
M06	AB3A013	46.7	0.2	0.0	2.0	0.0
	AB3A014	72.3	0.2	0.0	2.0	0.0
M07	AB3A015	64.5	0.2	0.0	2.0	0.0
	AB3A016	70.1	0.2	0.0	1.9	0.0
M08	AB3A017	45.5	0.1	0.0	2.1	0.0
	AB3A018	47.2	0.1	0.0	2.0	0.0
M09	AB3A019	30.9	0.1	0.0	1.9	0.0
	AB3A020	25.1	0.1	0.0	1.9	0.0
C19	AB3A021	2.0	0.0	0.0	2.0	0.0
	AB3A022	1.6	0.0	0.0	1.8	0.0

Table K.1-1
Results for Gamma-Emitting Radionuclides Detected above MDCs
(Page 2 of 4)

Sample Location	Sample Number	COPCs (pCi/g)				
		Am-241	Cs-137	Cm-243	Th-232	U-238
C20	AB3A023	4.6	0.2	0.0	2.1	0.0
C21	AB3A024	43.3	0.0	0.0	2.1	0.0
C22	AB3A025	16.7	0.0	0.0	2.3	0.0
C23	AB3A026	3.0	0.0	0.0	2.8	0.0
	AB3A027	0.3	0.0	0.0	2.1	0.0
C06	AB3A028	3.4	0.2	0.0	2.2	0.0
	AB3A029	4.1	0.2	0.0	2.0	0.0
C07	AB3A030	0.6	0.0	0.0	2.2	0.0
C26	AB3A031	12.7	0.3	0.0	2.2	0.0
C25	AB3A032	32.6	0.0	0.0	1.8	0.0
C24	AB3A033	135.0	0.2	0.0	2.2	0.0
C11	AB3A034	654.0	0.2	0.0	2.2	0.0
	AB3A035	112.0	0.0	0.0	2.2	0.0
C28	AB3A036	27.8	0.0	0.0	1.7	0.0
M10	AB3A037	25.3	0.1	0.0	1.8	0.0
	AB3A038	34.9	0.1	0.0	1.7	0.0
C05	AB3A039	110.0	0.3	0.0	1.7	0.0
C01	AB3A040	15.9	0.3	0.0	2.3	0.0
	AB3A041	15.1	0.3	0.0	1.7	0.0
C02	AB3A042	4.1	0.0	0.0	2.1	0.0
C03	AB3A043	123.0	0.2	0.0	2.2	0.0
C27	AB3A044	7.3	0.0	0.0	1.6	0.0
C28	AB3A045	23.6	0.1	0.0	2.2	0.0
C08	AB3A601	34.0	0.2	0.0	1.7	0.0
	AB3A602	42.2	0.3	0.0	1.8	0.0
	AB3A603	33.2	0.2	0.0	2.0	0.0
	AB3A604	38.7	0.2	0.0	1.9	0.0

Table K.1-1
Results for Gamma-Emitting Radionuclides Detected above MDCs
(Page 3 of 4)

Sample Location	Sample Number	COPCs (pCi/g)				
		Am-241	Cs-137	Cm-243	Th-232	U-238
C09	AB3A605	5.8	0.2	0.0	1.9	0.0
	AB3A606	7.2	0.2	0.0	2.1	0.0
	AB3A607	7.9	0.2	0.0	2.2	0.0
	AB3A608	8.7	0.2	0.0	1.9	0.0
C10	AB3A609	16.6	0.2	0.0	2.1	0.0
	AB3A610	16.8	0.2	0.0	2.0	0.0
	AB3A611	17.2	0.2	0.0	2.0	0.0
	AB3A612	19.6	0.2	0.0	2.0	0.0
C16	AB3A613	32.4	0.2	0.0	2.4	0.0
	AB3A614	31.6	0.2	0.0	2.0	0.0
	AB3A615	57.8	0.3	0.0	2.1	0.0
	AB3A616	29.3	0.2	0.0	2.3	0.0
C15	AB3A617	74.9	0.2	0.0	1.9	0.0
	AB3A618	99.3	0.2	0.0	1.9	0.0
	AB3A619	70.9	0.2	0.0	2.2	0.0
	AB3A620	94.7	0.2	0.0	1.8	0.0
C11	AB3A621	934.0	0.1	0.0	1.7	0.0
	AB3A622	347.0	0.1	0.0	1.7	0.0
	AB3A623	773.0	0.2	0.0	1.8	0.0
	AB3A624	375.0	0.1	0.0	1.6	0.0
C12	AB3A625	556.0	0.1	0.0	1.8	0.0
	AB3A626	715.0	0.2	0.0	1.6	0.0
	AB3A627	707.0	0.2	0.0	1.5	0.0
	AB3A628	845.0	0.2	0.0	1.9	0.0
C13	AB3A629	165.0	0.1	0.0	1.7	0.0
	AB3A630	166.0	0.2	0.0	1.7	0.0
	AB3A631	117.0	0.2	0.0	1.7	0.0
	AB3A632	152.0	0.2	0.0	1.8	0.0

Table K.1-1
Results for Gamma-Emitting Radionuclides Detected above MDCs
(Page 4 of 4)

Sample Location	Sample Number	COPCs (pCi/g)				
		Am-241	Cs-137	Cm-243	Th-232	U-238
C14	AB3A633	331.0	0.2	0.0	1.8	0.0
	AB3A634	294.0	0.2	0.0	1.8	0.0
	AB3A635	277.0	0.2	0.0	2.0	0.0
	AB3A636	283.0	0.2	0.0	1.8	0.0
C29	AB3A644	11.7	0.2	0.0	1.8	0.0
	AB3A645	26.7	0.2	0.2	2.0	0.0
	AB3A646	14.6	0.2	0.0	1.8	0.0
	AB3A647	3.0	0.2	0.0	1.8	0.0

MDC = Minimum detectable concentration

Table K.1-2
Results for Isotopic Radionuclides Detected above MDCs
(Page 1 of 4)

Sample Location	Sample Number	COPCs (pCi/g							
		Am-241	Am-242	Pu-238	Pu-239/ 240	Pu-241	U-234	U-235/ 236	U-238
C17	AB3A001	0.6	--	--	9.0	--	0.6	--	0.5
C18	AB3A002	0.8	--	0.3	16.6	--	0.6	0.1	0.7
M01	AB3A003	3.2	0.3	0.6	38.3	--	0.7	--	0.7
	AB3A004	1.5	--	--	23.9	--	0.6	--	0.9
M02	AB3A005	2.1	--	0.4	33.7	--	0.7	0.1	0.8
	AB3A006	4.2	--	--	78.3	--	0.7	--	0.7
M03	AB3A007	0.5	--	--	--	--	1.4	0.1	1.3
	AB3A008	0.1	--	--	0.2	--	1.6	0.1	1.3
M04	AB3A009	8.9	0.6	1.7	173	--	0.7	--	0.8
	AB3A010	15.3	1.0	2.1	280	--	0.7	--	1.0
M05	AB3A011	33.8	--	5.9	546	--	0.6	--	0.9
	AB3A012	38.0	--	9.1	715	--	0.8	--	1.0

Table K.1-2
Results for Isotopic Radionuclides Detected above MDCs
(Page 2 of 4)

Sample Location	Sample Number	COPCs (pCi/g							
		Am-241	Am-242	Pu-238	Pu-239/ 240	Pu-241	U-234	U-235/ 236	U-238
M06	AB3A013	39.1	--	5.9	824	--	0.8	0.1	1.2
	AB3A014	38.1	--	4.4	632	--	0.9	--	1.0
M07	AB3A015	214	7.8	28.1	4,190	485	0.8	0.1	1.5
	AB3A016	86.0	--	11.5	1,960	--	0.7	0.1	1.1
M08	AB3A017	66.6	--	10.0	1,240	--	0.9	--	1.3
	AB3A018	33.0	--	7.8	624	--	0.9	0.1	0.9
M09	AB3A019	12.5	--	2.1	257	--	0.9	--	0.7
	AB3A020	85.1	--	--	1,350	--	1.1	0.1	1.4
C19	AB3A021	1.1	--	--	12.3	--	0.6	--	0.6
	AB3A022	0.9	--	--	20.3	--	0.9	--	1.0
C20	AB3A023	1.8	--	--	38.0	--	0.7	--	0.7
C21	AB3A024	8.1	--	--	153	23.0	0.8	0.1	1.1
C22	AB3A025	8.2	--	1.5	188	--	0.6	0.1	0.7
C23	AB3A026	2.1	--	--	47.1	--	0.5	0.1	0.6
	AB3A027	0.1	--	0.0	1.7	--	0.6	--	0.7
C06	AB3A028	1.1	--	0.3	27.7	--	0.8	0.1	0.7
	AB3A029	5.8	--	--	151	21.5	0.6	--	0.5
C07	AB3A030	0.2	--	--	2.9	--	0.6	0.1	0.6
C26	AB3A031	12.4	--	1.5	279	36.9	0.6	--	0.7
C25	AB3A032	10.1	--	2.3	258	32.1	0.6	--	0.7
C24	AB3A033	185	--	29.6	4,630	542	0.7	0.2	1.7
C11	AB3A034	217	--	40.1	6,280	854	1.3	--	3.5
	AB3A035	112	--	12.6	2,040	263	0.7	--	1.4
C28	AB3A036	15.4	--	1.4	269	38.0	0.8	--	1.1
M10	AB3A037	14.7	--	--	239	--	0.9	--	0.9
	AB3A038	27.4	--	--	645	--	0.9	--	0.7
C05	AB3A039	44.9	--	4.9	828	109	0.8	--	1.2

Table K.1-2
Results for Isotopic Radionuclides Detected above MDCs
(Page 3 of 4)

Sample Location	Sample Number	COPCs (pCi/g							
		Am-241	Am-242	Pu-238	Pu-239/ 240	Pu-241	U-234	U-235/ 236	U-238
C01	AB3A040	5.2	--	0.9	137	18.7	0.7	--	0.7
	AB3A041	7.1	--	0.7	114	16.1	0.7	--	0.9
C02	AB3A042	2.4	--	0.3	36.3	--	1.1	--	1.0
C03	AB3A043	31.0	--	2.2	517	71.5	0.9	0.2	1.3
C27	AB3A044	1.1	--	0.2	12.2	--	0.7	--	0.9
C28	AB3A045	5.3	--	0.8	118	--	0.8	--	1.0
C08	AB3A601	13.7	1.0	--	303	54.7	0.8	--	1.0
	AB3A602	34.9	2.6	--	659	146	0.8	--	1.4
	AB3A603	8.5	0.4	--	165	25.4	0.9	--	1.0
	AB3A604	68.7	4.2	13.4	1,580	268	1.0	--	1.2
C09	AB3A605	8.4	0.7	2.5	330	--	0.8	--	0.7
	AB3A606	3.8	0.4	--	98.3	--	0.6	--	0.7
	AB3A607	4.0	--	--	137	--	0.5	--	0.6
	AB3A608	2.5	--	0.9	96.2	--	0.7	--	0.7
C10	AB3A609	11.9	0.5	3.4	398	62.0	0.7	--	0.8
	AB3A610	7.6	0.4	1.7	261	--	0.7	--	0.7
	AB3A611	7.8	--	2.4	271	--	0.6	--	0.7
	AB3A612	9.1	0.5	2.2	321	--	0.7	0.1	0.8
C16	AB3A613	14.2	0.8	3.2	546	--	0.8	0.1	0.8
	AB3A614	13.1	--	3.1	497	--	0.7	--	1.0
	AB3A615	13.7	0.9	5.5	611	--	0.8	--	0.9
	AB3A616	8.3	0.6	2.5	312	--	0.8	--	1.1
C15	AB3A617	103	7.1	30.6	4,220	--	0.6	--	2.1
	AB3A618	13.5	0.9	4.3	485	--	0.6	0.1	0.8
	AB3A619	15.7	1.1	--	634	--	0.7	--	0.9
	AB3A620	32.6	--	10.7	1,790	264	0.7	--	1.2

Table K.1-2
Results for Isotopic Radionuclides Detected above MDCs
(Page 4 of 4)

Sample Location	Sample Number	COPCs (pCi/g							
		Am-241	Am-242	Pu-238	Pu-239/240	Pu-241	U-234	U-235/236	U-238
C11	AB3A621	2,680	--	243	31,300	4,280	2.3	0.3	12.3
	AB3A622	628	--	64.1	7,810	1,100	1.6	--	3.8
	AB3A623	862	--	89.3	11,600	1,620	1.6	--	6.4
	AB3A624	474	--	41.1	4,660	640	1.3	--	4.0
C12	AB3A625	789	--	86.1	11,700	1,670	1.6	--	6.5
	AB3A626	692	--	123	15,200	2,210	1.9	0.5	7.8
	AB3A627	1,180	--	103	11,700	1,730	1.4	--	8.9
	AB3A628	930	--	103	13,600	1,910	1.8	0.3	6.5
C13	AB3A629	117	--	27.6	3,160	496	1.2	--	2.2
	AB3A630	150	--	25.3	3,010	478	0.8	--	2.1
	AB3A631	54.2	--	5.9	842	142	1.1	--	1.2
	AB3A632	284	--	52.2	6,050	873	0.8	--	1.6
C14	AB3A633	564	--	56.8	7,090	1,000	1.5	--	5.4
	AB3A634	651	--	70.6	8,470	1,200	1.6	--	5.0
	AB3A635	218	--	15.5	3,010	448	0.9	--	2.7
	AB3A636	215	--	24.9	3,520	511	1.3	--	3.2
C29	AB3A644	9.3	--	--	168	--	1.0	--	1.1
	AB3A645	--	--	--	151	--	0.8	0.1	0.8
	AB3A646	3.5	--	--	42.1	--	0.6	--	0.7
	AB3A647	1.6	--	--	13.9	--	0.7	--	0.7

-- = Not detected above MDC.

Appendix L

Nevada Division of Environmental Protection Comments

(34 Pages)

NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1. Document Title/Number: Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 413: Clean Slate II Plutonium Dispersion (TTR), Tonopah Test Range, Nevada, Draft	2. Document Date: January 2017
3. Revision Number: 0	4. Originator/Organization: Nevada Division of Environmental Protection
5. Responsible DOE NNSA/NFO Activity Lead: T. Lantow	6. Date Comments Due: March 2, 2017
7. Review Criteria:	
8. Reviewer/Organization Phone No.: NDEP	9. Reviewer's Signature:

10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
1.	Executive Summary, page ES-1, para 3		2nd sentence: since total effective dose (TED) is stated as being "estimated" should, "estimated" precede every occurrence of TED within the document?	To clarify and emphasize the point that doses are estimated, the following sentence was added to the end of Section 1.2: "Radiological doses presented throughout this document are a conservative estimate of maximum potential dose for FFACO closure decision-making purposes."
2.	2.0, page 5, para 1		Lack of clear description and figure display of where study groups are in relation to each other, to the CA boundary, to other site features has been a confusing feature of this document. Comment 4a offers suggestions for improvement.	The extent of study groups is sometimes not well-defined, as they are conceptual in nature. Several changes to figures and text have been made throughout the document to clarify. See responses to Comments 15–20, and 22–26. Also added figure and callout in Section 2.1 to show general locations of study groups.
3.	2.1, page 5, para 2		1st sentence: provide a figure showing the seven study groups.	The extent of study groups is sometimes not well-defined, as they are conceptual in nature. Several changes to figures and text have been made throughout the document to clarify. See responses to Comment 2.

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10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
4.	2.1.1, page 5, para 1		a) 1st sentence: require more clarity about location and extent of SG1; one method would be to reference Fig. A.3-1 and add a description such as, *'although SG1 has no precise boundary, its general extent - as defined by sampling results - is shown on Fig. A.3-1 by eight soil sample and TLD plots located inside the CA fence line; these are generally distributed from approximately 100 to 1200 feet south and southeast of the GZ'.* b) Section omits the statement that the FAL is assumed to be exceeded at SG1 in agreement with (IAW) CAIP commitments for the seven study groups in CAU 413: "CAA Meeting for CAU 413 Clean Slate II, Aug 2016, DHHQ". c) 3rd sentence: add the date when the FIDLER surveys were conducted. Based on the experience gained under the CAU 573, it appears that it may be necessary to repeat the FIDLER surveys if they were conducted prior to the June 2016 period when FIDLERs were calibrated.	a) To clarify, the following text was added after the first sentence in Section 2.1.1: "Although SG1 has no precise boundary, the general extent of the investigation is shown on Figure A.3-1 by eight soil sample and TLD plots located inside the CA fence line; these are generally distributed from approximately 100 to 1,200 ft south and southeast of GZ." b) The following text was added after the second sentence in Section 2.1.1: "Because the contamination associated with SG1 is assumed to exceed the radiological FAL, the CAI activities for this study group were focused on defining corrective action boundaries." c) As the FIDLER data were used in a relative manner as described in the response to Comment 5, calibration is not a driving data-quality criterion. Rather, the data-quality criterion for this use is the response of the instrument to the presence of radioactivity. This use of the FIDLER data for SG1 meets the definition of decision-supporting data in the Soils QAP. Per the QAP, the limitations and explanations of data quality have been added to Section B.1.6. To clarify, the following was added to the end of the second paragraph of Section 2.1.1: "These FIDLER data were not used for decision making (e.g., hot spot determinations) but as relative values (i.e., decision-supporting data)."
5.	2.1.1, page 6, para 2		1st sentence: describe the method for conducting the removable alpha contamination survey and provide a procedure reference for this process. Provide additional text explaining how any contamination found in soil is not considered removable contamination since soil can be easily removed from any location.	Inserted the following text after "Removable alpha……at the site." "These surveys were completed using the "stomp and tromp" methodology, which uses swipe samples of the ground surface to determine the activity of removable radioactive material in the soil in units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2)."

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10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
6.	2.1.2, page 8, para 1, 3		a) See comment 4a b) 3rd paragraph, 3rd sentence: should this sentence be reworded to state "…soil sample exceeded the field screening criteria ….''?	a) Added reference to Figure A.4-1 at the end of the first sentence in Section 2.1.2. b) The term "depth screening" is correct in this regard; to clarify, the following was added to the end of the sentence: "...as described in Section A.8.2.1 of the CAIP."
7.	2.1.3, page 7, para 1		See comment 4a	Added reference to Figure A.5-1 at the end of the first sentence in Section 2.1.3.
8.	2.1.4, page 8, para 1		See comment 4a	Added reference to Figure A.6-1 at the end of the first sentence in Section 2.1.4.
9.	2.1.5, page 8, para 1		See comment 4a	Added reference to Figure A.7-2 at the end of the first sentence in Section 2.1.5.
10.	2.1.6, page 8, para 1		See comment 4a	Added reference to Figure A.8-1 at the end of the first paragraph in Section 2.1.6.

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11.	2.1.6, page 9, para 2		Sentence beginning with, “A comprehensive FIDLER survey was completed ...”, the terms “comprehensive” and “target” imply decisional quality. What is the specific data quality indicators used to determine the degree of acceptability or utility of the data to ensure that the surveys were “comprehensive” and that “target” criteria were met? Soils QAPP Rev., 0 Section 1.5.5 Data Quality: “DQI criteria must be established during the site-specific DQO process to properly support the overall activity or sampling task objectives. For each investigation, the data must be assessed against the DQI criteria. The assessment results must be reported in the applicable FFACO report.”	The terms “target” and “comprehensive” are synonymous with “biased” and “extensive,” respectively. Changed “target” to “bias.” To clarify the DQIs for each study group, the following text was added in its appropriate section: Added the following to the end of Section 2.1.1: “The resolution of the DQO decision on the presence of COCs for this study group was not based on any data generated during the investigation but rather an assumption that COCs are present. This was agreed to in the DQO meeting with the CAU 413 stakeholders. Because no data were used to resolve this decision, there are no Decision I decisional data for SG1. The resolution of the DQO decision on the extent of COC contamination for this study group was based on TLD and analytical soil sample results. Therefore, the TLD and analytical data are considered decisional data. The sample locations were selected from varying relative contamination levels using the relative spatial distribution of contamination that was derived from the FIDLER radiological survey. This use of the FIDLER radiological survey data meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). The analytical data were supplemented with information about the relative spatial distribution of contamination that was derived from radiological survey data to better define the corrective action boundary. This use of the FIDLER radiological survey data meets the definition of decision-supporting data as defined in the Soils QAP. The corrective action boundary was expanded to include areas where HCA conditions were present outside the corrective action boundary. Although the determination of HCA conditions is very imprecise, as explained in Section 5.1.2, the initial corrective action boundaries were established for the purpose of planning. Actual corrective action boundaries will be revised based on verification soil sample results that will determine whether additional excavation is required or provide verification that the corrective action is complete. Therefore, actual corrective action boundaries may be smaller or larger than estimated herein. The corrective action boundaries were expanded to include HCA conditions because a dose to a potential receptor could not be estimated for the removable contamination. The HCA criterion does not represent dose and is used only as an indicator of when an assumption that dose exceeds the FAL may be appropriate in the absence of dose information associated with removable contamination. The HCA criterion was agreed upon in the CAU 413 DQOs as the level to be used to make an assumption that removable contamination exceeds the radiological FAL. This decision is consistent with other Soils release sites where corrective action is assumed to be necessary when the sites cannot be investigated to demonstrate that contamination information meets the definition of decision-supporting data as defined in the Soils QAP.” Added the following to the end of Section 2.1.2: “The resolution of DQO Decision I for SG2 was based on analytical soil sample results. Therefore, the analytical data are considered decisional data. The sample locations were selected from most elevated radiological readings using the relative spatial distribution of contamination that was derived from the FIDLER radiological survey. Depth samples to be submitted for analyses were selected at each location based on the relative differences of FIDLER readings between the surface soil and subsurface soil as described in Section A.8.2.1 of the CAIP. This use of the FIDLER radiological

				survey data for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified in the subsurface, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved." Added the following to the end of Section 2.1.3: "The resolution of the DQO decision on the presence of COCs for this study group was based on TLD and analytical soil sample results. Therefore, the TLD and analytical data are considered decisional data. The sample locations were selected from most elevated radiological readings using the relative spatial distribution of contamination derived from the FIDLER radiological survey. Depth samples to be submitted for analyses were selected at each location based on the relative differences of FIDLER readings between the surface soil and subsurface soil as described in Section A.8.2.1 of the CAIP. This use of the FIDLER radiological survey data for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved." Added the following to the end of Section 2.1.4: "The resolution of the DQO decision on the presence of COCs for this study group was based on analytical soil sample results. Therefore, the analytical data are considered decisional data. The sample locations were biased using visual and geographical information because the former staging area is a distinct feature visible in aerial photographs of the site and is readily distinguishable from surrounding soil. Within the former staging area, the two grab sample locations were selected on the edge closest to GZ. Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved." Added the following to the end of Section 2.1.5: "The resolution of the DQO decision on the presence of COCs for this study group was not based on any data generated during the investigation but rather on an assumption that COCs are present. This assumption was agreed to in the CAU 413 DQOs with the CAU 413 stakeholders. The resolution of the DQO decision on the extent of COC contamination for this study group is based on visual identification of buried debris and the collection of soil samples. Therefore, the visual survey and analytical data are considered decisional data. Locations for the excavation to identify buried debris is biased to information from the geophysical survey presented in Appendix I. Locations for the collection of soil samples from the edges of the excavation are biased to the most elevated radiological readings using the relative spatial distribution of contamination derived from a FIDLER radiological survey. This use of the geophysical survey and the FIDLER radiological survey data for biasing locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012)." Added the following text to the end of Section 2.1.6: "The resolution of the DQO decision on the presence of COCs for this study group was based on FIDLER survey results of hot spots compared to the Radiological Hot Spot Criterion as described in Appendix J. Therefore, the FIDLER survey data are

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				considered decisional data. Hot spots were determined from visible debris identified during a visual survey as well as from the most elevated radiological readings using a relative spatial distribution of contamination derived from the FIDLER radiological survey. This use of the visual and FIDLER radiological surveys for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved." Added the following text to the end of Section 2.1.7: "The resolution of the DQO decision on the presence of COCs for this study group was based on TLD and analytical soil sample results. Therefore, the TLD and analytical data are considered decisional data. The sample locations were selected from random locations within the soil mounds. Therefore, no data were used for selecting soil sample locations that meet the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). Because no COCs were identified, the resolution of the DQO decision on the extent of COC contamination for this study group did not need to be resolved." Added the following section to Appendix B: ***"B.1.6 Decision-Supporting Data Quality*** ***B.1.6.1 FIDLER Surveys for Contaminant Distribution*** The intended use of the FIDLER data is to depict the spatial distribution of a contaminant when used in conjunction with a GPS unit. The data must provide radiologic instrument relative response sufficient to differentiate areas of high and low instrument response in a reliable and repeatable fashion. The data also must be spatially representative of the distribution and therefore should have spatial accuracy of 1 to 2m. FIDLER surveys are conducted according to specific procedures that invoke the quality checks necessary to ensure that the data are usable for their intended use, as follows: • The FIDLERs are subject to a daily response check to a controlled source to ensure that they are operating as expected. • Operational guidance is given as to instrument configuration and speed of survey. • The GPS units are configured so that data of undesirable spatial quality are not recorded. The survey post-processing invokes additional quality controls that address the following: • Daily background signatures, collected in the field at a single location, are reviewed for histogram normality and response levels. • Processed surveys are verified for correctness by those who originally performed the survey. • Surveys adjacent to or overlapping area where previous surveys have been performed are inspected as to their agreement with the existing data. FIDLER radiological surveys produce quality data with well-documented pedigrees in accordance with rigorous procedures that guide how they are conducted. Those data meet quality checks designed to ensure that they are suitable for their intended use. The FIDLER survey, once processed into a continuous surface as described in the RBCA document (NNSA/NFO, 2014), can then be correlated with the decision-

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				supporting TED values to create an isopleth delineating a conservative estimate of where the FAL is exceeded. ***B.1.6.2 Removable Contamination HCA Criterion*** The instruments that generated the removable contamination levels used to compare to the HCA criteria were managed under processes fully compliant with the requirements listed in 10 CFR 835 (CFR, 2017). Specifically, instruments and equipment used for monitoring met the following requirements under 10 CFR 835.401(b): • Periodically maintained and calibrated on an established frequency. • Appropriate for the type(s), levels, and energies of the radiation(s) encountered. • Appropriate for existing environmental conditions. • Routinely tested for operability. Data generated under these conditions are sufficient to inform stakeholders to make the decision (i.e., assumption) that the removable contamination could be present at levels that could potentially cause a dose exceeding the radiological FAL. Although the determination of HCA conditions is imprecise, it is only used as an indicator of when an assumption that dose exceeds the FAL may be appropriate in the absence of dose information associated with removable contamination. ***B.1.6.3 Visual Surveys*** Visual surveys were used to determine the biasing of sample locations by determining the depth of fill material, extent of the soil mounds, identification of PSM, identification of major drainage channels, and identification of sedimentation areas. The CAU 413 DQOs specify criteria for the visual survey to be indicators such as discoloration, textural discontinuities, disturbance of native soils, or any other indication of potential contamination. This information does not have inherent data-quality properties but was agreed to in the DQOs as the identification of the listed biasing criteria by the field personnel. ***B.1.6.4 Surface Electromagnetic Survey Data*** The instruments that generated the electromagnetic survey values used to delineate probable locations of buried debris are operated according to specific procedures that invoke the quality checks necessary to ensure that the resultant data are usable for their intended use. The operating procedures invoke processes whereby the instruments are as follows: 1. Calibrated pre- and post-survey. 2. Periodically checked during the course of a survey. 3. Appropriate for the type(s), levels, and energies of the debris encountered; 4. Appropriate for existing environmental conditions. 5. Routinely tested for operability. Data generated under these conditions are sufficient to inform stakeholders to make the decision (i.e., assumption) that the buried debris could be present.”
12.	2.1.7, page 9, para 1		See comment 4a	Added reference to Figure A.9-1 at the end of the first sentence in Section 2.1.7.
13.	2.2, page 10, para 1		a) 1st sentence: this is not consistent with how the CW scenario was defined as stated in Section 3.1.1 of the CAU 413 CAIP, “The most exposed individual in this	a) Corrected to: “As detailed……., which assumes the most exposed individual is an adult construction worker who works at the site for 120 days per year (day/yr), 8 hours

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			scenario is defined as an adult construction worker who works at the site for 120 days per year (day/yr), 8 hours per day (hr./day), for a total of 960 hours per year (hr./yr)." b) 4th sentence: "CA of 1 m^2": seems inappropriate to refer to a hotspot in this sentence as a "CA" instead of "area of contamination."	per day (hr/day), for a total of 960 hours per year (hr/yr). The construction worker spends an average of 6 hr/day outdoors, and 2 hr/day indoors during the work day." b) "CA" changed to "area of contamination"
14.	2.2, page 10, Table 2-2		Under "Basis/Assumption" for SGs 1,2,3, and 7, suggest adding a brief footnote explaining the relationship of the smaller SG features (e.g. soil mounds) to the assumed 1,000 m^2 contaminated area (i.e., why this model value conservatively overestimates dose to include adjacent areas).	This is only one instance where conservatism results in an overestimation of actual dose. Attempting to identify and explain each instance would significantly add to the complexity of the document while detracting from the focus and clarity of the corrective action decision process. Sentence revised as follows: "Radiological doses calculated for SG1, SG2, SG3, SG4, and SG7 are a conservative estimate of maximum potential dose for FFACO closure decision-making purposes only." See also response to Comment 1.
15.	2.2.1.1, page 11, para 1		Provide figure reference.	Inserted reference to Figure A.3-1.
16.	2.2.1.1, page 11, para 2		Provide figure reference.	Inserted reference to Figure A.3-2.
17.	2.2.1.2, page 11, para 1		Provide figure reference.	Inserted reference to Figure A.4-1.
18.	2.2.1.3, page 12, para 1		a) Provide figure reference. b) 2nd sentence: Section A.5.2 should be Section A.5.4, correct the document.	a) Inserted reference to Figure A.5-1. b) The reference to Section A.5.2 is correct. Section A.5.2.2 states, "TLDs were placed at all sample locations except C18 and C20"; it goes on to point the reader to Section A.5.4 for an explanation on how external dose was estimated at these locations. No change to document.

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19.	2.2.1.4, page 12, para 1		a) Provide figure reference. b) 1st sentence: Later in the document this description includes text that the samples were obtained from below the gravel layer in the staging area making it clear that there is not contamination present in the original native soil layer. For clarity, suggest adding text to this section which clearly indicates that the grab samples were obtained from below the gravel in the native soil layer.	a) Inserted reference to Figure A.6-1. b) Added the following after the first sentence: "The purpose of sampling at SG4 was to determine whether radioactive contamination deposited on the surface by the CSII test had been covered over during construction of the staging area. In accordance with the CAIP (NNSA/NFO, 2016), the visible fill material was removed from each location before sample collection to ensure the samples consisted of soil."
20.	2.2.1.5, page 12, para 1		Provide figure reference.	Inserted reference to Figure A.7-2.
21.	2.2.1.5, page 13, para 1		2nd sentence: Since the readings on the instrument are "relative," can this "low" response indicate that there is a significant volume of deeply buried debris in the surveyed areas, as well as very little debris buried shallow? (see page 5 of Appendix I, first paragraph, and explain the conclusion drawn on page 13.)	Replaced the referenced sentence with the following: "It is not likely that there would be significant amounts of metal buried deeply because this would have elevated overall readings above background. In addition, no anomaly was estimated to be deeper than 1 m. In any case, the geophysical surveys are only used as a starting point for excavation locations to visually determine the presence and depth of buried debris."

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22.	2.2.1.6, page 13, para 1, 2		a) Provide figure references for sampling results summaries in paragraphs 1 and 2. b) 1st sentence: provide additional detail about "visible debris," i.e., bunker concrete, metal with surface contamination that was the subject of an extensive "interim corrective action" described in briefing materials dated December 15, 2015 ("Summary of the Removal Survey and Removal of Contaminated Debris at the Clean Slate II Site"). c) Reference the status of posted RMA outside the CA without debris but with "elevated" FIDLER readings as mentioned in the joint meeting notes for "CAA Meeting for CAU 413 Clean Slate II", Aug 2016 at DHHQ. d) 2nd sentence: substitute "radiological" for "debris." e) Is the "debris" in paragraph 2 the same debris described in Appendix F of the CAIP? If yes, provide additional detail about the debris removal (i.e., quantity, containerization, disposal destination, images).	a) Inserted references to Figures A.8-2 and A.8-3. b) Added the following text and reference to the CAIP after the first sentence in Section 2.2.1.6: "As discussed in the CAIP, contaminated debris (concrete, metal) was discovered up to 2,500 ft from GZ to the east. A faded black substance consisting of plutonium and depleted uranium was fused to the concrete and metallic debris. It is likely that the contaminated debris comprises pieces of the bunker interior that were exposed to molten metal from the test device during detonation. A photograph of one of the concrete debris pieces is provided in Figure 2-2." c) Revised the following sentence to indicate the area is currently posted as an RMA: "One soil sample plot and one TLD were established at the current RMA location (sample location C29); the results are discussed with SG1 in Section A.3.2." Additionally, revised the first sentence in Section A.3.0 as follows: "The Undisturbed Areas at CAU 413 include those areas not impacted by post-test operations (including the approximately 120-m^2 area currently posted as an RMA, as described in Section 2.2.1.6), exclusive of the areas defined by other study groups." d) Inserted "radiologically contaminated" before "debris." e) No, this is not the same debris. The debris discussed in Appendix F of the CAIP was removed and dispositioned prior to CAI activities, as discussed in the CAIP. To clarify, the following was added after the first sentence of Section 2.2.1.6: "Note that the debris described in Appendix F of the CAIP had been previously removed from the site, as described in the CAIP (NNSA/NFO, 2016c). As discussed in the CAIP, contaminated debris (concrete, metal) was discovered up to 2,500 ft from GZ to the east. A faded black substance consisting of plutonium and depleted uranium was fused to the concrete and metallic debris. It is likely that the contaminated debris comprises pieces of the bunker interior that were exposed to molten metal from the test device during detonation. A photograph of one of the concrete debris pieces is provided in Figure 2-2."

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23.	2.2.1.7, page 14, para 1		Provide figure reference.	Inserted reference to Figure A.9-1.
24.	2.3, page 15, para 1-4		a) Each time a finding is stated in this section, provide a reference to the appropriate figure, table, or document section. b) 1st paragraph, 1st sentence beginning with: "For CAU 413, there are two considerations for determining whether COCs are present and the FAL is exceeded: (1) area-based RRMGs based on 1,000 m2 and (2) hot spot RRMGs based on 1 m^2." There may be a third consideration since it is also stated in that paragraph that for areas meeting HCA conditions, corrective action is also required, i.e., the default assumption is that all HCAs are assumed to exceed FAL. c) 4th paragraph, 1st sentence: this summary sentence must be revised to state that one soil sample (C11, 0-5 cm bgs) nearest the GZ exceeded the FAL (by a factor of 2). d) 4th paragraph, 2nd sentence: this summary sentence does not make it clear why or how "SG2 results were included in the evaluation of SG1", although it is assumed it is because there is spatial overlap, but this is also unclear.	a) Callouts for figures, tables, document sections, etc. were added as appropriate. b) As stated, there are only two considerations for determining whether COCs are present and the FAL is exceeded; however, some text was added in Section 2.1.1 in response to Comment 11, as follows: "HCA criteria are not a basis for determining whether COCs are present; they are an additional consideration for making a conservative assumption of the need for corrective action where it cannot be determined whether COCs are present. The decision to include the additional area where HCA conditions exist is not based on dose information but rather a conservative assumption based on the presence of HCA conditions." c) The soil sample (0–5 cm) at location C11 is included in SG1, as it is a surface soil sample. However, to clarify, the paragraph was revised to the following: "At SG2, there is no subsurface contamination present at levels exceeding the FAL, and there is no subsurface contamination present at levels greater than that found in the surface soil. Therefore, Decision I was resolved that no COCs are present in subsurface soils at SG2, and no corrective action is required for SG2. However, contamination present in SG2 surface soil samples was evaluated in SG1 Decision II (resolution of the extent of surface COC contamination). CAI activities and results are presented in Section A.4.0. d) To clarify, the following text was inserted after the first sentence in Section 2.1.2: "The DQO Decision I was to determine whether COCs are present below the ground surface. COCs present in SG2 surface soil were evaluated in SG1 Decision II (resolution of the extent of surface COC contamination)."

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25.	2.3, page 16, Fig 2-1		Figure 2-1 identifies removable contamination via swipe survey and indicates that the UR boundary was extended to capture locations in excess of 2,000 dpm/100 cm2. Due to the high uncertainty associated with the determination of removable contamination were these measurement uncertainties included in evaluation against the 2,000 dpm/100 cm2 HCA criteria? It is not readily clear from Figure 2-1 that the UR was extended as appropriate since the plotting scale indicates a middle range of 1,001 – 1,999 dpm/100 cm2. This infers a minimum detectable concentration less than 1 dpm/100 cm2 for the removable alpha swipe survey. For these reasons, the legend appears to be misleading and the boundary adjustment may also be questionable.	Due to the insertion of additional figures, Figure 2-1 was renumbered as Figure 2-3. Figure 2-3 depicts the approximate location of the corrective action boundary for SG1. The legend and the scale on Figure 2-3 have been revised to reflect the capabilities of the instrument. Revised the title of the figure to "Corrective Action Boundary for SG1 with HCA Criteria Extensions." Also, see responses to Comment 11 in regard to clarifications in Sections 2.1.1 and B.1.6.2.

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26.	2.3, page 17, Fig 2-2		Address discrepancies between this figure and those shown in Appendix I, Figures 3, 5, 6:	Due to the insertion of additional figures, Figure 2-2 was renumbered as Figure 2-4. There are no discrepancies between the figures. Figure 2-4 displays the corrective action boundary for SG5. The figures in Appendix I display results from the geophysics survey performed at CSII.
			a) Figure 2-2 apparently omits the EM-31 survey results.	a) Figure 2-4 intentionally omits the EM31 results, as the results from the EM61 survey provide the best resolution for potential subsurface debris. This is also stated on Page 16 of 28 in Appendix I: "The EM61-MK2A data yields a detailed picture of the potential buried metallic debris." To clarify, the following note was added to Figure 2-4: "Note: EM31 results are not shown because the EM61 results provided the best resolution. (See Section A.7.1.1)."
			b) The "HCA Fence" in Figures 3 and 6 is shown as "Inner Fence" in Figure 2-2; if they coincide, recommend re-labeling throughout document as such.	b) The figures in the main document are consistent with those presented in the CAIP. Appendix I is a stand-alone document and cannot be altered. The HCA fence in the geophysics report (Appendix I) is the same as the inner fence referred to throughout the main document. In order to provide additional background on the fences currently located on the site, added the following to Section 1.0 after "The CSII test was ………….covered with 2 feet (ft) of soil." "After the test, metal and concrete debris was scraped from the ground surface and mounded/buried at ground zero (GZ). A 1.2-acre area around GZ consisting of contaminated soil, concrete, and metal was then fenced to prevent access (Burnett et al., 1964). This fence surrounded contamination with a mass concentration of 1,000 micrograms per square meter total transuranics (NNSA/NSO, 2004) and was posted with 'Alpha Contamination' signs. In 1963, the burial area at GZ was excavated to recover pieces of buried metal debris for further study (DASA, 1963; Johnson, 1963). This activity involved the removal of the earth cover and extraction of the debris using heavy equipment and hand tools, where necessary. The historical account of this activity does not include a discussion of site restoration after excavation. In 1973, the outermost fence at the CSII site was constructed to encompass approximately 120 acres, including the area previously fenced around GZ. This outer fence was established at a surface activity level of 40 picocuries per gram (pCi/g) total transuranics (NNSA/NSO, 2004) and is currently posted with contamination area (CA) signs. This outermost fence is referred to as the "CA fence" throughout this document. Between 1969 and 1973, an additional inner fence was established; however, the radiological criteria for this fence are unknown. Figure 1-2 shows the two inner fences and the outer CA fence at the site. The inner fences have been removed from subsequent figures throughout the document for clarity."
			c) The "CS2 Inner Fence" in Figures 3 and 6 should be re-labelled: "Inner Fence" IAW Figure 2-2 (CS2 is incorrect nomenclature).	c) See response to 26b above.
			d) Is the short fence run shown upper left corner Figure 2-2 the "Inner Fence?"	d) The inner fences have been removed from this figure. See response to Comment 26b above.
			e) Is the "SG5 Corrective Action Boundary" based on "Linear Anomaly" shown in Fig.5, Appendix I? How were the measured QV1 mS/m values shown in Figure 5 processed to produce the boundary shown on Figure 2-2?	e) The corrective action boundary is estimated based on the results of the geophysics report. The QV1 numbers are relative response values that define anomalies. The boundary was established judgmentally to encompass the anomalies as defined in the geophysics report. See also response to Comment 21.

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27.	3.2, page 21, para 1		a) 2nd bullet: the table refers to "environmental" cleanup standards; ensure this bullet and the table nomenclature is consistent. b) It would be helpful if the general standards had been arranged in Table 3-1 in the same order they have been bulleted and/or numbered as 1,2,3,4 as they appear in the CAA meeting record.	a) Changed "environmental" to "media" in Table 3-1 for clarity. b) This is the order in which they are listed in 40 CFR Section 264.525(a). No change to document.
28.	3.3, page 24		For each of three alternatives, ensure that content in 3.3.1 through 3.3.3 includes a brief description of the effect alternative implementation would have on the seven study groups; detail is not required, but an outline of effects on each SG would be helpful since the CAU has been stratified into SGs for remediation. This could be done by adding a table, for example.	To clarify that the CAA evaluation is applicable only to SG1 and SG5 COCs, the following text was added to the end of the first paragraph in Section 3.0: "Therefore, CAAs will be evaluated for the surface COC contamination identified for SG1 and the assumed presence of subsurface COC contamination identified for SG5." Inserted the following text at the end of Section 3.3.1: "This alternative is not an option for corrective actions at SG1 or SG5 because it does not meet the general corrective action standards listed in Section 3.2." Replaced the second sentence of Section 3.3.2 with: "For SG1, this alternative would remove all material in areas defined in Section 2.3 as requiring further corrective action, including removal of approximately 9,500 m^2 of soil to a depth of approximately 15 cm bgs, resulting in a total of approximately 1,400 cubic meters (m^3) of soil to be removed. For SG5, this alternative would remove all material in areas defined as requiring further corrective action in Section 2.3, including removal of an estimated volume of buried debris of approximately 430 m^3." The effects of implementing closure in place and clean closure on SG1 and SG5 are included in the text and in Table 3-1.
29.	3.3.2, page 24, para 1		The prior extensive "interim corrective action" taken at SG6 – PSM needs to be mentioned as part of the "Clean Closure" alternative.	As stated in Section 3.0: "This CAA evaluation is intended for use in making corrective action decisions for CAU 413 conditions at the conclusion of the CAI." The interim corrective actions were completed prior to completion of the CAAs. See response to Comment22e.

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30.	3.4.1, page 25, para 1		At no time during the August meeting at DHHQ with AF, DOE, and NDEP were these alternatives addressed, in so far as the meeting notes or other records are concerned. There is no evidence of discussions that any of these technologies were ever formally proposed or genuinely offered as closure methods for this CAU during the current FFACO cycle addressing CAU 413. The CAA alternative selection process may need to be re-opened.	Replaced the first sentence of Section 3.4.1 with: "The alternatives presented in this section were not proposed, discussed, or offered during the CAA meeting, as they were not considered viable closure methods. However, several alternatives considered in the 1990s and 2000s to evaluate remediation options for plutonium-contaminated soil at DOE sites generated information that is reported in this section."
31.	3.4 page 26, Table 3-1		a) Clean Closure column, 2nd row: record shows that during CAA meeting it was stated that a NESHAPS permit for the release of airborne radionuclides may be needed for the clean closure option. Has this determination been made? b) Change "regulator" to "NDEP." c) Clean closure – why is the wording different in this column than in the other two?	a) Yes, coordination with Sandia National Laboratories has indicated that there are no NESHAP concerns based on a CAP-88 model used to evaluate potential radiological air emissions. See response to Comment 41. b) Changed "regulator" to "NDEP." c) Comment rescinded during comment resolution meeting.
32.	3.4 page 27, Table 3-2		Table 3-2 identifies the Long-Term Reliability and Effectiveness as a Remedy Selection Decision Factor. Under this section, a discussion of the effectiveness of clean closure on reducing posting requirements under 10 CFR 835 and potential for release of the area under DOE Order 458.1 should be included as these are both relevant to the long term effectiveness of the proposed remedy.	Added to table cell: "May reduce posting requirements under 10 CFR 835 (CFR, 2017) and facilitate future potential release of the area under DOE Order 458.1 (DOE, 2013). After FFACO requirements are met, remaining contamination will be subject to DOE radiation control requirements."
33.	3.4, page 27, Table 3-2		a) Recommend indicating in the table which alternative was judged as the "Preferred CAA" (i.e., cell shading, footnote, etc. b) Clean Closure column, 2nd row: the record from CAA meeting shows: "…the contamination above FAL is removed." Explain the change.	a) Added a superscript to the Clean Closure heading and the following footnote: "[a] Recommended alternative" b) Replaced the second sentence with: "Provides reduction in dose by removing contamination exceeding the FAL."

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34.	4.0, page 31, Table 4-1		a) 2nd paragraph, 1st sentence beginning with: "The corrective action of clean closure consists of the removal of surface soil in the areas defined in Section 3.2 that require further corrective action." Have the institutional control requirements of DOE O 458.1 been evaluated and incorporated as necessary? b) A summary of the methodology, assumptions, uncertainties, and calculations used to produce the figures shown must be presented. Since this is essentially a cost/engineering exercise, it might be appropriate to be placed in Appendix E.	a) See response to Comment 32. b) The following text was added to the end of the second paragraph: "The volumes are based on estimated excavation depths of 15 cm and 1 m for SG1 and SG5, respectively. Although these areas and volumes may be very imprecise, the initial corrective action boundaries were established for the purpose of planning. Actual corrective action boundaries will be revised based on verification soil sample results that will determine whether additional excavation is required or provide verification that the corrective action is complete. Therefore, actual corrective action boundaries may be smaller or larger than estimated herein."
35.	4.0, page 32, Fig 4-1		a) Add "GZ" to figure and legend. b) Explain fence lines in text.	a) "GZ" added to legend. b) The CA fence is clearly delineated on Figure 4-1 and in the legend. The inner fences are not shown on this figure, as they are not relevant to the corrective action boundary. Also refer to response to Comment 26b.

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36.	5.1.2, page 33, para 1, 2		a) This entire section would be improved by the addition of a basic site plan showing essential features of the excavation and stockpile plan such as features described in Section 5.1.1.	a) Added new Figure 5-1, and the following sentence to the end of Section 5.1.1: "Figure 5-1 is a conceptual site layout for corrective action implementation."
			b) Does the 1,880m^3 figure include the contingency for removal until "debris is no longer visible"?	b) Added the following text to the end of this sentence: "...based on the assumption that the area defined in Section 4.0 contains buried material. If the actual area of buried material is larger or smaller, the actual waste volume may be larger or smaller." Also replaced the last paragraph of Section 5.1.2 with and added to the end of Section A.3.3: "All initial corrective action boundaries established for the CAA of clean closure were established for the purpose of planning the areas and volumes to be excavated. The excavation will be guided by visual surveys, radiological surveys, and geophysical surveys, as appropriate. Upon completion of excavation, a comprehensive FIDLER survey will be performed and recorded with a Global Positioning System (GPS) to select the locations for verfication soil sampling. Soil sampling will be completed in accordance with Section 5.4 and Appendix F. Results of the soil sampling will determine whether additional excavation is required or provide verification that the corrective action is complete. Therefore, corrective action waste volumes may be less or more than estimated herein."
			c) Additional detail is required about the excavation/stockpile plan such as estimates of how much, how large, placement location and duration; control of airborne emissions, dust, and runoff/run-on; and if permits from NDEP will be required for stockpiling radiological and HCA soils on site.	c) Refer to response to Comment 36a above. Revised the second paragraph of Section 5.1.2 as follows: "After staking the boundaries of the remediation area, heavy equipment (e.g., excavator, grader, front-end loader, backhoe) will be used to excavate soil and debris from the corrective action areas. Excavated material will be stockpiled within the CA boundary or loaded directly into appropriate waste packages (Figure 5-1). Hand-held or heavy equipment may be used to size-reduce contaminated material. The excavated material will be wet down to minimize dust generation, as needed. Waste packages will be loaded, surveyed for release from the CA, and staged for loading and transport for disposal. Each waste container may include a combination of debris and soil to meet weight and activity concentration requirements. See Figure 5-1 for a conceptual site layout and Section 5.3 for a discussion on waste management."

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37.	5.1.3, page 34, para 1		Clarify whether no managed re-vegetation on excavated areas is planned, e.g. restoration was attempted at Double Tracks and Clean Slate I.	Replaced sentence with: "Only natural revegetation of the site is planned because the active revegetation of the Double Tracks site did not provide better results than the natural revegetation of the CS I site. Final actions will be documented in the closure report (CR)."
38.	5.3, page 34, para 1		Are excavated soils destined for disposal classified as "waste?" It appears that a subsection under 5.3 is needed specifically to address excavation/contaminated soils since they are of very large volume and are the product of corrective action.	Deleted the last sentence and revised the first two paragraphs of Section 5.3.2 as follows: "The waste streams anticipated to be generated during the implementation of clean closure at CAU 413 include radiologically contaminated soil and debris from the corrective action areas, decontamination fluids, personal protective equipment (PPE), disposable sampling equipment, and small quantities of non-contaminated industrial solid waste. Although not anticipated, hydrocarbon waste (debris, soil) may be generated from leaks/spills from heavy equipment used during corrective action implementation. Approximately 1,800 m^3 of radiologically contaminated soil and debris could be excavated. Expansion of the soil volume, estimated to be 30 percent based on experience with similar sites, will occur during packaging. Compactable radioactive waste—such as booties, gloves, and filters that become contaminated during closure activities—will be dispositioned in the same waste stream. Therefore the net volume of LLW (e.g., soil, debris, compactable waste) may be approximately 2,400 m^3. LLW will be removed from the CSII site, and transported to the Area 5 Radioactive Waste Management Complex (RWMC) for disposal in accordance with the *Nevada National Security Site Waste Acceptance Criteria* (NNSSWAC) (NNSA/NFO, 2016d). All low-level radioactive waste must meet the characterization, packaging, certification, and shipping waste acceptance criteria established in the NNSSWAC."
39.	5.4, page 37, para 1		Have the independent verification requirements of DOE O 458.1 been evaluated and incorporated as necessary?	DOE Order 458.1 is outside the scope of the FFACO and this document. See also response to Comment 32. No change to document.
40.	5.4, page 37, para 2		1st bullet: it appears there are five corrective action areas shown in Figure 4-1. Clarify.	There are six discrete areas shown on Figure 4-1. The figure was revised to more clearly identify the six areas.

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41.	5.5, page 37, para 1		Has the need for an air emissions permit for excavation and/or on-site radiological soil stockpiling and related earth moving activities been established?	Yes. Although it is estimated that less than five acres of land will be disturbed by the excavation activities, DOE/NFO will follow the current Class II Air Quality Operating Permit #AP8733-0680.03 for the Tonopah Test Range, issued to DOE Sandia Field Office. In particular, DOE/NFO will implement the *Surface Area Disturbance Permit Fugitive Dust Control and Process Equipment Emission Control Plan* dated October 17, 2014, for the proposed surface disturbance activities. This Plan is included as a part of the TTR's Class II Air Quality Operating Permit. Regarding NESHAP, analytical results for the highest activities in the CSII HCA were presented to SNL (DOE/ABQ) personnel, and they used the EPA's CAP-88 air modeling program to evaluate whether there are any NESHAP concerns. It was determined that they do not have any concerns with radiological air emissions from this work. For the purpose of annual reporting, in the year this work is conducted the radionuclides and activity found from analysis of the filters from the air samplers that will be used during operations will be the preferred estimate of actual air emissions for NESHAP reporting. Add to the end of this section: "Activities will be conducted in compliance with DOE Sandia Field Office current Class II Air Quality Operating Permit #AP8733-0680.03 for the TTR (Beausoleil, 2014). In particular, the permit's *Surface Area Disturbance Permit Fugitive Dust Control and Process Equipment Emission Control Plan,* dated October 17, 2014, for the proposed surface disturbance activities will be implemented for the proposed activities. That plan is included as a part of the TTR's Class II Air Quality Operating Permit."
42.	7.1, page 40, para 1		Specify that no post-closure inspections will be required under the FFACO. Assuming that 10 CFR 835 is still applicable at the site, there may be a need to conduct routine post-closure inspections for these requirements (e.g. postings).	Add: "because no fencing or signage will be required under the CAA of clean closure" to the end of the sentence. Add to Section 7.0: "Implementation of the CAA of clean closure will reduce contamination levels such that there will be no post-closure requirements under the FFACO (1996, as amended). This does not preclude other radiological control requirements for residual radioactive materials remaining after the completion of FFACO corrective actions." Also, refer to response to Comment 32.

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43.	7.2, page 40, para 1		During the joint AF/NDEP/NFO August 2016 meeting at DHHQ, it was stated that NFO intends to install 2 meteorological stations at CAU 413 in FY 2017. NDEP considers this broadly to be "monitoring." Clarify if these stations will operate during the post closure phase and if they might monitor radiological dust/soil migration near the site.	These stations are not part of FFACO monitoring requirements but may be useful information that can support potential future questions concerning the airborne transport of contaminants during and after corrective action excavations. Following the excavation activities, these stations might be used in other locations for similar purposes. Added: "because no fencing or signage will be required under the CAA of clean closure" to the end of the sentence.
44.	7.3, page 40		Clarify the disposition of all existing fences (HCA/interior, and CA) during the post-closure phase.	As stated in Section 5.1.1: "In order to maintain control of the site and delineate work areas, existing fencing may be reconfigured, additional fencing installed, and/or fencing removed during the progression of field activities." Added for clarification: "because no fencing or signage will be required under the CAA of clean closure" to the end of the sentence.
45.	A.2.0, page A-3, para 3		a) 2nd and 3rd sentences: Correct this statement. The FIDLER data sets were used to evaluate compliance with "Hot Spot" criteria and the removable alpha data set was used to extend UR boundaries. The FIDLER and Swipe sample data sets were both used to define the presence of COCs and make corrective action decisions. b) Last sentence: specify each type of survey data used in this report this statement applies to, i.e. geophysical, AMS, etc. State the role of FIDLER data as decision supporting and/or corrective action decision-making.	a) This was clarified for each study group in Sections 2.1.1 through 2.1.7. Refer to response to Comment 11. b) This was clarified for each study group in Sections 2.1.1 through 2.1.7. Refer to response to Comment 11.

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46.	A.2.2.1, page A-4, para 1, 2		a) 1st paragraph, 5th sentence: due to the concerns with the FIDLER measurements identified during CAU 573 CADD/CAP review, discuss how the data sets were normalized over the date ranges, with respect to the lack of standardized control of the voltage/gain settings, differing instrument efficiencies, and effects due to cosmic, terrestrial, and radon that can change the results on a day-by-day basis on the order of hundreds of cpm. Provide the background values (data) used to establish the basis for Multiples of Background. Should any future surveys of this location be required, it will be beneficial to know what value of background (and consequently MOB) was used so that comparison can be made.	a) Added background values to all figures that present MOB values. Replace last two sentences of the first paragraph with the following: "Many surveys were conducted at CSII between 2012 and 2016, and the data from these individual surveys were combined into one dataset. However, while each survey produced valid relative differences in radioactivity over the surface area of the release site, the numerical range of values from one day to another or from one instrument to another may be significantly different. This is a result of differences in instrument efficiencies as well as daily variations in background cosmic, terrestrial, and radon radiation. Therefore, to be able to combine different surveys into one dataset, the data must be converted into comparable units. This was accomplished by transforming the data to make them relative to the background radiation level of the specific day as measured by the survey instrument used for the survey. The resulting normalized transformed survey data are presented in units of multiples of background (MOB). Each day, before conducting the field survey, a background radiation level was established for that day's survey for that particular instrument. This was done at a location that had been determined to have field conditions (e.g., soil type, elevation, vegetative cover) similar to what was observed over most of the site to be surveyed but was not impacted by contaminants from the release. The location used to establish the background radiation level is shown on Figure A.2-1. The background radiation level was established as the average of the one-second readings (in cpm) collected over a five-minute interval. Each of the survey values for that day were divided by this background to produce a value representing a multiple of the background level and is expressed in units of MOB. When the radiation survey results are related to the background level and expressed in terms of MOB, the results of surveys conducted on different days and using different instruments become comparable and can be combined for the purpose of defining relative contamination levels over the surface area of a release site. The survey point data were combined together in a Geographic Information Systems database for subsequent analysis. This was done for all of the radiation surveys conducted at Soils Activity release sites and has been verified by comparing results from different surveys at overlapping survey locations."
			b) 2nd paragraph, 2nd sentence: this statement appears to contradict how the FIDLER data were used to "better define the distribution of contamination at the site…," and "The FIDLER data were used to target additional locations with elevated radioactivity.." as stated in a previous section of this document.	b) To clarify this statement, replace the second and third sentences of this paragraph with: "Values from the individual data points from the CAU 413 FIDLER surveys exhibit patterns of radioactivity that are representative of two different release distributions. These two release distributions support the CSM associated with the liquid and gaseous phases of the test material released by the CSII test as described in Section A.8.2. The FIDLER survey data that were determined to be associated with the liquid phase (i.e., hot spots) were separated from the FIDLER survey data that were determined to be associated with the gaseous phase (i.e., airborne deposition). This was done by identifying and separating out those data points (or sets of data points) whose values are anomalous to the values of the surrounding data points that are consistent with the CSM element of airborne deposition (i.e., a generally consistent decrease in activity with distance from the release point). The separated data point values are used to represent hot spots that are evaluated independently of the airborne deposition contamination (see Sections 2.2.1.6 and A.8.0 associated with SG6). The remaining data points were used to create a continuous spatial distribution (i.e., interpolated surface) using an inverse distance weighted interpolation technique of the geostatistical analyst extension of the ArcGIS software."

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47.	A.2.2.1, page A-5, para 2		2nd and 3rd sentences: The PRM-470 data set appears to meet the definition of decisional data as provided in Section A.2.0 of this document, "Data used to define the presence of COCs are classified as decisional and will be used to make corrective action decisions"; include a comparison showing PRM-470 results for Cs-137 were indistinguishable from background; provide text that established the background level for Cs-137 that was used in this comparison.	Inserted the following before the second sentence: "The CAIP states that Cs-137 is not a contaminant of potential concern (COPC) for CAU 413 and is not in the CSM. This area was surveyed to determine whether a questionable and anomalous sample result could indicate the presence of a small area of Cs-137 contamination that would violate the CSM. A radiation survey using a PRM-470 instrument was conducted in the area of the 1992 sample location to see whether there is a gamma signature above background levels that would violate the CSM and require the CSM to be reevaluated. This was evaluated by visually inspecting the spatial results to see whether a pattern of elevated readings could be identified and by looking for any statistical anomaly. No patterns of elevated readings were identified; and the coefficient of variation of the dataset was 0.12, indicating very consistent readings throughout the survey area."
48.	A.2.2.1, page A-6, Fig A.2-1		a) This figure is not acceptable for the following reasons: overlaying an "interpolated" and multiyear "composite" FIDLER plot with the 2006 AMS survey data (which is not addressed in A.2.2.1) produces a graphic that confuses which data are from which survey. Near the CA boundary, it is impossible to distinguish AMS from FIDLER data. The color-coded FIDLER MOB values in the legend are too small to be useful. The spacing of the FIDLER data does not appear to be "comprehensive" as stated in the document. It would helpful to present the three individual FIDLER Survey results rather than a composite. b) Identify the location of the background for FIDLER surveys. c) Describe the fences.	a) Revised figure with the following improvements; 1) removed the aerial survey, 2) added interpolated FIDLER surface, and 3) added the FIDLER survey background location. b) Background location identified on the figure as recommended. c) The inner fences are not shown for clarity. The CA fence is shown on the figure and identified in the legend. No change to document.

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49.	A.2.2, page A-7, Fig A.2-2		a) The plot is not consistent with previous plots of radiological survey data. Please identify the background location and radiological readings. b) Add the measurement data to a new table as described in A.2.2.2	a) Figure A.2-2 as explained in the document, presents the area of the PRM survey. There is no data to present, as all results were less than background. This is also discussed in the document. Refer to response to Comment 47. b) Added the following note to the figure: "Note: All PRM-470 survey results were indistinguishable from background."
50.	A.2.2.3, page A-8, para 1		a) 4th sentence: clarify how it was determined that one of the background TLDs was not representative of natural conditions. b) 5th sentence: identify the location of the background TLDs; expand on how the two background TLDs were determined to be representative and a good estimate of true average background dose for all environmental TLDs. How does this compare/contrast with the TLD data as presented in the 2015 Annual Site Environmental Report for Sandia National Laboratories Tonopah Test Range, Nevada and Kaua'I Test Facility, Hawai'I, SAND2016-7282 R?	a) Replace the sentence with the following: "One of the background TLD locations (B02) was located in the debris field and therefore considered to not be representative of natural conditions. This TLD was not used in the calculation of external dose at CAU 413 (see Section A.3.2.4)." b) The location of the background TLDs was added to Figure A.2-1. The TTR ASER value for 2014 was 145.4 mrem/yr; this corresponds to the CAU 413 value of 163.4. Both values are well within the range observed on site at TTR ranging from 115 to 199 mrem/yr. To clarify, replaced sentence with: "The other two background TLDs (Figure A.2-1) were placed in locations with the same geomorphological properties as the release site but outside the influence of the release. Therefore, they were determined to be representative of the general area and were used as a good estimate of average background dose for all of the TLDs placed within the release plume."

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51.	A.2.3.2, page A-10, para 1, 2		a) 1st paragraph, Last sentence: explain why skin dose is not "relevant" to external dose in this case. b) 2nd paragraph, 1st sentence: explain why RESRAD-modeled dose multiplied by a "correction factor" based on an internal data sets from "previous data from Soils Activity" provides improved site characterization over direct TLD measurement. c) 2nd paragraph, 4th sentence beginning with "Evaluation of this data …": there is no corroborating methodological detail about how this evaluation (shown in Figs A.2-3 through A. 2-5) was conducted and validated; is the evaluation in the current working revision of RBCA?	a) Inserted the following at the end of the first paragraph: "TLD Element 1 is less sensitive to low-energy photons, is more variable, and is not replicated within the TLD badge. As the other three elements overrespond to low-energy photons, the predictions of external dose are conservatively high." b) This correction factor was developed to account for the observed differences between RESRAD-derived external dose and TLD readings shown in Figures A.2-3 through A.2-5. This results in a more conservative (higher) estimate of external dose than if the RESRAD external dose was used without adjustment. This is explained at the end of the paragraph. Inserted the following after the second sentence in this paragraph: "This results in a more conservative (higher) estimate of external dose than if the RESRAD external dose was used without correction." c) The explanation is discussed in this paragraph and presented in Figures A.2-3 through A.2-5. Refer to response to Comment 52.
52.	Figure A.2-3, page A-11		Figure A.2-3: the y-axis identifies "TLD Dose (mrem/IA-yr)." Please provide the correlation to the CW scenario.	Added the following to the second paragraph of Section A.2.3.2: "The correlations were made using the Industrial Area scenario (as doses for this scenario were calculated for all Soils release sites). As external dose is directly related to exposure time, the correlation is the same for any period of exposure. Therefore, the Industrial Area scenario provides the most accurate results because it is the scenario that uses the longest exposure time."
53.	Figure A.2-5, page A-12		Figure A.2-5: the x-axis identifies "RESRAD External Dose (mrem/IA-yr)." Please provide the correlation to the CW scenario.	See the response to Comment 52.

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54.	A.3.1.2, page A-15, para 1		5th sentence: Table A.3-1 does not provide a summary of the radioanalytical results. The text in this section states that the samples were analyzed for radioactive constituents, yet the document never states what was identified and what was not identified based on that analysis. Add data/tables.	The analytical data have been provided in new Appendix K. Additionally, the following sentence was added to the end of Section A.3.1.2: "The analytical data are provided in Appendix K."
55.	A.3.2.1, page A-17, para 1		Entire section: state the methodology for removable contamination survey. Since the removable contamination survey results were used to make a corrective action decision, provide a discussion on the uncertainty of the measurement and impact on the false negative error.	Explanation of the use and quality category of removable surveys was added to Section 2.1.1. Refer to the response to Comment 11.
56.	A.3.3, page A-23, para 1		3rd sentence: identify which FIDLER data set was used for the correlation since there are multiple data sets. If multiple data sets were used then please discuss how they were combined and correlated. Using the FIDLER data set to define a FAL boundary meets the definition of decisional data. Please include the DQO/DQI criteria for the FIDLER data sets.	1) The FIDLER data used in the correlation was a compilation of 67 surveys using two instruments conducted between 2012 and 2016. 2) These FIDLER values were presented in terms of MOB so that data collected by different instruments on different days can be used in conjunction with one another. On each day that a radiological survey is conducted, the survey instrument collects data for five minutes (one-second readings in cpm) at a location that has been determined to be out of any contaminant plume and is representative of background radiation levels at the release site to be surveyed. The average of these readings is considered background for that day's survey for that particular instrument. This is essential because cosmic, terrestrial and radon radiation values change significantly from day to day and each instrument has different efficiencies. The survey readings are then expressed as a multiple of the background level (MOB). When survey results taken on different days and with different instruments are expressed in relation to the background level of the day the survey was taken (i.e., MOB), the survey results are comparable and can be combined into a single dataset. This has been done in all of the radiation survey results from the beginning of the Soils Activity and has been verified by comparing results from different surveys at overlapping survey locations. 3) See the response to Comment 5 on the use of FIDLER data to support DQO decisions. 4) An evaluation of FIDLER data quality was added in Section B.1.6. 5) Refer to response to Comment 46.

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57.	A.3.4, page A-27, para 1		2nd sentence: There is no explanation of any deviation from the CAIP in regards to the number of background samples. What was done was just stated.	The deviation from the plan is explained in this section and in Sections A.2.2.3 and A.4.2.2. No change to document.
58.	A.4.1.2, page A-28, para 1		7th sentence: Table A.4-1 provides no summary of the radioanalytical results; document states that the samples were analyzed for radioactive constituents; include a table showing results, i.e. pCi/g.	Table A.4-1 provides results in terms of dose that can be directly compared to the FAL consistent with past Soils FFACO report documents. The analytical data have been provided in new Appendix K. Additionally, the following sentence was added to the end of Section A.4.1.2: "The analytical data are provided in Appendix K."
59.	A.4.2.2, page A-30, para 1		a) 1st sentence: justify the use of estimated/calculated dose at SG2 sample locations instead of direct TLD measurements, given that TLD measurements were used for developing TED at other SGs in this CAU; explicitly justify with complete technical basis. b) Reference to Section A.2.2.3 should be A.2.3.1.	a) Replace the first two sentences with: "In accordance with the CAIP (NNSA/NFO, 2016), TLDs were not placed at SG2 sample locations because the DQO decision for SG2 was based on the presence of COCs in the subsurface. However, as location C11 was collocated with an SG1 sample plot location where a TLD had been placed, data from this TLD were used to calculate external dose for the surface soil at location C11." See also clarifications made in Section 2.1.2 (response to Comment 11). b) Corrected reference to A.2.3.1.
60.	A.5.0, page A-35, para 1		Describe all fences as shown on Figure A.5-1.	The inner fences have been removed from all figures for clarity. The CA fence is shown on the figure and identified in the legend.
61.	Figure A.5-1, page A-36		Legend indicates upper color range of 26000 to 56000 counts per second. Where are these located on the provided figure? If this range does not occur, remove from legend.	Legend revised to remove categories that do not appear on the figure.

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62.	A.5.3, page A-41, para 1		a) 2nd sentence: expand on this sentence since it is not clear how field instrumentation indicated the presence of buried contamination, yet the subsurface soil dose was less contaminated that the surface. b) 3rd sentence: although no corrective action is required at these locations since the TED is below the FAL, describe if and how the locations will be managed (or not managed) under 10 CFR 835 and under DOE Order 458.1 should additional action be required at a later date under this order.	a) To clarify, replace "buried contamination" with "elevated readings," as follows: "Although radiological field screening suggested the presence of elevated readings at SG3 locations C23 and C28, the subsurface soil dose was less contaminated than the surface and was below the FAL at both locations (Table A.5-5)." b) Inserted the following sentence: "However, any remaining radiological contamination will be managed in compliance with all applicable DOE requirements."
63.	A.5.4, page A-41, para 1		Has the effective field of view of a TLD been determined to ensure that an approximate 1 meter separation in distance is appropriate to represent external exposure?	Added the following text after the third sentence: "Based on the correlation of TED to the interpolative radiation survey surface described in Section A.2.2.1 and that external dose is approximately 28 percent of TED, the change in external dose per meter of distance at these locations is approximately 0.008 mrem/CW-yr."
64.	A.6.1.1, page A-44, para 1		Last sentence: inconsistent with previous sections which have included a summary table for soil samples.	Tables A.6-1 through A.6-3 provide results in terms of dose that can be directly compared to the FAL consistent with past Soils FFACO report documents. The analytical data have been provided in new Appendix K. Additionally, the following sentence was added to the end of Section A.6.1.1: "The analytical data are provided in Appendix K."
65.	A.7.3, page A-49, para 1		2nd sentence: is the "cluster of metal debris" shown on Figure A.7-1?	Labels for the "cluster or metal" and the "linear feature" were added to the figure.
66.	A.7.1.1, page A-50, Fig A.7-1		What is EM-61? Include explanation from Appendix I.	Added the following after the first sentence of Section A.7.1.1: "The EM31-MK2 earth conductivity meter measures the conductivity of the soil as well as detecting the presence of metal. The EM61-MK2A four channel time domain metal detector detects both ferrous and nonferrous conductive objects." Added the following before the last sentence of Section A.7.1.1: "The EM61 provided the best results, and these results were used to determine locations and depths of buried debris."

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67.	A.8.2, , page A-55, para 1, 2		a) 1st paragraph, 2nd sentence: provide the radiological survey. b) 1st paragraph, 4th sentence: discuss how the data were modified to include criteria used to separate out "hot spots." c) 2nd paragraph, 1st sentence: use of the FIDLER data set meets the decisional data criteria, please include DQO/DQI criteria (e.g., Scan MDC, reference NUREG-1507).	a) Added "(see Figure A.8-2 for survey results)" at the end of the second sentence. b) See response to Comment 46b. c) The quality of the FIDLER data for making this decision is discussed in Appendix J.
68.	A.8.4, , page A-57, para 1		1st sentence: discuss methodology used to assess removable contamination from soil to include the uncertainty and detection limits of the method. Although no removable contamination was observed per the method, there is no confirmation that contamination was present at each of the locations after the debris was removed. Indicate whether these areas are still subject to control under 10 CFR 835 as a result of residual contamination.	The methodology was discussed in Section 2.1.1. Refer to responses to Comments 11 and 32. Inserted the following after the first sentence: "Any remaining radiological contamination will be managed in compliance with all applicable DOE requirements."
69.	A.8.5, page A-57, para 1		The collection of swipes from beneath the PSM is not addressed in the CAU 413 CAIP which state in Section 4.2.4.6 and A.8.6.1: "The Site Supervisor will determine whether a grab soil sample(s) will be collected (e.g., directly underneath a piece of debris) or a composite soil sample(s) of the impacted area (e.g., stained area) will be collected." Explain.	As noted in Section A.8.5, this is a deviation to the CAIP. Since the CAIP was written, the hot spot criterion described in Appendix J was utilized for CAU 413. New Appendix J has been inserted. Also replaced the third and fourth sentences of this paragraph with: "The approach to evaluating PSM hot spots in the CAIP was not followed. That approach was superseded by a recently adopted hot spot evaluation approach developed and implemented at two other Soils CAUs (CAU 573 and CAU 414). This revised approach is presented in Appendix J. This describes the development of a hot spot criterion that allows for the estimation of dose associated with PSM used to make a conservative assumption of when a hot spot may provide a dose exceeding the radiological FAL."

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70.	A.9.1.1, page A-59, para 1		2nd paragraph, 1st sentence: CAU 413 CAIP states in Section A.8.7.1, "Six random subsamples will be collected from the surface (0 to 5 cm [0 to 2 in.]) of each mound and composited. One composite soil sample from the interior of each mound will also be collected to confirm the homogeneity of the mounds. For each mound, this sample will be collected at the same six random subsample locations at which the surface composite sample was collected, but at a depth of 15 to 30 cm (6 to 12 in.) below the surface of the mound." Explain deviation.	Sentence revised to clarify as follows: "Two grab samples consisting of six subsamples were collected at each soil mound, one from the surface of the mound (0 to 15 cm) and the other from the mound interior (15 to 30 cm from the mound surface) in accordance with the sampling methodology specified in the CAIP (NNSA/NFO, 2016)."
71.	B.1.1.1.1, B-9, 10; para 1,2,and 4		a) How can the Precision and Accuracy criterion have been met if none of the analytical results were qualified for precision or accuracy? b) *Representativeness*: include the Am and Pu isotopic ratios established from the isotopic analytical results and evaluation in the CADD/CAP. These ratios are important to proper site characterization, waste disposal, and any future site investigation and should be included in the CADD/CAP.	a) Replaced "None of the analytical results were qualified for…" in the second sentences of these two sections with: "No data quality issues were identified for the analytical results that resulted in their being qualified for…" b) Added to the end of the second paragraph: "For CAU 413, the isotopic ratios of Am-241 to Pu-238, Pu-239/240, and Pu-241 are 0.0995, 12.671, and 1.7622, respectively."
72.	App. F, cover		Revise cover sheet and TOC to read: "Sampling and Analysis Plan for Confirmation of Corrective Action"	The title of this appendix cannot be changed, as it is specified in the FFACO outline. No change to document.

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10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
73.	F.8.0, page F-11, para 2		1st sentence: Since the FIDLER data will be used to determine the location of the soil sample plot, what are the criteria that determine usability of FIDLER data set?	See response to Comment 11. The following text was added to the end of Section F.4.1 to clarify the quality requirements for information needed to resolve and support DQO decisions: "The resolution of DQO Decision I for each excavated area will be based on analytical soil sample results. Therefore, the analytical data will be considered decisional data. To ensure samples are collected in the areas most likely to contain a COC (if present), sample locations will be selected from the most elevated radiological readings using relative readings from a radiological survey. This use of the FIDLER radiological survey data for selecting soil sample locations meets the definition of decision-supporting data as defined in the Soils QAP (NNSA/NSO, 2012). To additionally ensure that samples are collected in the areas most likely to contain a COC (if present), visual and geophysical surveys will be conducted to ensure that all buried debris is removed before collecting the verification samples. These surveys meet the definition of decision-supporting data as defined in the Soils QAP. As the dose to a potential receptor cannot be estimated for removable contamination, the decision to require corrective action for removable contamination will be based on an assumption that removable contamination exceeds the radiological FAL when the HCA criterion is exceeded. The HCA criterion does not represent dose and is not a basis for determining whether COCs are present. It is an additional consideration for making the conservative assumption of the need for corrective action where it cannot be determined whether COCs are present. This use of removable contamination information meets the definition of decision-supporting data as defined in the Soils QAP."
74.	F.8.0, page F-11, para 3		1st sentence: since the removable contamination survey data are being compared to an authorized limit, add discussion about conformance with the radiological survey requirements of DOE O 458.1 and how they apply to this CAU.	The removable contamination limit is not compared to an authorized limit, and as stated in earlier responses, DOE O 458.1 is outside the scope of this document (see response to Comment 32). The following text was inserted at the end of Section F.4.2 to clarify the quality requirements for information needed to resolve and support DQO decisions: "Information to support the DQO decision for all excavated areas will be generated by performing a radiological survey of the remediated areas and of the adjacent undisturbed soil. Additional information to support the DQO decision for SG5 will be generated by performing visual and geophysical surveys."

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75.	Appendix I		The following comments refer to content and format of Appendix I, "Geophysical Survey Report": a) A separate appendix containing at least the same level of documentary and methodological detail for the radiological surveys such as the FIDLER instrument, as those shown in this appendix is warranted, given the importance of such radiological data on site closure decisions. b) Appendix I appears to be from a different author than rest of document. Identify the author/organization and state if this work was subcontracted.	a) Appendix I is a stand-alone document. The format of the Geophysics Report is similar to Geophysics reports that have been submitted and approved with past FFACO documents (e.g., CAU 573 CADD/CAP). No change to document. b) Added the following Background and Errata Section at the beginning of Appendix I: **"I.1.0 Background** Geophysical surveys were conducted by the Navarro Geophysics group in 2015 and 2016 at the debris burial area addressed under SG5 to determine whether buried metallic materials are present within the area of the suspected disposal trenches. The surveys were conducted both within the HCA and CA on July 14 and 15, 2015. Additional surveys were conducted on May 17 and 18, 2016, within the CA to provide supplemental information. The Navarro Geophysics group submitted the results, and an interpretation of the results of the geophysical surveys in the report is presented in Attachment I-1. All of the EM31 runs were accomplished with the unit suspended from a shoulder harness. All of the EM61 runs were conducted with the coils mounted to the wheels except for the survey conducted in the HCA, which was conducted with the coils suspended from a harness worn by the operator. With the wheels attached, the bottom coil is about 40 cm above the ground surface. When the coils are suspended from the harness (rather than being mounted on the wheels), the bottom coil is about 20 cm from the land surface. Surface metallic debris and man-made structures/materials that might be detected by the instruments and interfere with the interpretation of results were visually identified. The data acquisition, processing, and reduction software described are considered commercial off-the-shelf items and were used for the intended purpose without modification. All data transcriptions, reductions, and conversions were verified using a checkprint process." **I.2.0 Errata for Attachment I-1** Page 4 of 28: Change "antennae" to "antenna." Page 7 of 28: "CS2" refers to CSII. Page 15 of 28: "CS2" refers to CSII.
			c) Appendix I must be reformatted to conform to the style of other appendices and the document as a whole. NOTE: this concern has also been submitted on a previous FFACO document regarding geophysical data presentation, so there is precedent for concern about format uniformity among appendices and documents. d) Figure 2 is very poor quality making it difficult to discern the features (i.e. "the coils") described on page 3; suggest using photos of actual equipment used instead of manufacturer-supplied photos for clarity.	c) Appendix I is a stand-alone report. It is therefore unnecessary for formats to match among all appendices. The format of the Geophysics Report is similar to Geophysics reports that have been submitted and approved with past FFACO documents (e.g., CAU 573 CADD/CAP). See response to Comment 75b above. d) This is the best photo available. No change to document.

			e) Although implied by Figures 1 and 2, clarify which surveys were carried out with hand-held technique and which were carried out using wheeled technique (i.e., add notes to Tables 1 and 2).	e) Refer to response to Comment 75b.
			f) Page 4 of 28, 1st paragraph: "antennae" is the plural of "antenna"; correct the document if you are referring to "a model."	f) Refer to response to Comment 75b.
			g) page 4 of 28, 2nd paragraph: "technical memorandum"; this section is an appendix, not a technical memorandum; correct the document.	g) This document was written as a technical memorandum documenting the work done and results achieved for a specific work location. It has since been incorporated as an appendix in this document. No change to the document.
			h) IAW with the Sec. 1.8 (Software) of Soils QAP, please add content about the following:	h) Refer to response to Comment 75b.
			1. Whether or not the data acquisition, processing, and reduction software described are considered COTS; how are they classified under the Soils QAP?	1) Yes, the software are commercial off-the-shelf (COTS).
			2. Whether or not this software was determined to be subject to QA steps described in Soils QAP Sec. 1.8.1 (Verification).	2) As the COTS software was used for its intended purpose without modification, this was not necessary. Refer to response to Comment 75b.
			3. Whether or not any software quality assurance checks were performed for error and configuration reporting; i.e., when "reducing" "raw" data logger files, when location data were converted to the project standard UTM 11 Datum NAD 27, when 'XYZ' extension files are imported into Excel; and when data are "imported" into ArcMap for contouring and visualization. For an example, see statement on page 5 of 2nd paragraph, last sentence.	3) Yes, checkprints were done on data reductions. The coordinate datum conversions were done on ArcGIS, a COTS.
			i) Page 6 of 28, 1st paragraph, 1st sentence: "…were identified." Was this a visual id?	i) Yes, this was visual identification. Refer to response to Comment 75b.
			j) Figure 3: Legend, Correct the "CS2" notation; clarify the "Burial Mound" as it has not been previously plotted or described as such anywhere in the document; address the terms "HCA Fence" and "CSII Inner Fence" in light of previous comments about nomenclature ambiguity of fencing in various figures; "GPS Location" appears to indicate the position of metal debris, so should the symbol call be 'metal debris'? What is the purpose of showing EM31 survey file names as shown within the "Surveyed Area"?	j) This appendix is a stand-alone technical memorandum documenting the work done and results achieved for a specific work location. Small discrepancies between this figure and the CADD/CAP do not affect the content of the document and do not change the results of this appendix.
			k) page 8 of 28, 2nd paragraph: this is not a "memorandum"; does the .xlsx file mean "Attachment 1" at the end of this Appendix? Clarify.	k) The "xlsx" suffix identifies it as an Excel workbook. No change to document.
			l) page 9 of 28, 1st paragraph: In addition to the "two areas of elevated readings near the center…," there is a third elevated area about 140 feet northeast of the middle area, explain; elaborate on why the determination that the "low" instrument responses "do not indicate significant amounts of burial material"; explain why the elevated area near the center of the area surveyed "do not correspond to metal debris observed at the surface";	l) The third elevated area the commenter is referring to is the signal from a t-post in the fence line. Its expression can be seen in both datasets. The EM31-MK2 measures both "in-phase" and "quadrature phase" signals. Use of these terms is to let the reader know which of the two signal responses is being discussed. The equipment manufacturer gives the following description: "There are two components of the induced magnetic field measured by the EM31. The first is the quadrature-phase component, which gives the ground conductivity measurement as described. The second is the in-phase component used primarily

NEVADA ENVIRONMENTAL MANAGEMENT OPERATIONS ACTIVITY
DOCUMENT REVIEW SHEET

1. Document Title/Number: Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 413: Clean Slate II Plutonium Dispersion (TTR), Tonopah Test Range, Nevada, Draft	2. Document Date: January 2017
3. Revision Number: 0	4. Originator/Organization: Nevada Division of Environmental Protection
5. Responsible DOE NNSA/NFO Activity Lead: T. Lantow	6. Date Comments Due: March 2, 2017
7. Review Criteria:	
8. Reviewer/Organization Phone No.: NDEP	9. Reviewer's Signature:

10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
			explain jargon , "in-phase instrument response at each data point." m) page 9 of 28, 2nd paragraph: explain jargon, "quadrature-phase instrument response at each data point"; the third elevated area 140 feet northeast of the middle area that appears in the "In-Phase" data does not appear in the "Quadrature-Phase" data, explain; provide an estimate or approximation of depth to "disturbed earth/metallic debris". n) Figures 4 and 5: there is no discussion about the meaning of the measurement units shown in legend boxes in the upper right corner of each figure; why were the legend unit count intervals varied?; the "Linear Anomaly" shown in Figure 5 is not incontrovertibly evident from visual inspection of the plot, explain; page 13 of 28, bottom paragraph "… the bottom coil was some 20 cm above the ground surface." If Fig. 1 can be used as reference, the antenna/coil appears to be carried at much higher than 20 cm above ground surface, explain.	in the EM31 for calibration purposes. The in-phase component, however, is significantly more sensitive to large metallic objects and hence very useful when looking for buried metal drums." No change to document. m) See above response. No change to document. n) The intervals displayed by each of the colors in Figures 4 and 5 were varied to enhance the amount of information that can be drawn from the data/figures. The linear anomaly in the HCA is not very clear in Figure 5, but there is some indication of it and it is very clear in other surveys. This was merely an attempt to point out the expression of this feature as it is seen here. See response to Comment 75b for information about detector height.
	J.1-1, page J-1, para 1		2nd sentence: Due to the change in approach based on CAU 573 comments with respect to the MOB approach, this appendix will need to be updated to reflect the change.	Appendix J was replaced.
	J.1-1, page J-3, para 2		Based on the information obtained from CAU 573, will the 28 MOB value (and expression of this value as MOB) corresponding to 25 mrem/yr need to be revised to a new value derived using calibrated FIDLER instrumentation. Update the new hot spot threshold based on the use of calibrated FIDLERs.	Appendix J was replaced.

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8. Reviewer/Organization Phone No.: NDEP				9. Reviewer's Signature:
10. Comment Number/Location		11. Type[a]	12. Comment	13. Comment Response
	Table J.1-3, page J-5		Table J.1-3: The methodology used to determine total alpha contamination and the removable fraction is not discussed in this appendix; include the methodology and associated uncertainty since it is being used to modify decisional criteria.	Appendix J was replaced.
	Throughout the document			Several other editorial corrections were made.

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