REVISION 0

IOWA ARMY AMMUNITION PLANT OPERABLE UNIT 8 ANNUAL ENVIRONMENTAL MONITORING DATA AND ANALYSIS REPORT FOR CALENDAR YEAR 2016

MIDDLETOWN, IOWA

JUNE 29, 2017

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

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ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	contaminant of concern
CY	calendar year
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQO	data quality objective
DU	depleted uranium
EDE	effective dose equivalent
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer Manual
EMDAR	Environmental Monitoring Data and Analysis Report
ER	Engineer Regulation
FS	firing site
FUSRAP	Formerly Utilized Sites Remedial Action Program
GIS	geographic information system
IAAAP	Iowa Army Ammunition Plant
LAP	load, assemble, and pack
MARSSIM	*Multi-Agency Radiation Survey and Site Investigation Manual*
MDA	minimum detectable activity
MDC	minimum detectable concentration
MED	Manhattan Engineer District
NAD	normalized absolute difference
NRC	U.S. Nuclear Regulatory Commission
OU	operable unit
PDI	pre-design investigation
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QSM	*Department of Defense (DoD)/Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories*
RA	remedial action
RG	remediation goal
RI WP	*Remedial Investigation Work Plan for Line 1, Firing Sites Area, Yards C, G, and L, Warehouse 3-01 and the West Burn Pads Area South of the Road*
Rn	radon
ROD	*FUSRAP Record of Decision for the Iowa Army Ammunition Plant*
RPD	relative percent difference
SOP	standard operating procedure
SU	survey unit
TEDE	total effective dose equivalent
U	uranium
USACE	U.S. Army Corps of Engineers

ACRONYMS AND ABBREVIATIONS (Continued)

USEPA	U.S. Environmental Protection Agency
VQ	validation qualifier

UNIT ABBREVIATIONS

Both English and metric units are used in this report. The units used in a specific situation are based on common unit usage or regulatory language (e.g., depths are given in feet, and areas are given in square meters). Units included in the following list are not defined at first use in this report.

$^{\circ}$C	degrees Celsius (centigrade)
µCi/mL	microcurie(s) per milliliter
Ci	curie(s)
cm	centimeter(s)
cm^3	cubic centimeter(s)
m	meter(s)
m^3	cubic meter(s)
mL	milliliter(s)
mrem	millirem
pCi/g	picocurie(s) per gram
pCi/L	picocurie(s) per liter
yd^3	cubic yard(s)

EXECUTIVE SUMMARY

This Annual Environmental Monitoring Data and Analysis Report (EMDAR) for calendar year (CY) 2016 applies to the Iowa Army Ammunition Plant (IAAAP) Operable Unit (OU)-8 (Figure 1-1), which is within the scope of the Formerly Utilized Sites Remedial Action Program (FUSRAP). This EMDAR provides an evaluation of the data collected as part of the environmental monitoring conducted for IAAAP OU-8. IAAAP OU-8 consists of the Firing Sites Area (containing five subareas: Firing Site (FS) -1 and FS-2; FS-3, FS-4, and FS-5; FS-6 Area [FS-6, FS-7, FS-8, and FS-15]; FS-12 Area [FS-9, FS-10, FS-11, and FS-12]; and FS-14); Line 1 Structures; Yards C, G, and L; and Warehouse 3-01. The M-Yard is not included as part of OU-8 in the *FUSRAP Record of Decision for the Iowa Army Ammunition Plant* (ROD) (USACE 2011); however, references to OU-8 include the M-Yard for the purposes of this EMDAR. Environmental monitoring of various media at IAAAP OU-8 is required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and under the commitments in the ROD (USACE 2011).

The U.S. Army Corps of Engineers (USACE) St. Louis District collects environmental monitoring data as a component of remedial action (RA). These data serve as a critical component in the evaluation of the current status of residual contaminants and assessment of the potential future migration of residual contaminants.

The collection and evaluation of environmental monitoring data for IAAAP OU-8 is used to demonstrate compliance with the applicable or relevant and appropriate requirements (ARARs).

Radiological air data collected at IAAAP OU-8 through airborne radioactive particulate monitoring were evaluated. In addition to environmental monitoring purposes, radiological air data were also used as inputs to calculate the total effective dose equivalent (TEDE) to the hypothetical maximally exposed individual from IAAAP OU-8.

The TEDE calculated for the hypothetical maximally exposed individual at IAAAP OU-8 was less than 0.1 millirem (mrem) per year. The results of the radiological air monitoring conducted at IAAAP OU-8 demonstrate compliance with the ARARs for IAAAP OU-8.

Surface-water and sediment sampling was completed as a best management practice in April and November of 2016. Samples were collected from 10 surface-water and sediment sampling locations (Figure 4-1). The results of the sampling were used to evaluate the radiological conditions of Long Creek and its tributary downgradient of the FS-12 Area and running to the east and south of the FS-12 Area.

The results of the surface-water and sediment sampling demonstrate no adverse impacts from the remedial activities at OU-8.

Storm water that accumulated in the bermed loadout area at the M-Yard in CY 2015 was pumped into a frac tank, sampled for uranium isotopes, and stored until CY 2016. Analysis of sample results did not indicate elevated levels of uranium. All storm water (i.e., the storm-water from CY 2015 that had been stored in the frac tank and the storm water that accumulated in the bermed loadout area in CY 2016) was discharged to an adjacent field in CY 2016.

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1.0 HISTORICAL SITE BACKGROUND AND CURRENT SITE STATUS

1.1 INTRODUCTION

This Annual Environmental Monitoring Data and Analysis Report (EMDAR) for calendar year (CY) 2016 applies to the Iowa Army Ammunition Plant (IAAAP) Operable Unit (OU)-8 (Figure 1-1), which is within the scope of the Formerly Utilized Sites Remedial Action Program (FUSRAP). This EMDAR provides an evaluation of the data collected as part of the environmental monitoring conducted for IAAAP OU-8. IAAAP OU-8 includes the Firing Sites Area (consisting of five subareas: Firing Site (FS)-1 and FS-2; FS-3, FS-4, and FS-5; FS-6 Area [FS-6, FS-7, FS-8, and FS-15]; FS-12 Area [FS-9, FS-10, FS-11, and FS-12]; and FS-14); Line 1 Structures; Yards C, G, and L; and Warehouse 3-01. The M-Yard is not included as part of OU-8 in the *FUSRAP Record of Decision for the Iowa Army Ammunition Plant* (ROD) (USACE 2011); however, references to OU-8 include the M-Yard for the purposes of this EMDAR. Environmental monitoring of various media at IAAAP OU-8 is required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and under the commitments in the ROD (USACE 2011).

1.2 PURPOSE

The primary purpose of this EMDAR is to calculate the total effective dose equivalent (TEDE) from radionuclide emissions (exclusive of radon) to the hypothetical maximally exposed individual and other receptors from the IAAAP OU-8 sites at which a reasonable potential for radionuclide emissions due to FUSRAP activities exists to demonstrate compliance with the applicable or relevant and appropriate requirements (ARARs) or other federal and state benchmarks. During CY 2016, the FS-12 Area and the loadout area at the M-Yard had a reasonable potential for radionuclide emissions due to FUSRAP activities. The air emissions from the FS-12 Area and M-Yard are releases of particulate radionuclides in soil as a result of windblown action and remedial action (RA) in the form of excavation, stockpiling, on-site treatment (i.e., sorting), and loadout of soil.

This EMDAR additionally serves to enhance the reader's awareness of the current condition of IAAAP OU-8, summarize the data collection efforts for CY 2016, and provide analysis of the CY 2016 environmental monitoring data results. This EMDAR presents the following information:

- IAAAP OU-8 sample collection data and interpretation of CY 2016 results; and
- The status of IAAAP OU-8 regarding compliance with the ARARs or other federal and state benchmarks.

1.3 PROGRAM AND SITE HISTORY

The FUSRAP was executed by the U.S. Atomic Energy Commission (AEC) in 1974 to identify, remediate, or otherwise control sites at which residual radioactivity remained from operations conducted for the Manhattan Engineer District (MED). The FUSRAP was continued by the successor agencies to the AEC until 1997, when the U.S. Congress transferred responsibility for the execution aspect of the FUSRAP from the U.S. Department of Energy (DOE) to the U.S. Army Corps of Engineers (USACE).

The IAAAP is a government-owned, contractor-operated facility that occupies approximately 76,890,000 m^2 (19,000 acres) in Des Moines County near Middletown, Iowa, approximately

10 miles west of Burlington, Iowa, and the Mississippi River (Figure 1-1). The installation's mission is to load, assemble, and pack (LAP) ammunition items, including projectiles, mortar rounds, warheads, demolition charges, and munitions components such as fuses, primers, and boosters.

All IAAAP land is currently owned by and under the control of the U.S. Army. Approximately one-third of the IAAAP property is occupied by active or formerly active munitions production or storage facilities. The remaining property is generally either forested (30,350,000 m^2 [7,500 acres]) or leased for agricultural use (31,160,000 m^2 [7,700 acres]).

Since operations began in 1941, the IAAAP has used explosives and lead-based initiating compounds to produce a wide variety of ordnance items. During the summer of 1947, Mason & Hanger – Silas Mason Company Inc., the operating contractor, entered into a contract with the Ordnance Department to assist in the design and engineering, to perform the construction, and to operate a facility for the purpose of supplying the AEC with explosive components for nuclear weapons. From 1947 to 1975, the IAAAP OU-8 sites were under the control of the AEC or its successors for weapon-assembly operations. Based on IAAAP project history reports, the first nuclear weapon assembly operations are believed to have begun in 1949. Throughout the remaining years of AEC control, the IAAAP tested, assembled, conducted surveillance on, and disassembled a wide variety of nuclear weapons. Detailed descriptions and histories of the IAAAP OU-8 sites are contained in the *Iowa Army Ammunition Plant FUSRAP Remedial Investigation Report for Firing Sites Area, Yards C, E, F, G, and L, Warehouse 3-01 and Area West of Line 5B* (USACE 2008) and the ROD (USACE 2011).

1.4 CALENDAR YEAR 2016 ACTIVITIES

1.4.1 IAAAP Operable Unit 8 Calendar Year 2016 Documents

During CY 2016, the following OU-8 documents were finalized.

- *Iowa Army Ammunition Plant Operable Unit 8 Annual Environmental Monitoring Data and Analysis Report for Calendar Year 2014* (May 31); and
- *Iowa Army Ammunition Plant Operable Unit 8 Annual Environmental Monitoring Data and Analysis Report for Calendar Year 2015* (October 17).

1.4.2 IAAAP Operable Unit 8 Calendar Year 2016 Remedial Actions

During CY 2016, an RA was performed at the FS-12 Area. The RA began at the FS-12 Area in the first quarter and continued through the fourth quarter. A total of 7,243 yd^3 of soil was excavated from the IAAAP OU-8 sites, with 1,327 yd^3 of the soil stockpiled as contaminated material after sorting at the FS-12 Area.

In CY 2016, a total of 1,410 yd^3 of contaminated material from 2016 and previous years' sorting activities was transported to the M-Yard. In CY 2016, a total of 2,001 yd^3 of contaminated material, including material stockpiled at the M-Yard, was loaded on railcars and shipped offsite for disposal at Energy Solutions in Clive, Utah. At the end of CY 2016, approximately 466 yd^3 of soil stockpiled as contaminated material remained at FS-12 and no soil remained at the M-Yard.

During CY 2016, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (DOD 2000) Class 1 verifications were performed at the FS-12 Area (survey units [SUs] 10, 15, 16, 17, 18, 22, 23, 24, 25, 28, 29, 30, and 31). Verifications at the FS-12 Area were performed to confirm that the remediation goals (RGs) of the ROD were achieved.

Characterizations/pre-design investigations (PDIs) were performed at the FS-12 Area (SUs 69, 70, 71, 72, 78, 79, 80, 81, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 106, and 116).

No excavation or decontamination water was released in CY 2016. However, storm water from the M-Yard loadout area was sampled and released into an adjacent field to allow for natural infiltration. See Section 6.0 for additional information on the storm water released in CY 2016.

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2.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS EVALUATION

Section 2.8.2 of the ROD lists two ARARs that are evaluated in this EMDAR. The first ARAR, from 10 *Code of Federal Regulations [CFR]* 20.1403(b), requires that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group not exceed 25 mrem per year. The second ARAR, from 10 *CFR* 20.1101(d), requires that emissions of radioactive material to the environment, excluding radon (Rn)-222 and its daughters, be maintained so the highest individual dose to the public does not exceed 10 mrem per year. For the purposes of the CY 2016 evaluation, the critical group is the current IAAAP employee not engaged in FUSRAP RA (i.e., an employee working at FS-1 and FS-2, located approximately 1,285 m south of the FS-12 Area and approximately 521 m northwest of the M-Yard).

The evaluation for compliance with the 10 *CFR* 20.1101(d) ARAR is accomplished using the U.S. Environmental Protection Agency (USEPA) computer code CAP88-PC to determine dose from radioactive airborne emissions to members of the public located at specific distances and directions from the site. The evaluation for compliance with the 10 *CFR* 20.1403(b) ARAR is typically accomplished by calculating dose from all pathways, including radioactive airborne emissions (inhalation), ingestion, dermal contact, external gamma radiation, and radon; however, based on the location of the current site worker at FS-1 and FS-2, the ROD considers exposure from all pathways except airborne emissions to be insignificant. Therefore, both ARARs will be evaluated using only the dose from airborne emissions. Additionally, compliance with 10 *CFR* 20.1101(d) will automatically ensure compliance with 10 *CFR* 20.1403(b), because both are dose-based limits of 10 mrem per year and 25 mrem per year, respectively to the same receptor.

Exposures to potential trespassers and recreational users (e.g., hunters) are considered infrequent and insignificant, because of access restrictions to the IAAAP property, as well as the physical characteristics of each area therein.

Although not required to be followed, 40 *CFR* 61.103 (the USEPA's equivalent regulation to 10 *CFR* 20.1101(d)), Appendix E, provides a procedure to determine compliance with radioactive airborne emissions. This procedure was followed to calculate dose to the potential receptors (e.g., residential, farm, business, and school receptors), and is described in the subsequent sections.

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3.0 EVALUATION OF RADIOLOGICAL AIR MONITORING DATA

3.1 METHOD

Emission rates for the IAAAP OU-8 sites were modeled using guidance documents referenced in 40 *CFR* 61, Appendix E, *Compliance Procedures Methods for Determining Compliance with Subpart I* (USEPA 1989), and were measured by collection of environmental air samples for radioactive particles. Emission rates were input into the USEPA computer code CAP88-PC, Version 4.0.1.17, along with appropriate meteorological data and distances to receptors[1], to obtain the effective dose equivalent (EDE) from the air emissions.

Although 40 *CFR* 61.103 requires the use of the USEPA computer code COMPLY, the USEPA no longer supplies technical support for COMPLY. Because the USEPA lists both COMPLY and CAP88-PC as “Atmospheric transport models for assessing dose and risk from radioactive air emissions” (USEPA 2015), CAP88-PC was used as a comparable and conservative method to demonstrate compliance with the ARARs.

3.1.1 EMISSION RATE

The method used to determine particulate radionuclide emission rates from the IAAAP OU-8 sites was 40 *CFR* 61, Appendix D, *Methods for Estimating Radionuclide Emissions*. Emissions during excavations and waste loadout were evaluated using air sampling data at the excavation and waste loadout perimeters.

3.1.2 EFFECTIVE DOSE EQUIVALENT

The EDE to receptors[1] is obtained using the USEPA computer code CAP88-PC, Version 4.0.1.17 (USEPA 2014). CAP88-PC uses a Gaussian plume equation to estimate the dispersion of radionuclides. An area ground release at a height of 1 m is modeled for IAAAP OU-8.

The EDE is the dose from inhalation; exposures from ingestion, air immersion, and external ground surface are insignificant. CAP88-PC contains historical weather data libraries for major airports across the country, and the results can be modeled for receptors at multiple distances from the emissions source.

3.2 METEOROLOGICAL DATA

Meteorological data were obtained from CAP88-PC for the Quad City International Airport in Moline, Illinois (wind file 14923.WND). The Quad City International Airport, located 60 miles northeast of the IAAAP, is the closest airport to the IAAAP with meteorological data. Data in the file were accumulated from 1988 through 1992.

- Average Annual Wind Velocity: 4.252 m per second
- Average Annual Precipitation Rate: 103 cm per year
- Average Annual Air Temperature: 11 ºC

Wind direction frequency was obtained from the CAP88-PC wind file, 14923.WND (Table 3-1).

[1] “Receptors,” as used in this EMDAR, are the locations for the nearest residence, school, business, and farm.

Table 3-1. Quad City International Airport Wind Rose Frequency

Wind Direction		Wind Frequency	Wind Direction		Wind Frequency
Wind Toward	Wind From		Wind Toward	Wind From	
North	South	0.128	South	North	0.050
North-Northwest	South-Southeast	0.045	South-Southeast	North-Northwest	0.033
Northwest	Southeast	0.036	Southeast	Northwest	0.055
West-Northwest	East-Southeast	0.052	East-Southeast	West-Northwest	0.090
West	East	0.086	East	West	0.005
West-Southwest	East-Northeast	0.052	East-Northeast	West-Southwest	0.085
Southwest	Northeast	0.035	Northeast	Southwest	0.066
South-Southwest	North-Northeast	0.025	North-Northeast	South-Southwest	0.069

3.3 IAAAP OPERABLE UNIT 8 SITES UNDER ACTIVE REMEDIATION

3.3.1 Material Handling and Processing for Calendar Year 2016

At the IAAAP OU-8 sites in CY 2016, remedial activities were performed at the FS-12 Area, and waste loadout activities were conducted at the M-Yard. Excavated soils (7,243 yd^3) were placed at the FS-12 Area prior to treatment (i.e., soil sorting). The excavated soils were then sorted, and 1,327 yd^3 of the soils were diverted to a post-sorting contaminated soil pile. The post-sorting contaminated soil pile was covered when sorting activities were concluded. The clean soil piles were not covered. Verification data for the clean soil piles and the excavation surface are less than the RG and are thus protective of human health and the environment. Contaminated soil (1,410 yd^3) from 2016 and previous years' remedial activities was transported to the M-Yard via covered dump trucks, stockpiled, and loaded onto railcars for offsite disposal. The remaining post-sorting contaminated soil pile (466 yd^3) at the FS-12 Area will be transferred to the M-Yard and then to a licensed disposal facility at a later date. General area air samples were collected around active excavation perimeters, soil sorting activities, and loadout activities during CY 2016, with the results used to determine the site emissions. In-situ emissions from inactive areas of IAAAP OU-8 were not calculated, because the ground surface soil at the IAAAP is generally covered with vegetation that limits the potential for material to become airborne.

3.3.2 Source Description – Radionuclide Soil Concentrations

For the IAAAP OU-8 excavation area, the depleted uranium (DU) activity fractions listed in Section 2.5.7 of the ROD were used. Activity fractions for the contaminants of concern (COCs) are:

- 90.14 percent (uranium [U]-238),
- 1.45 percent (U-235), and
- 8.40 percent (U-234).

The averaged total alpha air particulate concentrations at the FS-12 Area and the M-Yard, along with the three uranium activity fractions, were used to calculate the emission rate for each area.

3.3.3 List of Assumed Air Releases for Calendar Year 2016

Wind erosion during periods of RA excavations and periods in which the excavated soil pile, post-sorting contaminated soil pile at the FS-12 Area, and loadout pile at the M-Yard were uncovered is assumed for the particulate radionuclide emission determinations from IAAAP OU-8. Verification data for post-sorting clean soil piles and non-backfilled excavation surfaces are less than the RG. Therefore, the post-sorting clean soil piles and non-backfilled excavation surfaces are protective of human health and the environment and do not contribute to the emission determinations. Unexcavated areas do not contribute to the emission determinations for periods of inactivity due to the low activity and vegetative cover.

The excavation area, the excavated soil pile, the post-sorting contaminated soil pile, and loadout pile at the M-Yard were assumed to be contributing to air releases during the 2016 dates when the SUs were open and when the sorting and loadout piles were uncovered. Appendix A, Table A-1, lists the 2016 dates of potential air releases by location.

3.3.4 Distances to Receptors

The distances to receptors are listed in Table 3-2. Distances and directions to receptors are determined by using tools in a geographic information system (GIS). The location of the receptors is shown on Figure 3-1.

Table 3-2. IAAAP Operable Unit 8 Receptors for CY 2016

Sources	Resident		Farm		Business[a]		School	
	Distance (m)	Direction	Distance (m)	Direction	Distance (m)	Direction	Distance (m)	Direction
FS-12 Area	2,714	W	2,714	W	1,285	S	7,894	NW
M-Yard	3,498	NW	3,498	NW	521	NW	9,463	NW

[a] The business receptor, an IAAAP employee at FS-1 and FS-2, is an average member of the critical group.

3.4 EMISSIONS DETERMINATION

3.4.1 Measured Airborne Radioactive Particulate Emissions

Particulate air samples were collected from several locations around the perimeter of the FS-12 Area excavation, soil sorting area, soil stockpile areas, and the M-Yard loadout area to measure the radionuclide emissions from the RA, soil sorting, and soil loadout. The samples provide the basis for determining the radionuclide emission rates during CY 2016. Air sample data for particulate air samples were determined through the use of calibrated field instruments. Appendix C, Attachment C-1, is the Air Sample Reports and Appendix C, Table C-1, is a summary table of the particulate air sample data. One or two particulate air samples per week were submitted to the USACE St. Louis District FUSRAP Radioanalytical Laboratory for analysis to verify sample results from the calibrated field instruments (see Table C-2). Results less than zero indicate the result was less than the average background value for the instrument. When calculating an average airborne concentration, negative data points were rounded to a zero value. The average gross alpha concentration (in μCi/mL) was determined for the FS-12 Area and the M-Yard for CY 2016 and is presented in Table 3-3.

Table 3-3. IAAAP Operable Unit 8 Average Gross Alpha Airborne Particulate Emissions for CY 2016

Sampler Location	Average Concentration (μCi/mL)
	Gross Alpha
FS-12 Area[a]	1.86E-14
M-Yard[b]	2.09E-15

[a] Includes the emission rates from the RA, soil sorting, and soil stockpiles.
[b] Includes the emission rates from the soil stockpile and loadout activities.

The activity fractions for DU at IAAAP OU-8 were determined as described in Section 3.3.2. The product of the DU activity fraction and the gross concentration provides the radionuclide emission concentration (in μCi/mL) for that area. The gross average concentration (in μCi/mL) is converted to a release (i.e., emission) rate, measured in Ci per year, using Equations 1 and 2.

A Guide for Determining Compliance with the Clean Air Act Standards for Radionuclide Emissions from NRC-Licensed and Non-DOE Federal Facilities (USEPA 1989) (page 3-21, [2]) provides Equation 1 for determination of the effective diameter of a non-circular stack or vent.

$$D = (1.3\ A)^{1/2} \qquad \textit{Equation 1}$$

where:

D = effective diameter of the release (in m), and
A = area of the stack, vent, or release point (in m^2).

Table 3-4 provides (1) the effective surface area available for release of airborne radionuclides normalized to 1 year for the FS-12 Area and the M-Yard and (2) the effective diameter for the FS-12 Area and the M-Yard, at which excavation and/or soil stockpiling was conducted in CY 2016. Calculation of the effective surface area is presented in Appendix A.

Table 3-4. IAAAP Operable Unit 8 Excavation Effective Areas and Effective Diameters for CY 2016

IAAAP OU-8 Location	Effective Area (m^2)	Effective Diameter (m)
FS-12 Area	6,496	92
M-Yard	303	20

The average annual wind speed for the Quad City International Airport is provided in CAP88-PC as 4.252 m per second. Conversion of this wind speed to a flow rate through stacks with the listed effective diameters for each area is completed using Equation 2.

$$F = V\ \pi\ (D)^2 / 4 \qquad \textit{Equation 2}$$

where:

F = flow rate (in m^3 per minute),
V = wind velocity (in m per second),
π = mathematical constant, and
D = effective diameter of the release determined using Equation 1 (in m).

Converting the velocity of emissions from the FS-12 Area and M-Yard to an effective flow rate results in the following site release flow rates for the IAAAP OU-8 sites, as listed in Table 3-5. The product of the flow rate, the activity fraction associated with each radionuclide, and the appropriate conversion factors provide the site emission rate for each radionuclide, as illustrated in Table 3-6. Appendix A contains flow rates and average radionuclide concentration data.

Table 3-5. IAAAP Operable Unit 8 Site Release Flow Rate for CY 2016

IAAAP OU-8 Location	Site Release Flow Rate (m^3/minute)
FS-12 Area	1.7E+06
M-Yard	7.9E+04

3.4.2 IAAAP Operable Unit 8 Total Airborne Radioactive Particulate Emission Rates

The CY 2016 emission rates for the FS-12 Area and M-Yard are presented in Table 3-6 and are based on the air samples collected from the perimeter of the excavated area, soil sorting area, and stockpiled soil.

Table 3-6. IAAAP Operable Unit 8 Airborne Radioactive Particulate Emission Rates Based on Excavation Perimeter Air Samples for CY 2016

Radionuclide	Emission Rate (Ci/year)[a]	
	FS-12 Area	M-Yard
U-238	1.5E-02	7.8E-05
U-235	2.4E-04	1.3E-06
U-234	1.4E-03	7.3E-06

[a] Emission rate based on 366-day period at a respective flow rate (as presented in Table 5-4) as determined from the average annual wind speed (4.252 m per second) and the effective site area (as presented in Table 5-3) for each location.

3.4.3 CAP88-PC Results

The CAP88-PC report is contained in Appendix B. The effective area factor input was taken from Table 3-4. The individual dose results for the FS-12 Area and the M-Yard were summed. As shown in Table 3-7, this evaluation demonstrates that all IAAAP OU-8 receptors, including the hypothetical maximally exposed individual at IAAAP OU-8 (i.e., the business receptor, an IAAAP employee at FS-1 and FS-2, who is an average member of the critical group), receive less than the dose standards prescribed in 10 *CFR* 20.1101(d) (10 mrem per year) and 10 *CFR* 20.1403(b) (25 mrem per year).

Table 3-7. IAAAP Operable Unit 8 CAP88-PC Results for Receptors for CY 2016

Source	Dose (mrem/year)			
	Resident[a]	School[b]	Business[c]	Farm[a]
FS-12 Area and M-Yard	<0.1	<0.1	<0.1	<0.1

[a] 100 percent occupancy factor.
[b] Corrected for the 23 percent occupancy factor (40 hours per week for 50 weeks per year).
[c] The business receptor, an IAAAP employee at FS-1 and FS-2, is an average member of the critical group.

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4.0 SURFACE-WATER, SEDIMENT, AND STORM-WATER MONITORING

4.1 SURFACE-WATER AND SEDIMENT MONITORING

Surface water and sediment monitoring in Long Creek and its tributary, downgradient of the FS-12 Area and running to the east and south of the FS-12 Area, was performed as a best management practice. The purpose of the monitoring was to determine if RA is having a negative effect on Long Creek.

Surface water and sediment were sampled for the uranium isotopes to evaluate/determine if runoff from the FS-12 Area affects the quality of surface water and sediment in Long Creek and its tributary. Surface water and sediment sampling was conducted during April and November of CY 2016. Grab samples were collected and analyzed according to the protocol defined in Appendix D of the *Remedial Investigation Work Plan for Line 1, Firing Sites Area, Yards C, G, and L, Warehouse 3-01 and the West Burn Pads Area South of the Road* (RI WP) (USACE 2007).

The sampling events were conducted at 10 monitoring stations. Eight (8) of the stations were established in 2007 during the remedial investigation, and the remaining 2 stations (IAAP177509 and IAAP177517) were established in December 2014. Locations of the 10 surface-water and sediment monitoring stations are shown on Figure 4-1.

4.2 SURFACE-WATER MONITORING RESULTS

The radiological monitoring results for the CY 2016 surface-water sampling events are summarized in Table 4-1. FUSRAP surface-water monitoring analysis included unfiltered water samples for radionuclides associated with DU (i.e., U-234, U-235, and U-238). The monitoring results are presented in Appendix D, Table D-1, of this EMDAR.

Table 4-1. Radiological Results for CY 2016 Surface-Water Monitoring

Monitoring Station	Collection Date	Monitoring Parameters (pCi/L)		
		U-234	U-235	U-238
IAAP100153	04/18/16	0.64	0.63[a]	0.30
IAAP100153	11/14/16	1.28	0.20[a]	0.91
IAAP100154	04/19/16	0.48[a]	0.22[a]	0.52
IAAP100154	11/15/16	0.83	0.23[a]	1.07
IAAP100155	04/19/16	0.71[a]	0.23[a]	0.42[a]
IAAP100155	11/15/16	0.62	0.24[a]	0.44[a]
IAAP100164	04/20/16	0.37	0.19[a]	0.45
IAAP100164	11/15/16	[b]	[b]	[b]
IAAP100165	04/20/16	0.61[a]	0.48[a]	0.68
IAAP100165	11/15/16	0.74	0.25[a]	0.20[a]
IAAP100178	04/19/16	0.60	0.22[a]	0.49
IAAP100178	11/15/16	0.42[a]	0.52[a]	0.80
IAAP100180	04/20/16	0.62	0.24[a]	0.58
IAAP100180	11/15/16	0.35[a]	0.20[a]	0.35[a]
IAAP100187	04/20/16	0.43	0.21[a]	0.43
IAAP100187	11/16/16	0.39	0.71[a]	0.29
IAAP177509	04/19/16	0.43[a]	0.24[a]	0.19[a]
IAAP177509	11/16/16	1.06	0.20[a]	0.72
IAAP177517	04/19/16	0.47	0.65[a]	0.68
IAAP177517	11/14/16	0.93	0.57[a]	0.50

[a] Reported result is less than the minimum detectable concentration (MDC) and is therefore set equal to the MDC.
[b] No surface water was present at the sample location due to seasonal weather conditions. No surface water sample was collected.

The historical radiological surface water monitoring data for all monitoring stations is summarized in Table 4-2.

Table 4-2. Comparison of Historical Radiological Surface-Water Results

Stations	Radionuclide	Units	December 2014	August 2015	December 2015	April 2016	November 2016
IAAP100153	U-234	pCi/L	0.20[a]	0.22[a]	0.44[a]	0.64	1.28
	U-235	pCi/L	0.64	0.33	0.38	0.63[a]	0.20[a]
	U-238	pCi/L	0.95	0.54[a]	0.70	0.30	0.91
IAAP100154	U-234	pCi/L	0.14[a]	0.22[a]	0.47[a]	0.48[a]	0.83
	U-235	pCi/L	0.34	0.75	0.54[a]	0.22[a]	0.23[a]
	U-238	pCi/L	1.12	0.72	0.31[a]	0.52	1.07
IAAP100155	U-234	pCi/L	0.16[a]	0.58[a]	0.47[a]	0.71[a]	0.62
	U-235	pCi/L	1.44	0.64	0.13[a]	0.23[a]	0.24[a]
	U-238	pCi/L	0.68	0.16[a]	0.45	0.42[a]	0.44[a]
IAAP100164	U-234	pCi/L	0.16[a]	0.59[a]	0.17[a]	0.37	[b]
	U-235	pCi/L	0.58	0.16[a]	0.36	0.19[a]	[b]
	U-238	pCi/L	0.39	0.36	0.67	0.45	[b]
IAAP100165	U-234	pCi/L	0.15[a]	0.39[a]	0.42[a]	0.61[a]	0.74
	U-235	pCi/L	0.37[a]	0.13[a]	0.41	0.48[a]	0.25[a]
	U-238	pCi/L	0.77	0.36	0.42	0.68	0.20[a]
IAAP100178	U-234	pCi/L	0.16[a]	0.20[a]	0.15[a]	0.60	0.42[a]
	U-235	pCi/L	0.43	0.38[a]	0.40	0.22[a]	0.52[a]
	U-238	pCi/L	1.07	0.52	0.34[a]	0.49	0.80
IAAP100180	U-234	pCi/L	0.20[a]	0.55[a]	0.52[a]	0.62	0.35[a]
	U-235	pCi/L	0.48[a]	0.33	0.42	0.24[a]	0.20[a]
	U-238	pCi/L	0.90	1.79	0.48	0.58	0.35[a]
IAAP100187	U-234	pCi/L	0.17[a]	0.21[a]	0.19[a]	0.43	0.39
	U-235	pCi/L	0.43	1.17	0.29	0.21[a]	0.71[a]
	U-238	pCi/L	0.71	0.54[a]	0.63	0.43	0.29
IAAP177509	U-234	pCi/L	0.16[a]	0.22[a]	0.17[a]	0.43[a]	1.06
	U-235	pCi/L	0.52	0.43[a]	0.51	0.24[a]	0.20[a]
	U-238	pCi/L	0.20[a]	0.22[a]	0.44[a]	0.19[a]	0.72
IAAP177517	U-234	pCi/L	0.64	0.33	0.38	0.47	0.93
	U-235	pCi/L	0.95	0.54[a]	0.70	0.65[a]	0.57[a]
	U-238	pCi/L	0.14[a]	0.22[a]	0.47[a]	0.68	0.50

[a] Reported result is less than the MDC and is therefore set equal to the MDC.
[b] No surface water was present at the sample location due to seasonal weather conditions. No surface water sample was collected.

4.3 SEDIMENT MONITORING RESULTS

Sediment samples were collected in depositional environments near each of the 10 previously described surface-water locations (Figure 4-1). Sediment samples were evaluated for the radiological constituents associated with DU (i.e., U-234, U-235, and U-238).

The radiological results for CY 2016 sediment sampling events are presented in Table 4-3. The ROD (USACE 2011) established a soil RG for DU which uses U-238 as a surrogate. Therefore, sediment sampling results for U-238 were compared against the corresponding soil RG of 150 pCi/g. The analytical results from these monitoring activities are presented in Appendix D, Table D-2, of this EMDAR.

Table 4-3. Radiological Results for CY 2016 Sediment Monitoring

Monitoring Station	Collection Date	Monitoring Parameters (pCi/g)		
		U-234	U-235	U-238
IAAP100153	04/18/16	0.99	0.17[a]	0.85
IAAP100153	11/14/16	0.42	0.21[a]	0.31[a]
IAAP100154	04/19/16	0.82	0.36[a]	1.08
IAAP100154	11/15/16	0.36[a]	0.44[a]	0.75
IAAP100155	04/19/16	0.76	0.18[a]	0.86
IAAP100155	11/15/16	0.40	0.20[a]	0.30[a]
IAAP100164	04/19/16	0.74	0.14[a]	0.47
IAAP100164	11/15/16	0.52	0.40[a]	0.84
IAAP100165	04/20/16	0.38	0.26[a]	0.41
IAAP100165	11/15/16	0.26	0.33[a]	0.35
IAAP100178	04/19/16	0.62	0.15[a]	0.18
IAAP100178	11/15/16	0.39	0.19[a]	0.29
IAAP100180	04/20/16	0.31[a]	0.21[a]	0.49
IAAP100180	11/15/16	0.40	0.28[a]	0.39
IAAP100187	04/20/16	0.29[a]	0.27[a]	0.25
IAAP100187	11/16/16	0.58	0.15[a]	0.31
IAAP177509	04/19/16	0.32[a]	0.21[a]	0.81
IAAP177509	11/16/16	0.39	0.17[a]	0.25
IAAP177517	04/19/16	0.32	0.16[a]	0.28
IAAP177517	11/14/16	0.47	0.16[a]	0.28[a]

[a] Reported result is less than the MDC and is therefore set equal to the MDC.

All sediment monitoring results for U-238 were below the RG established in the ROD. The historical radiological sediment monitoring data for all monitoring stations is summarized in Table 4-4.

Table 4-4. Comparison of Historical Radiological Sediment Results

Stations	Radionuclide	Units	April 2007	December 2014	August 2015	December 2015	April 2016	November 2016
IAAP100153	U-234	pCi/g	[a]	0.56	0.51	0.43	0.99	0.42
	U-235	pCi/g	0.11[b]	0.05[b]	0.58[b]	0.13[b]	0.17[b]	0.21[b]
	U-238	pCi/g	0.50	0.43	1.00	0.20[b]	0.85	0.31[b]
IAAP100154	U-234	pCi/g	[a]	0.37	0.53[b]	0.46	0.82	0.36[b]
	U-235	pCi/g	0.17[b]	0.13[b]	0.55[b]	0.28[b]	0.36[b]	0.44[b]
	U-238	pCi/g	0.49	0.50	0.44[b]	0.45	1.08	0.75
IAAP100155	U-234	pCi/g	[a]	0.19	0.61[b]	0.61	0.76	0.40
	U-235	pCi/g	0.17[b]	0.12[b]	0.61[b]	0.24[b]	0.18[b]	0.20[b]
	U-238	pCi/g	0.37	0.24	0.49	0.83	0.86	0.30[b]
IAAP100164	U-234	pCi/g	[a]	0.79	0.52[b]	0.94	0.74	0.52
	U-235	pCi/g	0.22[b]	0.12[b]	0.57[b]	0.33[b]	0.14[b]	0.40[b]
	U-238	pCi/g	0.87	0.84	0.59	1.01	0.47	0.84
IAAP100165	U-234	pCi/g	[a]	0.17	0.20[b]	0.59	0.38	0.26
	U-235	pCi/g	0.13[b]	0.05[b]	0.24[b]	0.37[b]	0.26[b]	0.33[b]
	U-238	pCi/g	0.29	0.14	0.43	1.07	0.41	0.35
IAAP100178	U-234	pCi/g	[a]	0.33	0.53	0.30[b]	0.62	0.39
	U-235	pCi/g	0.11[b]	0.13[b]	0.49[b]	0.17[b]	0.15[b]	0.19[b]
	U-238	pCi/g	0.23[b]	0.37	0.33	0.30[b]	0.18	0.29
IAAP100180	U-234	pCi/g	[a]	0.26	0.23[b]	0.39	0.31[b]	0.40
	U-235	pCi/g	0.16[b]	0.13[b]	0.52[b]	0.27[b]	0.21[b]	0.28[b]
	U-238	pCi/g	0.41	0.19	0.23[b]	0.59	0.49	0.39

Table 4-4. Comparison of Historical Radiological Sediment Results (Continued)

Stations	Radionuclide	Units	April 2007	December 2014	August 2015	December 2015	April 2016	November 2016
IAAP100187	U-234	pCi/g	[a]	0.34	0.39	0.34	0.29[b]	0.58
	U-235	pCi/g	0.14[b]	0.16[b]	0.36[b]	0.27[b]	0.27[b]	0.15[b]
	U-238	pCi/g	0.30	0.37	0.29[b]	0.64	0.25	0.31
IAAP177509[c]	U-234	pCi/g	[d]	0.17	0.14[b]	0.62	0.32[b]	0.39
	U-235	pCi/g	[d]	0.04[b]	0.33[b]	0.15[b]	0.21[b]	0.17[b]
	U-238	pCi/g	[d]	0.27	0.32[b]	0.68	0.81	0.25
IAAP177517[c]	U-234	pCi/g	[d]	0.27	0.41	0.40	0.32	0.47
	U-235	pCi/g	[d]	0.04[b]	0.23[b]	0.17[b]	0.16[b]	0.16[b]
	U-238	pCi/g	[d]	0.18	0.41	0.54	0.28	0.28[b]

[a] Sample was not analyzed for U-234.
[b] Reported result is less than the MDC and is therefore set equal to the MDC.
[c] Stations IAAP177509 and IAAP177517 were established and initially sampled in December 2014.
[d] Sample not collected in 2007.

4.4 STORM-WATER MONITORING

Storm-water monitoring was performed at the M-Yard to determine if the loadout pile was having an effect on storm water.

The bermed contaminated soil staging area is located at the M-Yard to contain water that contacted the loadout pile prior to transfer to railcars. Storm-water collects and ponds inside the staging area. The storm-water from CY 2015 was pumped from the staging area into a frac tank, sampled for uranium isotopes, and stored until CY 2016. Upon receipt and analysis of the sample results, approximately 20,000 gallons of storm-water stored in the frac tank was discharged and/or pumped into an adjacent field to allow for natural infiltration on August, 17, 2016. An additional 34,000 gallons of storm-water from CY 2016 that collected in the staging area was discharged and/or pumped to the adjacent field to allow for natural infiltration in August and September 2016. At the end of CY 2016, a drainage pipe was installed in the northwest corner of the staging area as a more permanent solution to the storm water that collects and ponds in the staging area. The location of the staging area is shown on Figure 4-1.

4.5 STORM-WATER MONITORING RESULTS

The radiological monitoring results for the CY 2016 storm-water sampling event are summarized in Table 4-5. Storm-water monitoring analysis included unfiltered water samples for radionuclides associated with DU (i.e., U-234, U-235, and U-238). The monitoring results are presented in Appendix D, Table D-3, of this EMDAR.

Table 4-5. Radiological Results for CY 2016 Storm-Water Monitoring

Monitoring Station	Collection Date	Monitoring Parameters (pCi/L)		
		U-234	U-235	U-238
M-Yard	11/20/15[a]	1.31	0.54	5.66

[a] Sample collected in 2015 but released on 08/17/16.

4.6 CONCLUSION

No excessive short-term increase of DU concentrations in IAAAP surface water, sediment, or storm-water was observed; therefore, the RA at the FS-12 Area and the stockpiling and loadout of soil at the M-Yard did not adversely IAAAP surface water, sediment, or storm-water.

5.0 ENVIRONMENTAL QUALITY ASSURANCE PROGRAM

5.1 PROGRAM OVERVIEW

The environmental quality assurance (QA) program includes management of the QA/quality control (QC) programs, plans, and procedures governing environmental monitoring activities at the IAAAP and at a USACE subcontracted vendor QA laboratory. This section describes the environmental monitoring standards of the FUSRAP and the goals for these programs, plans, and procedures.

The environmental QA program provides the FUSRAP with reliable, accurate, and precise monitoring data. The program furnishes guidance and directives to detect and prevent problems from the time a sample is collected until the associated data are evaluated.

Key elements in achieving the goals of this program are personnel training; compliance assessments; use of QC samples; documentation of field activities and laboratory analyses; and a review of data documents for precision, accuracy, and completeness.

General objectives are to:

- Provide data of sufficient quality and quantity to support ongoing remedial efforts.
- Ensure samples were collected using approved techniques and are representative of existing site conditions.

5.2 QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan (QAPP) for environmental monitoring activities performed at the IAAAP OU-8 sites is contained in Appendix D of the RI WP (USACE 2007). The QAPP provides the organization, objectives, functional activities, and specific QA/QC activities associated with environmental monitoring activities at the IAAAP OU-8 sites.

QA/QC procedures are performed in accordance with applicable professional technical standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. The QAPP was prepared in accordance with USEPA and USACE guidance documents, including *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (USEPA 1991), *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (USEPA 1994), and Engineer Manual (EM) 200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001).

The QAPP summarizes standard operating procedures (SOPs) and data quality requirements for collecting and analyzing environmental data. The QAPP integrates protocols and methodologies identified under various USACE and regulatory guidance. It describes administrative procedures for managing environmental data and governs sampling plan preparation; data review, evaluation, and validation; database administration; and data archiving.

5.3 FIELD SAMPLE COLLECTION AND MEASUREMENT

Prior to beginning field sampling, field personnel were trained, as necessary, and participated in a project-specific readiness review. These activities ensured that standard procedures were followed in sample collection and in completion of field logbooks, chain-of-custody forms, labels, and custody seals. Documentation of training and readiness were submitted to the project file.

The master field investigation documents are the site field logbooks. The primary purpose of these documents is to record daily field activities; personnel on each sampling team; and any administrative occurrences, conditions, or activities that may have affected the fieldwork or data quality of any environmental samples for a given day. Guidance for documenting specific types of field sampling activities in field logbooks or log sheets is contained in Appendix C of *Requirements for the Preparation of Sampling and Analysis Plans*, EM 200-1-3 (USACE 2001).

At any point in the process of sample collection or data and document review, a non-conformance report may be initiated if non-conformances are identified (Leidos 2015a). Data entered into the database may be flagged accordingly.

5.4 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of both field and laboratory activities were conducted to verify that sampling and analysis activities were performed in accordance with the procedures established in the QAPP.

5.4.1 Field Assessments

Internal assessments (i.e., audit or surveillance) of field activities (i.e., sampling and measurements) were conducted by the QA/QC Officer (or designee) for the FUSRAP. Assessments included an examination of field sampling records, field instrument operating records, sample collection, handling and packaging procedures, maintenance of QA procedures, and chain-of-custody forms. These assessments occurred at the onset of the project to verify that all established procedures were followed (system audits).

Performance assessments followed the system audits to ensure that deficiencies had been corrected and to verify that QA practices/procedures were being maintained throughout the duration of the project. These assessments involved reviewing field measurement records, instrumentation calibration records, and sample documentation.

External assessments may be conducted at the discretion of the USACE, USEPA Region 7, or the State of Iowa.

5.4.2 Laboratory Audits

The USACE St. Louis FUSRAP laboratory is subject to periodic review(s) by the local USACE Chemist (system audits) to demonstrate compliance with the *Department of Defense (DoD)/Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (QSM) (DOD and DOE 2013). In conjunction, the USACE St. Louis FUSRAP laboratory participates in blind, third-party performance evaluation studies (performance audits) at least twice per year, with results reported to the local USACE point(s) of contact. In addition, contract laboratories are required to be accredited under the U.S. Department of Defense (DOD) Environmental Laboratory Accreditation Program (ELAP). The DOD ELAP requires an annual audit and re-accreditation every 3 years.

System audits include examining laboratory documentation of sample receipt, sample log-in, sample storage, chain-of-custody procedures, sample preparation and analysis, and instrument operating records. Performance audits consist of USACE laboratories receiving performance evaluation samples from an outside vendor for an ongoing assessment of laboratory precision and accuracy. The analytical results of the analysis of performance evaluation samples are evaluated by USACE Hazardous, Toxic, and Radioactive Waste – Center of Expertise and/or a local oversight chemist to ensure that laboratories maintain acceptable performance.

Internal performance and system audits of laboratories were conducted by the Laboratory QA Manager as directed in the *Laboratory Quality Assurance Plan for the FUSRAP St. Louis Radiological Laboratory* (USACE 2013). Internal system audits included an examination of laboratory documentation of sample receipt, sample log-in, sample storage, chain-of-custody procedures, sample preparation and analysis, and instrument operating records against the requirements of the laboratory SOPs. Internal performance audits were also conducted on a regular basis. Single-blind performance samples were prepared along with project samples and submitted to the laboratory for analysis. The Laboratory QA Manager evaluated the analytical results of these single-blind performance samples to ensure that the laboratory maintained acceptable performance. Quarterly QA/QC reports are generated and provided to the local USACE authority; these reports document the ongoing QC elements and allow further monitoring of quality processes/status. In addition, QA plans and methodology are to follow the guidance presented in the QSM (DOD and DOE 2013).

5.5 SUBCONTRACTED LABORATORY PROGRAMS

All samples collected during environmental monitoring activities were analyzed by USACE-approved laboratories. The QA samples collected for surface water and sediment was analyzed by the designated USACE-subcontracted QA laboratory. The laboratory supporting this work maintained statements of qualifications, including organizational structure, QA manual, and SOPs. Additionally, the subcontracted laboratory is an accredited laboratory under the DOD ELAP.

Samples collected during these investigations were analyzed by the USEPA methods contained in *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846*, Third Edition (USEPA 1993), and by other documented USEPA or nationally recognized methods. Laboratory SOPs are based on USEPA SW-846 methods.

5.6 QUALITY ASSURANCE AND QUALITY CONTROL SAMPLES

The QA/QC samples were analyzed for the purpose of assessing the quality of the sampling effort and the reported analytical data. The QA/QC samples include duplicate samples (–1) and split samples (–2). The equations utilized for accuracy and precision are presented in Section 5.8.

5.6.1 Duplicate Samples

These samples, which measure precision, were collected by the sampling teams and were submitted for analysis to the USACE St. Louis FUSRAP laboratory. The purpose of these samples is to provide activity-specific, field-originated information regarding the homogeneity of the sampled matrix and the consistency of the sampling effort. These samples were collected concurrently with the primary environmental samples and equally represent the medium at a given time and location. Duplicate samples were collected from each medium addressed by this project and were submitted to the USACE St. Louis FUSRAP laboratory for analysis. One duplicate sample was collected for approximately every 20 field samples of each matrix and analyte. Precision is measured by the relative percent difference (RPD) or the normalized absolute difference (NAD) for radiological analyses.

The RPDs and NADs for radiological analyses are presented in Tables 5-1 and 5-2. The overall precision for CY 2016 environmental monitoring sampling activities was acceptable. See Section 5.8 for the evaluation process.

Table 5-1. Radiological Duplicate Sample Alpha Analysis for CY 2016 – Surface Water

Surface Water Sample Name	U-234[a]		U-235[a]		U-238[a]	
	RPD	NAD	RPD	NAD	RPD	NAD
IAAP187912 / IAAP187912-1	4.28	NA	NC	NA	11.99	NA

a RPD criterion for water matrix samples is less than or equal to 30 percent. If the RPD is greater than 30 percent, then the NAD shall be less than or equal to 1.96 to remain within the control limits.
-1 Sample Duplicate
NA Not applicable; see RPD.
NC Not calculated due to one or both concentrations being below MDCs.

Table 5-2. Radiological Duplicate Sample Alpha Analysis for CY 2016 – Sediment

Sediment Sample Name	U-234[a]		U-235[a]		U-238[a]	
	RPD	NAD	RPD	NAD	RPD	NAD
IAAP193759 / IAAP193759-1	68.34	0.61	NC	NA	35.71	NA

a RPD criterion for solid matrix samples is less than or equal to 50 percent. If the RPD is greater than 50 percent, then the NAD shall be less than or equal to 1.96 to remain within the control limits.
-1 Sample Duplicate
NA Not applicable; see RPD.
NC Not calculated due to one or both concentrations being below MDCs.

5.6.2 Split Samples

Split samples measure accuracy and were collected by the sampling team and sent to a USACE-subcontracted QA laboratory for analysis to provide an independent assessment of contractor and subcontractor laboratory performance. One split sample was collected for approximately every 20 field samples of each matrix for radiological analytes.

The RPDs and NADs for radiological analyses are presented in Tables 5-3 and 5-4. The overall accuracy for the CY 2016 environmental monitoring sampling activities was acceptable. See Section 5.8 for the evaluation process.

Table 5-3. Radiological Split Sample Alpha Analysis for CY 2016 – Surface Water

Surface Water Sample Name	U-234[a]		U-235[a]		U-238[a]	
	RPD	NAD	RPD	NAD	RPD	NAD
IAAP187912 / IAAP187912-2	46.38	0.47	NC	NA	32.74	0.33

a RPD criterion for water matrix samples is less than or equal to 30 percent. If the RPD is greater than 30 percent, then the NAD shall be less than or equal to 1.96 to remain within the control limits.
-2 Sample Split
NA Not applicable; see RPD.
NC Not calculated due to one or both concentrations being below MDCs.

Table 5-4. Radiological Split Sample Alpha Analysis for CY 2016 – Sediment

Sediment Sample Name	U-234[a]		U-235[a]		U-238[a]	
	RPD	NAD	RPD	NAD	RPD	NAD
IAAP193759 / IAAP193759-2	12.15	NA	NC	NA	47.45	NA

a RPD criterion for solid matrix samples is less than or equal to 50 percent. If the RPD is greater than 50 percent, then the NAD shall be less than or equal to 1.96 to remain within the control limits.
-2 Sample Split
NA Not applicable; see RPD.
NC Not calculated due to one or both concentrations being below MDCs.

5.6.3 Equipment Rinsate Blanks

Equipment rinsate blank samples are typically taken from the rinsate water collected from equipment decontamination activities. These samples consist of analyte-free water that has been rinsed over sampling equipment for the purposes of evaluating the effectiveness of equipment decontamination.

Sediment samples are collected from each station using a clean sampling spoon. These spoons are segregated after use and decontaminated according to Field Technical Procedure 400, “Equipment Decontamination” (Leidos 2015b). Because the process of collecting sediment occurs below the surface of the water, a rinsate blank would not represent the wetted surface of the sampling spoon at the time of sample collection and, therefore, would not apply. The surface water samples are collected using new nitrile gloves and new laboratory sample containers. Equipment rinsate blanks for these samples are also not required, because no potential for contamination exists.

5.7 DATA REVIEW, EVALUATION, AND VALIDATION

All data packages received from the analytical laboratory were reviewed and either evaluated or validated by data management personnel. Data validation is the systematic process of ensuring that the precision and accuracy of the analytical data are adequate for their intended use. Validation was performed in accordance with *Data Verification and Validation* (Leidos 2015c), and/or with project-specific guidelines. General chemical data quality management guidance found in Engineer Regulation (ER)-1110-1-263 (USACE 1998b) was also used when planning for chemical data management and evaluation. Additional details of data review, evaluation, and validation are provided in the *FUSRAP Laboratory Data Management Process for the St. Louis Site* (USACE 1999b). Data assessment guidance to determine the usability of data from hazardous, toxic and radioactive waste projects is provided in EM-200-1-6 (USACE 1997)

One hundred (100) percent of the data generated from all analytical laboratories was independently reviewed and either evaluated or validated. The data review process documents the possible effects on the data from various QC failures; it does not determine data usability, nor does it include assignment of data validation qualifier (VQ) flags. The data evaluation process uses the results of the data review to determine the usability of the data. The process of data evaluation summarizes the potential effects of QA/QC failures on the data, and the USACE District Chemist or District Health Physicist assesses their impact on the attainment of the project-specific data quality objectives (DQOs). Consistent with the data quality requirements, as defined in the DQOs, approximately 10 percent of all project data were validated.

5.8 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, COMPLETENESS, AND SENSITIVITY

The data evaluation process considers precision, accuracy, representativeness, completeness, comparability, and sensitivity. The following subsections detail the particular parameters and the data evaluation method for each.

Accuracy and precision can be measured by the RPD or the NAD using the following equations:

$$RPD = \left(\frac{[S - D]}{\frac{S + D}{2}} \right) x\ 100$$

$$NAD = \frac{|S - D|}{\sqrt{U_S^2 + U_D^2}}$$

where:

- S = Parent Sample Result
- D = Duplicate/Split Sample Result
- U_S = Parent Sample Uncertainty
- U_D = Duplicate/Split Sample Uncertainty

The RPD is calculated for all samples for which a detectable result is reported for both the parent and the QA field split or field duplicate. For surface water radiological samples, when the RPD is greater than 30 percent, the NAD is used to determine the accuracy or precision of the method. The RPD criterion for sediment samples is equal to 50 percent. NAD accounts for uncertainty in the results; RPD does not. The NAD should be equal to or less than a value of 1.96. Neither equation is used when the analyte in one or both of the samples is not detected. In cases in which neither equation can be used, the comparison is counted as acceptable in the overall number of comparisons.

Precision is a measure of mutual agreement among individual measurements performed under the same laboratory controls. To evaluate for precision, a field duplicate is submitted to the same laboratory as the original sample to be analyzed under the same laboratory conditions.

The RPD and NAD between the two results was calculated and used as an indication of the precision of the analyses performed (Tables 5-1 and 5-2). Sample collection precision was evaluated in the laboratory by the analyses of duplicates. The overall precision for the CY 2016 environmental monitoring sampling activities was acceptable.

Accuracy provides a gauge or measure of the agreement between an observed result and the true value for an analysis. The RPD and NAD between the two results was calculated and used as an indication of the accuracy of the analyses performed (Tables 5-3 and 5-4). For this EMDAR, accuracy is evaluated through the use of the field split samples through a comparison of the prime laboratory results versus the results of an independent laboratory. The overall accuracy for CY 2016 environmental monitoring sampling activities was acceptable.

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that depends upon the proper design of the sampling program and proper laboratory protocols. Representativeness is satisfied through proper design of the sampling network, use of proper sampling techniques, following proper analytical procedures, and not exceeding holding times of the samples.

Representativeness was determined by assessing the combined aspects of the QA program, QC measures, and data evaluations. The sampling protocol from the RI WP QAPP was followed, and analytical procedures were conducted in accordance with the QAPP. The overall representativeness of the CY 2016 environmental monitoring sampling activities was acceptable for the media and sampling described in this EMDAR.

Comparability expresses the confidence with which one dataset can be compared with another. The extent to which analytical data will be comparable depends upon the similarity of sampling and analytical methods, as well as sample-to-sample and historical comparability. Standardized and consistent procedures used to obtain analytical data are expected to provide comparable results. Some sample media (e.g., radiological monitoring) have values that are primarily useful in the present, thus the comparison to historical data is not as relevant. The overall comparability of the applicable environmental monitoring sampling data met the project DQOs.

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under normal conditions. Laboratories are expected to provide data meeting QC acceptance criteria for all samples tested. For the CY 2016 environmental monitoring sampling activities, the data completeness was 100 percent (the FUSRAP DQO for completeness is 90 percent).

Sensitivity is the determination of minimum detectable concentration (MDC) values that allows the investigation to assess the relative confidence that can be placed in an analytical result in comparison to the magnitude or level of analyte concentration observed. For this report, MDC is a term generically used to represent the minimum detectable activity (MDA) for radiological analytes. The closer a measured value to the MDC, the less confidence and more variation the measurement will have. Project sensitivity goals were expressed as quantitation level goals in the RI WP QAPP. These levels were achieved or exceeded throughout the analytical process.

The MDC is reported for each result obtained by laboratory analysis. These very low MDCs are achieved through the use of alpha spectroscopy. Variations in MDCs for the same radiological analyte reflect variability in the detection efficiencies and conversion factors due to factors such as individual sample aliquot, sample density, and variations in analyte background radioactivity for alpha spectroscopy at the laboratory. In order to complete the data evaluation (i.e. precision, accuracy, representativeness, and comparability), analytical results that exceed the MDC of the analyte are desired.

5.9 DATA QUALITY ASSESSMENT SUMMARY

The overall quality of the data meets the established project objectives. Through proper implementation of the project data review, evaluation, validation, and assessment process, project information has been determined to be acceptable for use.

Data, as presented, have been qualified as usable, but estimated when necessary. Data that have been estimated have concentrations/activities that are below the quantitation limit or are indicative of accuracy, precision, or sensitivity less than desired but adequate for interpretation.

These data can withstand scientific scrutiny, are appropriate for the intended purpose, and are technically defensible. The environmental information presented has an established confidence, which allows utilization for the project objectives and provides data for future needs.

5.10 RESULTS FOR PARENT SAMPLES AND THE ASSOCIATED DUPLICATE AND SPLIT SAMPLES

A summary of the QA parent sample results and associated duplicate and/or split sample results are presented in Tables 5-5 and 5-6.

Table 5-5. Radiological Parent Samples and Associated Duplicate and Split Samples for CY 2016 – Surface Water

Surface Water Sample Name[a]	U-234[b,c]				U-235[b,c]				U-238[b,c]			
	Result	Error	MDC	VQ	Result	Error	MDC	VQ	Result	Error	MDC	VQ
IAAP187912	0.60	0.44	0.49	J	0.16	0.23	0.22	UJ	0.49	0.39	0.40	J
IAAP187912-1	0.62	0.46	0.58	J	0.04	0.17	0.46	UJ	0.56	0.38	0.17	J
IAAP187912-2	0.37	0.18	0.12	=	0.05	0.07	0.8	UJ	0.36	0.18	0.10	J

[a] Samples ending in "-1" are duplicate samples. Samples ending in "-2" are split samples.
[b] Results are expressed in pCi/L.
[c] Results from alpha spectroscopy.
VQ symbols indicate: "=" for positively identified results, "U" for not detected, "J" for analyte was identified as estimated quantity, and "UJ" for analyte was not detected and had QC deficiencies.

Table 5-6. Radiological Parent Samples and Associated Duplicate and Split Samples for CY 2016 – Sediment

Sediment Sample Name[a]	U-234[b,c]				U-235[b,c]				U-238[b,c]			
	Result	Error	MDC	VQ	Result	Error	MDC	VQ	Result	Error	MDC	VQ
IAAP193759	0.26	0.24	0.14	J	-0.02	0.03	0.33	UJ	0.35	0.29	0.26	J
IAAP193759-1	0.53	0.37	0.35	J	-0.03	0.05	0.39	UJ	0.51	0.35	0.26	J
IAAP193759-2	0.23	0.12	0.11	=	0.03	0.04	0.07	UJ	0.22	0.11	0.10	J

[a] Samples ending in "-1" are duplicate samples. Samples ending in "-2" are split samples.
[b] Results are expressed in pCi/g.
[c] Results from alpha spectroscopy.
VQ symbols indicate: "=" for positively identified results, "U" for not detected, "J" for analyte was identified as estimated quantity, and "UJ" for analyte was not detected and had QC deficiencies.

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40 *CFR* 61, Appendix E. *Compliance Procedures Methods for Determining Compliance with Subpart I.*

FIGURES

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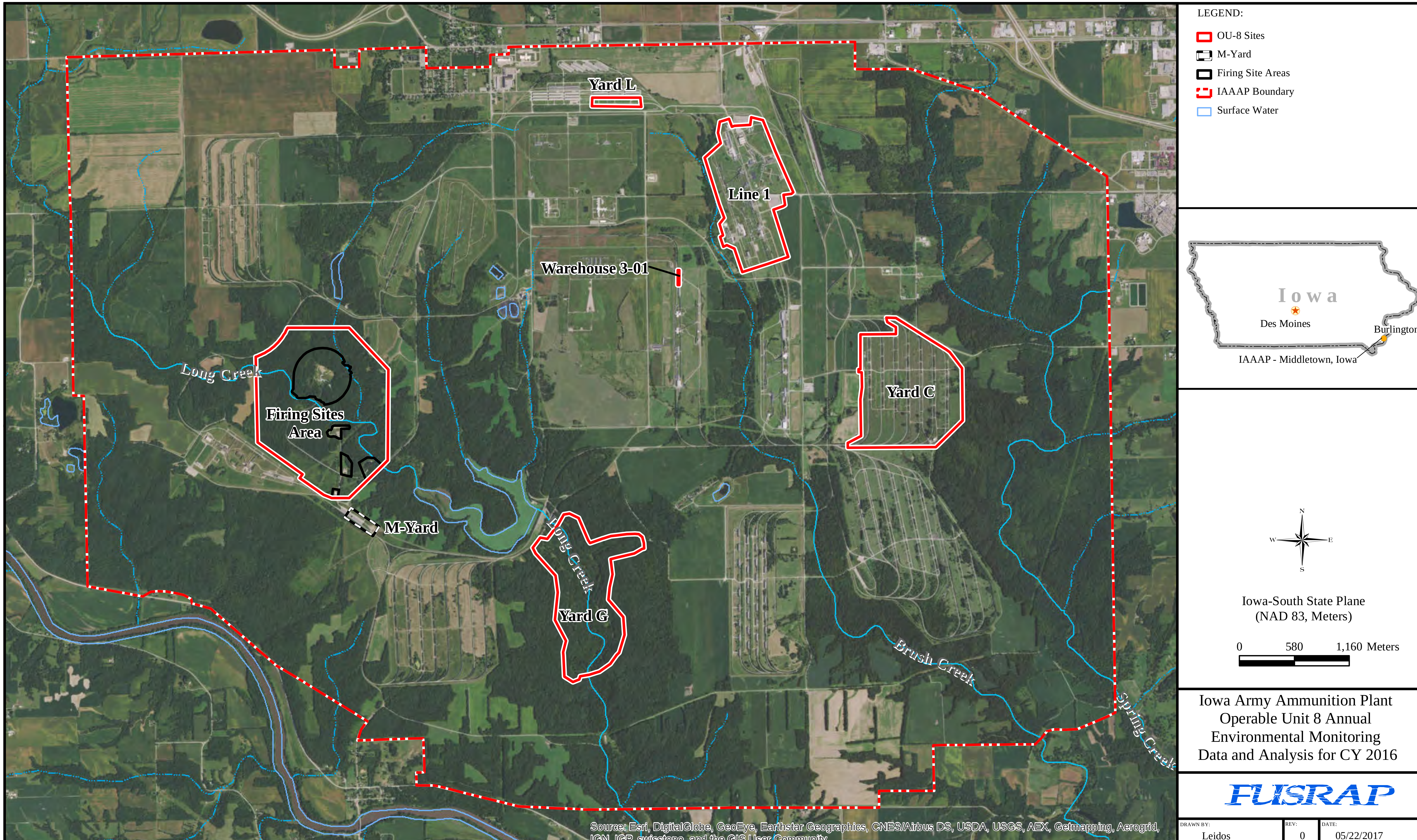
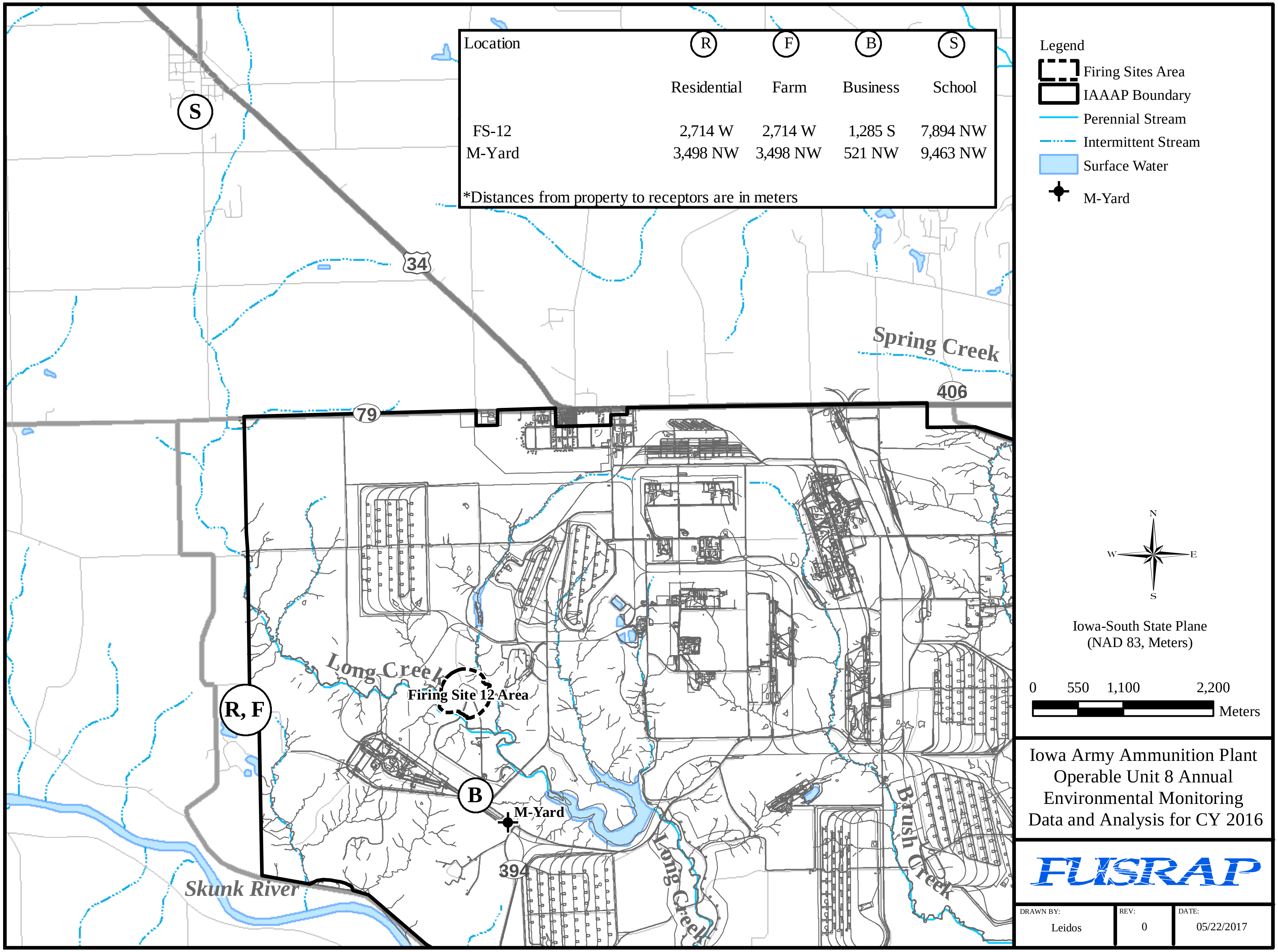


Figure 1-1.
FUSRAP Areas at the IAAAP



Location	(R) Residential	(F) Farm	(B) Business	(S) School
FS-12	2,714 W	2,714 W	1,285 S	7,894 NW
M-Yard	3,498 NW	3,498 NW	521 NW	9,463 NW

*Distances from property to receptors are in meters

Path: U:\GPS\IAAAP\FS12\Projects\Verification\Projects\EMDAR\Figure 3-1 FS-12 EMDAR (Letter).mxd

Figure 3-1. IAAAP
Firing Sites Area Critical Receptors

Path: U:\GPS\IAAAP\FS12\Projects\Verification\Projects\EMDAR\Figure 4-1 Firing Sites Sediment Sample Locations Emdar.mxd

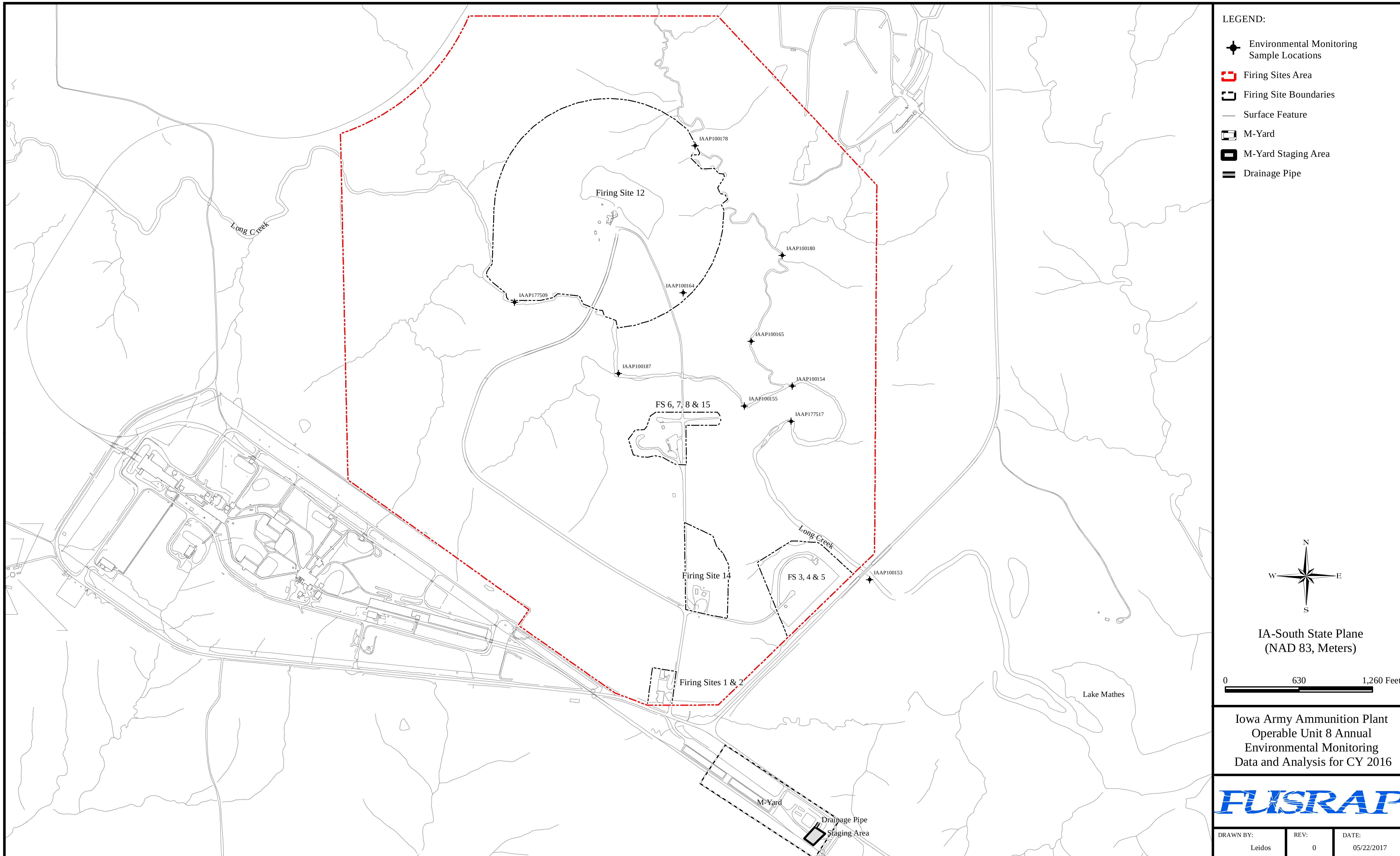


Figure 4-1. Surface-Water and Sediment Monitoring Locations