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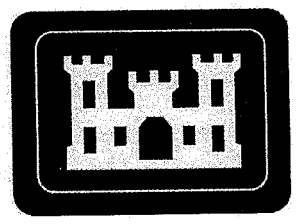
REV. 0

IOWA ARMY AMMUNITION PLANT RADIOLOGICAL SURVEY PLAN FOR YARD C, YARD G, YARD L, WAREHOUSE 3-01, AND LINE 1

APRIL 12, 2006



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APRIL 12, 2006

prepared by

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

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TABLE OF CONTENTS

Section — Page

ACRONYMS AND ABBREVIATIONS iii

1 INTRODUCTION 1

1.1 INTRODUCTION 1

1.2 PURPOSE AND SCOPE 1

2 SITE BACKGROUND 3

3 ROLES AND RESPONSIBILITIES 4

4 SURVEY DESIGN 5

4.1 THE PROBLEM 5

4.2 THE DECISION 5

4.3 INPUTS TO THE DECISION 5

4.3.1 Historical Information and Data Review 5

4.3.2 Radiological surveys 6

4.4 SOIL SAMPLE COLLECTION 12

4.4.1 Biased Soil Sample Collection 12

4.4.2 Random/Systematic Sampling 12

4.4.3 Reference/Background Area Soil Samples 13

4.4.4 Obtaining a Soil Sample 14

4.4.5 Sample Analysis 15

4.5 STUDY BOUNDARIES 15

4.5.1 Radiological Contaminants of Concern 15

4.5.2 Depth Boundaries 15

4.6 DEVELOPMENT OF DECISION RULE 16

4.6.1 Soil Screening Level 16

4.6.2 Structure Screening Level 16

4.7 SPECIFY TOLERABLE LIMITS ON DECISION ERRORS 17

4.8 OPTIMIZATION OF DESIGN FOR OBTAINING DATA 17

4.9 DATA QUALITY OBJECTIVES 18

5 SURVEY IMPLEMENTATION 19

5.1 YARD C 19

5.1.1 Historical Information and Data Review 19

5.1.2 Gamma Walkover Surveys 21

5.1.3 Radiological Survey of Structures 21

5.1.4 Soil Sample Collection 21

5.2 YARD G 21

5.2.1 Historical Information and Data Review 21

5.2.2 Gamma Walkover Surveys 23

5.2.3 Structure Radiological Survey 23

5.2.4 Soil Sample Collection 24

5.3 YARD L 24

5.3.1 Historical Information and Data Review 24
5.3.2 Gamma Walkover Surveys 24
5.3.3 Structure Radiological Survey 24
5.3.4 Soil Sample Collection 24
5.4 BUILDING 3-01 26
5.4.1 Historical Information and Data Review 26
5.4.2 Structure Radiological Survey 26
5.4.3 Soil Sample Collection 26
5.5 LINE 1 26
5.5.1 Historical Information and Data Review 26
5.5.2 Operational History of Line 1 29
5.5.3 Previous Environmental Investigations at the IAAAP and Line 1 34
5.5.4 Topography and Surface Water Features of Line 1 41
5.5.5 Hydrogeology 41
5.5.6 Gamma Walkover Surveys 43
5.5.7 Structure Radiological Survey 43
5.5.8 Soil Sample Collection 43
6 SAFETY AND HEALTH 46
6.1 SITE SAFETY AND HEALTH 46
6.2 SAFETY AND HEALTH TRAINING 46
6.3 TASK-SPECIFIC PERSONAL PROTECTIVE EQUIPMENT 46
6.4 PERSONNEL MONITORING REQUIREMENTS 47
6.5 FIELD LOGBOOK ENTRIES 47
6.6 IAAAP SITE COORDINATION 47
7 SAMPLE AND WASTE DISPOSITION 48
8 REFERENCES 49

LIST OF APPENDICES

APPENDIX A. IAAAP Survey Screening Level DCGL Risk/Dose Assessment
APPENDIX B. 2" x 2" NaI Detector Scan Detection of Depleted Uranium Fragments

LIST OF FIGURES

FIGURE 1-1. Iowa Army Ammunition Plant 2
FIGURE 5-1. Yard C Random Sample Locations 21
FIGURE 5-2. Yard G Random Sample Locations 23
FIGURE 5-3. Yard L Random Sample Locations 25
FIGURE 5-4. Warehouse 3-01 27
FIGURE 5-5 Line 1 29
FIGURE 5-6 Line 1 Previously Surveyed Buildings 30
FIGURE 5-7 IAAAP Topography and Water Courses 43
FIGURE 5-8 Line 1 Random Sample Locations East 45
FIGURE 5-9 Line 1 Random Sample Locations West 46

LIST OF TABLES

TABLE 3-1. ROLES AND RESPONSIBILITIES 4
TABLE 4-1. REFERENCE AREA SOIL SAMPLE RESULTS 14
TABLE 4-2. SELECTED SCREENING LEVELS 17

ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
AHA	activity hazard analyses
Ac	actinium
Am	americium
ANSI	American National Standards Institute
bcpm	instrument background counts per minute
Bgs	below ground surface
CAMU	corrective action management unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cm	centimeters
COC	contaminants of concern
cpm	counts per minute
CS	cesium
Ci/g	Curies per gram
DCGL	derived concentration guideline level
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DPH	Department of Health
dpm	disintegrations per minute
DQO	data quality objective
DU	depleted uranium
EC&HS	environmental compliance and health and safety
EDA	Explosive Disposal Area
EPA	Environmental Protection Agency
FFA	Federal Facilities Agreement
ft	feet
ft/s	feet per second
FUSRAP	Formerly Utilized Sites Remedial Action Program
gcpm	Gross counts per minute
GIS	geographic information systems
GPS	global positioning system
HAZWOPER	Hazardous Waste Operator Training
HMX	His/her Majesty Explosives
HSWP	health and safety work permits
HTRW	Hazardous, toxic, and radiological waste
IA	Iowa
IAAAP	Iowa Army Ammunition Plant
IRP	Installation Restoration Program
k	potassium
LAP	load, assemble, and pack
m	meter
m/sec	meters per second
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	minimum detectable activity
MDC	minimum detectable concentration

ACRONYMS AND ABBREVIATIONS (CONT'D)

MDCR	minimum detectable count rate
MOCA	methylene-bio-orthochloraniline
mrem	millirem
mrem/hr	millirem per hour
mrem/yr	millirem per year
n/a	not applicable
NAD	normalized absolute difference
NAD83	North American Datum 1983
ncpm	net counts per minute
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
ORNL	Oak Ridge National Laboratory
PA	Preliminary Assessment
Pa	protactinium
PA/SI	preliminary assessment/site investigation
PCB	polychlorinatedbiphenyls
pCi/g	picocuries per gram
PRG	preliminary remediation goal
QA/QC	Quality Assurance/Quality Control
Ra	radium
RD/RA	remedial design/remedial action
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
RESRAD	Residual Radioactivity code
RG	remediation goal
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
RSO	Radiation Safety Officer
SAIC	Science Applications International Corporation
SrY	strontium yttrium
SSHO	Site Safety and Health Officer
SVOC	Semi-volatile organic compound
Th	thorium
TNT	trinitrotoluene
TOW	tube launched optically tracked wire guided warhead
U	uranium
USACE	United States Army Corps of Engineers
VOC	volatile organic compound
WP	work plan
WRS	Wilcoxen Rank Sum
µR/hr	microroentgen per hour

1 INTRODUCTION

1.1 INTRODUCTION

This Radiological Field Survey Plan describes the radiological screening survey activities at selected areas of the Iowa Army Ammunition Plant (IAAAP) near Middletown, Iowa (Figure 1-1) and was prepared by the St. Louis District United States Army Corps of Engineers (USACE) as lead agency authorized to conduct response actions pursuant to the Formerly Utilized Sites Remedial Action Program (FUSRAP) at IAAAP. Region VII Environmental Protection Agency (EPA), State of Iowa, and the Iowa Army Ammunition Plant are all stakeholders in the FUSRAP activities at IAAAP.

1.2 PURPOSE AND SCOPE

This plan is being prepared to define the activities required to complete a radiological survey of soils in applicable areas defined within the *Preliminary Assessment: Iowa Army Ammunition Plant, Middletown, Iowa* (USACE, 2001) (PA) as warranting further investigation for potential radioactive contamination (Figure 1-1). Based on the data from the historical evaluation and the aerial radiological survey, the only radiological contaminant of concern is depleted uranium. Areas covered by this plan are Yard C, Yard G, Yard L, Warehouse 3-01, and Line 1. This radiological screening survey will be used to supplement the existing data for use in the RI work plan.

The areas under investigation have been designated as impacted in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). The scope of this survey plan is to generate data, which, when combined with data from the aerial scan, will support a determination of a MARSSIM Classification as a Class III, Class II, or Class I and the need for additional delineation data.

This document was prepared using guidance from *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), *Soil Screening Guidance for Radionuclides: Technical Background Document "Measuring Contaminant Concentrations in Soil"*, ANSI/HPS N13.12 and NUREG 1507. Specific guidance was obtained from MARSSIM, Chapter 3 – Historical Site Assessment.

This document is organized so that much of the background and preliminary information leading up to the survey design is contained in the first four sections. Site-specific information for each of the areas to be surveyed and parameters for the gamma walkover surveys, the radiological survey of structures, and soil sample collection is within Section 5. Information about safety, health, and waste disposition is found in Sections 6 and 7.

LEGEND:

Survey Areas

N
W
E
S

Iowa State Plane
(NAD 83, Meters)

0 400 800 Meters

Figure 1-1
Iowa Army Ammunition Plant
Burlington, Iowa

FUSRAP

DRAWN BY:	REV:	DATE:
SAIC	0	08/23/05

J:\GPS\IAAP\Remedialinvestigation\Projects\Figure 1-1.mxd

2 SITE BACKGROUND

IAAAP is owned by the United States Army and operated by a private contractor, American Ordnance, LLC. It is located in the southeastern part of Iowa, near the town of Middletown, approximately 10 miles west of the Mississippi River. The IAAAP is a secured facility covering approximately 19,000 acres in a rural setting. Approximately 7,700 acres are leased for agricultural use, 7,500 acres are forested land, and the remaining area is used for administrative and industrial purposes.

The Department of Energy (DOE) created FUSRAP in 1974 to address sites used during the United State's early atomic energy program. Congress transferred the responsibility for administration and execution of cleanup at eligible FUSRAP sites to USACE in 1997. On 30 March 2000, after performing historical research regarding Atomic Energy Commission (AEC) activities at the IAAAP, the DOE provided USACE with a determination that portions of the IAAAP may contain contamination resulting from activities that supported the nation's early atomic energy program.

According to the *Remedial Investigation/Risk Assessment, Iowa Army Ammunition Plant, Middletown Iowa* (USATHEMA, 1996), AEC operations began at the site in 1947. A portion of Line 1, the Explosive Disposal Area, Yards C, G, and L, and the Firing Site areas came under the control of AEC and their contractor. These areas occupied approximately 1,630 acres within IAAAP.

IAAAP is currently operated to load, assemble, and pack (LAP) ammunition items, including projectiles, mortar rounds, warheads, demolition charges, anti-tank mines, anti-personnel mines, and the components of these munitions, including primers, detonators, fuses, and boosters. The LAP operations use explosive material and lead-based initiating compounds. Only a few of the existing production lines are in operation.

3 ROLES AND RESPONSIBILITIES

On-site coordination and implementation of the screening survey described in this plan is the responsibility of the Science Applications International Corporation (SAIC) project manager/survey supervisor under the direction of the USACE. The screening survey team will consist of, at a minimum, a project manager/survey supervisor, a sample manager, geographic information systems (GIS) analyst, and health physics technicians. USACE will be responsible for approving all required field changes and communicating field investigation results to all stakeholders in a timely manner. The roles and responsibilities of key personnel for this screening survey are listed in Table 3-1.

Table 3-1. Roles and Responsibilities

Role	Person	Phone	Responsibility
Survey Supervisor	Eric Danielson	(314) 581-6084	Assures sample/survey activities are performed in accordance with this plan and that project quality, compliance, and health and safety requirements are followed.
Sample Manager	SAIC	(314) 770-3000	Assures samples are handled in accordance with the project sampling and analysis guide and that that GIS data are collected and analyzed in a defensible manner.
IAAAP Point of Contact	Steve Bellrichard	(319) 753-7150	Provides oversight, direction and coordination for activities in this plan that impact or affect IAAAP.
IAAAP Safety	Robert Haines	(319) 753-7859	Provides safety and occupational oversight for the hazards presented by the IAAAP.
USACE Health Physicist	USACE	(314) 260-3905	Provides the overall technical oversight, direction, and coordination for the implementation of this plan.

4 SURVEY DESIGN

Evaluation and investigation activities will be performed in accordance with the *Environmental Protection Agency (EPA) Soil Screening Guidance for Radionuclides: Technical Background Document and User's Guide* (EPA, 2000). The methodology described in this document will be applied to the land areas of the IAAAP.

4.1 THE PROBLEM

Individual areas located within the boundaries of IAAAP have been identified as potentially affected by various modes of radiological contamination. Each area will be addressed as an individual unit unless the areas are contiguous and have similar modes of contamination.

During this first stage of the survey design, a simple conceptual area model has been developed for each area to clarify the questions that require answers. The area model will include known locations of contaminants/waste, types and expected concentrations of contaminants, a potential mode of contamination of the area, and the potential human and ecological receptors. This investigation plan describes the activities to be performed and decision logic for each area.

4.2 THE DECISION

The decision for the individual areas will be based on accepting or rejecting the Null Hypothesis (H_0): Residual radioactive contamination does not exceed the radiological screening levels. If the null hypothesis is rejected for a specific area, a decision must be made to re-define the area, and for those in which radiological contamination exceeds the radiological screening levels for the site classify them as Class I or Class II areas. If the null hypothesis is accepted, the individual areas will be cleared by a Class III Final Status Survey,

4.3 INPUTS TO THE DECISION

The evidence required to support the decision for each specific area is developed based on the conceptual model established. Historical information, radiological surveys, and soil sampling will be utilized, as necessary, to support the final decision. The results of the historical information evaluation and the aerial radiological scan (documented as Aerial Radiological Survey), will be combined with the results of the soil samples obtained in this survey and the scanning data from waterways, between buildings and other areas possibly not detected by the flyover to form a complete survey of each area.

4.3.1 Historical Information and Data Review

Previous characterization, removal actions, and associated reports have been reviewed during the initial assessment of each area. Data points from previous sampling campaigns have been reviewed to optimize necessary future fieldwork.

Historical photographs and records have been examined, as necessary, to assist in establishing historical area use, physical features that logically would have the highest concentration of radiological contamination based on contamination modes, and construction dates of existing buildings or areas covered with asphalt or concrete. Those areas that were beneath such cover when contamination most likely occurred have been excluded from the assessment unless a mechanism for contaminant migration into these areas is identified.

4.3.2 Radiological surveys

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

Gamma walkover scans will be utilized for radiological survey of any land/soil areas to be investigated. Beta scans, fixed-point alpha/beta measurements, and loose surface contamination measurements will be utilized for the radiological survey of any structures investigated.

4.3.2.1 Gamma Walkover Surveys

General area scans for gross gamma radiation will be performed to identify locations of elevated external radiation that suggest possible residual radiological contamination. Processed natural uranium emits sufficient gamma radiation to identify the presence of residual contamination and estimate the concentrations potentially present at the IAAAP.

A Ludlum Model 44-10 2" × 2" NaI gamma scintillation detector coupled with a Global Positioning System (GPS) (or equivalent) will be used for performance of the gamma walkover scans. Screening gamma walkover scans will focus on areas most likely to have elevated levels of activity as determined by the survey supervisor. The surveyor will advance at a speed of approximately 2 feet (ft) per second (s) (approximately 0.5 meters per second) while passing the detector 4-6 inches over the ground surface. Scanning results will be recorded in counts per minute (cpm). The survey coverage will initially be higher near the expected radiological source point or areas having the highest potential to contain residual radiological contamination. If no elevated gamma radiation levels are encountered the gamma scan coverage will decrease with increased distance from the source. This approach will concentrate the greatest effort in the areas of highest risk and still provide some coverage over other portions of the property. If relatively high levels of gamma radiation are encountered that indicate the presence of radiological contamination well in excess of the radiological screening levels, the gamma scan coverage will be utilized to best establish a rough boundary and magnitude of identified radiological contamination.

Audible response of the instrument will be monitored, and locations of elevated audible response will be investigated. The initial investigation level for the gamma scans will be set at 3,000 cpm above the relative background for the given area. This investigation level is based on an average background level at the site that typically falls within the range of 8,000 to 12,000 cpm. The investigation level may be adjusted by the Survey Supervisor based on the deviation of count rates encountered as the survey progresses. This investigation level will be dependent upon the relevant background in each specific area. Locations exceeding the investigation level will be investigated and, if appropriate, sampled. Gamma scan data will be recorded in real time, using position and data recording methods. If satellite visibility is not available, the data will be geo-referenced at a later time.

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

4.3.2.2 Radiological Survey of Structures

Uranium has associated alpha, gamma, and beta radiations, which can be used to identify the presence of residual contamination and estimate the concentrations potentially present at the IAAAP. Beta scans will be used because alpha radiation is a less reliable indicator of true surface activity levels due to greater attenuation.

A Ludlum Model 2360 coupled with a Ludlum 43-89 (ZnS plastic scintillator) (or equivalent) will be used for performance of the beta scans. Scan speed with these detectors will be approximately 1 to 2 inches per second. Distance from the detector probe to the surface being scanned will be approximately 1/4 inch.

Instrument response will be continuously monitored during scanning through use of the audible instrument signal. Scanning results will be recorded in cpm, which along with the appropriate instrument geometry and calibration information will be used to convert the data to dpm/100cm^2 for comparison to criteria.

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

Total alpha-beta surface activity (fixed-point) measurements will be conducted as necessary based on the results of the beta scans. Fixed-point gross beta activity measurements will be made with 30 second static counts using a (43-89) ZnS plastic scintillator. The results of the survey for both alpha and beta will be recorded in cpm and converted to dpm upon completion of the survey.

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

Survey locations will be limited to only those areas that are reasonably accessible for personnel and instrument safety. Areas likely to be considered for this survey may include but are not limited to:

- entrances and exits;
- ventilation;
- sumps and floor drains;
- high traffic areas; and
- shipping and receiving loading and offloading areas.

Beta scan surveys will be conducted by moving the detector at 1 to 2 inches per second and with the active area of the detector approximately 1/4 inch from the surface being surveyed. If the investigation level (80% of the screening level) is reached during scanning, the surveyor will pause to allow the instrument response to stabilize. A biased fixed-point measurement and smear should be performed where elevated activity was noted (and confirmed) during the scan survey. Activity will be calculated using the following equations:

ncpm = gcpm – bcpm

where:

ncpm = net counts per minute

gcpm = gross counts per minute
bcpm = instrument background counts per minute

$$\text{dpm}/100\ \text{cm}^2 = \frac{\text{ncpm}}{\varepsilon_i \times \varepsilon_s \times \text{DA}} \times \frac{100\ \text{cm}^2}{100\ \text{cm}^2}$$

where:
DA = detector area
ε_i = instrument efficiency (cd-1)
ε_s = surface efficiency (unitless)
Ludlum 43-89 detector area = 125 cm2

The effects of self-absorption may produce considerable error in the reported surface activity levels. A surface efficiency (ε_s) of 0.5 (unitless) for beta, and 0.25 for alpha will be used based on recommendations found in NUREG-1507, Section 5.3.2.

4.3.2.3 Instrument Use and Quality Assurance

Survey instruments used for radiological measurements will be:

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

Radiological field instrumentation used for this site screening survey will have been calibrated in accordance with ANSI N323A within the past 12 months (or more frequently if recommended by the manufacturer). Daily quality control checks will be conducted on each instrument and operated in accordance with USACE-approved SAIC Health Physics Procedures. Only data obtained using instruments that satisfy these performance requirements will be accepted for use during this survey.

The instruments selected for this site screening are:

- Ludlum Model 2360 ratemeter/scaler coupled with a Ludlum Model 43-89 (ZnS plastic scintillator) hand held probe or equivalent for scanning and fixed-point measurements
- Canberra Gamma Spectroscopy and Alpha Spectroscopy Laboratory Equipment
- Ludlum Model 2929 scaler coupled with a Ludlum Model 43-10-1 smear counter, or equivalent to count smears for removable activity
- Ludlum Model 44-10; 2 x 2 NaI Gamma Scintillation Detector coupled with a GPS system

Pre-operational checks

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

- Verifying instrument has current calibration.
- Visually inspecting instrument for physical damage that may affect operation.

- Performing satisfactory battery check. (Manufacturer's operating instructions will be used to define satisfactory battery check)
- Checking cable connection and cable integrity.

Daily background checks

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

Daily source check

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

Sources will be stored and handled as specified by SAIC procedures and shipped in accordance to Department of Transportation (DOT) regulations.

4.3.2.4 Static and Scan Minimum Detectable Concentrations (MDCs)

NUREG-1507, Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions (NRC, 1998), and NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (EPA, 2000) provide methodology for calculation of minimum detectable concentrations (MDCs). The following details the approach for calculating site specific MDCs for use in the site reconnaissance survey process at IAAAP.

The steps utilized for calculating MDCs follow the approach detailed in NUREG-1507. The steps include:

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

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

b' = (background count rate) × (observation interval) × (1 min/60 sec) = counts/interval

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

$$s_i = d' \sqrt{b_i}$$

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

$$MDCR = s_i \times (60/i) = \text{cpm}$$

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

$$\text{Scan MDC} = \frac{MDCR}{\sqrt{p}\,\varepsilon_i\,\varepsilon_s \dfrac{probe\ area}{100\ cm^2}}$$

Where:

MDCR = minimum detectable count rate (cpm)
ε_i = instrument efficiency (cd^{-1})
ε_s = surface efficiency (unit less)
p = surveyor efficiency (unitless, typically assumed to be 0.5)

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

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

Where:

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

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

The fixed point measurement minimum detectable activity (MDA) is calculated as follows:

$$\text{MDA (dpm/100 cm}^2) = \frac{L_D}{[DA][\varepsilon_i][\varepsilon_s][T]} x \frac{100\,cm^2}{100\,cm^2}$$

Where:

DA = detector area (cm^2)

L_D = *a priori* detection limit [minimum significant activity level]
ε_i = instrument efficiency (cd^{-1})
ε_s = surface efficiency (unitless)
T = count time (minutes)

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

$$\text{Smear MDA (dpm/100cm}^2) = \frac{L_D}{(T)\,(\varepsilon_i)}$$

Where:
L_D = *a priori* detection limit [minimum significant activity level]
T = smear count time (minutes)
ε_i = instrument efficiency (cd^{-1})

The calculations of MDCs for selected instrumentation proposed for IAAAP are presented below.

Surface: Steel structural beams
Background (R_B) = 160 cpm β, 1 cpm α
Probe dimensions: 3.0" x 6.5"
Probe active area: 125 cm^2
Scan Speed = 2 inches/sec
Fixed point measurement time (T_S) = 30 seconds
Background count time (T_B) = 10 minutes
ε_i = 0.27 β, 0.16 α
ε_s = 0.5 β, 0.25 α (NUREG-1507, Section 5.3.2)
p = 0.50
d' = 1.38

Scan Measurement – beta (β)

l = 5.0 inches/2 in sec^{-1} = 2.5 seconds
b_i = (160 cpm) (1 min/ 60 sec) (2.5 sec) = 6.67 counts/observation interval

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

MDCR = 3.6 (60/2.5) = 86 cpm

$$\text{Scan MDC} = \frac{86 \text{ cpm}}{\sqrt{0.50}(0.27)(0.5)(1.25)} = 721 \text{ dpm/100 cm}^2$$

Fixed Point Measurement – beta/gamma (β)

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

$$\text{MDA} = \frac{33}{[125][0.27][0.5][0.5]} \times \frac{100\text{cm}^2}{100\text{cm}^2} = 391 \text{ dpm/100cm}^2$$

Fixed Point Measurement – alpha (α)

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

$$MDA = \frac{5}{[125][0.16][0.25][0.5]} x \frac{100\,cm^2}{100\,cm^2} = 200 \text{ dpm}/100cm^2$$

4.4 SOIL SAMPLE COLLECTION

Biased and systematic/random soil samples will be utilized for performance of the radiological screening. Coordinates for soil sample locations will be located using GPS referenced to NAD 83 or other appropriate coordinate system. Samples will be collected, labeled, logged, and analyzed for appropriate radiological parameters. QC duplicate and split samples will be collected at one sample for every twenty samples collected or portion thereof.

4.4.1 Biased Soil Sample Collection

Biased soil sampling will be used to investigate the radiological concentration of suspect areas identified during the site screening. Biased sample locations will be chosen during the site screening by the survey team in coordination with the USACE to clarify the radiological status of the various areas. Biased sample locations will be chosen to investigate site anomalies and areas of elevated gamma radiation.

Site anomalies, if present, will be identified during the initial site investigation. Anomalies cannot be clearly defined until the site investigation occurs. Examples of anomalies include obvious soil discoloration, concrete stains adjacent to building effluent points, areas with no or limited vegetation growth, and other features that the survey team identifies as unusual. Site anomalies will be investigated. Biased soil samples will be obtained in these areas as necessary to clarify the radiological status.

Based on the results of the radiological walkover survey, biased soil investigation samples may be taken. The number of biased samples taken, if any, will be determined by the survey supervisor after review of the walkover survey findings. The survey supervisor will identify suspect locations from areas that exceed the investigation level and/or from various count rate ranges in areas that have multiple locations that exceed the investigation level. Biased sample locations will be selected from identified suspect locations in a given area. The locations will be selected to maximize input for the decision or obtain biased samples from representative count rate locations within an area. Not only is the collection of biased soil samples from multiple count rate ranges needed to accept or reject the null hypothesis but also to assist in the planning future characterization efforts.

4.4.2 Random/Systematic Sampling

Random/systematic sampling will be utilized to determine if a specific area requires additional investigation/remediation to meet the radiological screening level. The decision to perform systematic or random sampling will be based on the potential for contamination expected within the given area. A random sampling technique will be used for areas that are not expected to contain radiological constituents at a fraction of the radiological screening levels or at slightly above the reference/background area values. A systematic grid will be used to sample areas that are expected to contain radiological constituents in excess of background but below the radiological screening level.

The number of samples required will depend upon the deviation of contamination levels across the specific area and the deviation for the potential of contamination across the area. For example, if an individual area contains two drastically different types of areas, one which exhibits significant fluctuation of gamma levels and the other at or near background, it would be logical to sample these two distinct areas as individual entities instead of one homogenous area.

It is necessary during the planning stages of any survey to estimate the number of data points required to statistically support the final decision. The number of required samples is based on many factors, but the statistical tests to be used during data evaluation assist in calculating the estimated number. The Wilcoxen Rank Sum test has been chosen since the radiological contaminant of concern is present in the background. In order to determine the number of samples, the value for a number of parameters must be assigned. For the purposes of this survey, the alpha error (α) is assigned a value of 0.05 and a false positive error (β) 0.10. Lacking preliminary information, a coefficient of variation (standard deviation (σ)) may be set at 0.3, and the lower bound may be set at one half the radiological screening level. Since the radiological contaminant of concern is micron-size depleted uranium (DU) particles, the MDC for scanning with a 2" x 2" NaI detector for soil contaminated with DU, 56 picoCuries per gram (pCi/g), will be used as the radiological screening level. Additional information on soil screening levels is contained in Section 4.6.

Consequently:

$\sigma = 0.3 \times 56 = 16.8$ pCi/g

Shift (width of Data Quality Objective (DQO) gray region (∇) = 56 – 28 = 28 pCi/g

Relative Shift $= \nabla/\sigma = 28/16.8 = 1.75$

$\alpha = 0.05$

$\beta = 0.10$

From Table 5.3 (page 5-30) of Multi Agency Radiation Survey and Site Investigation Manual, the number of samples for each area will be 12. The final number of required samples will be calculated after the fact using values from the data set collected during this investigation.

4.4.3 Reference/Background Area Soil Samples

As described in the *Iowa Army Ammunition Plant Scoping Survey Plan for Firing Sites 6 and 12* (USACE 2001), a reference area was selected to determine background uranium levels at the site located northeast of IAAAP Gate 4 directly behind Casey's General Store. The reference area was selected upon agreement of the USACE the Iowa Department of Health, and EPA Region 7 representatives. Seven locations were sampled within the reference area. Soil samples were analyzed for gamma emitting isotopes and processed for alpha spectroscopy analysis to determine the isotopic concentrations of all three uranium isotopes present in DU (U-238, U-235, and U-234). The soil sample alpha spectroscopy analysis results for the uranium isotopes are shown in Table 4-1.

Table 4-1. Reference Area Soil Sample Results

Reference Area Data Summary			
	U-234 pCi/g	U-235 pCi/g	U-238 pCi/g
Mean	1.19	0.04	1.36
Median	1.35	0.03	1.42
St. Dev	0.29	0.05	0.26
Maximum	1.50	0.13	1.73
No. Samples	9	9	9
Reference Area Data			
Sample ID	**U-234 pCi/g**	**U-235 pCi/g**	**U-238 pCi/g**
IAAP25025	0.96	0.04	1.62
IAAP25026	1.40	0.00	1.73
IAAP25027	1.35	0.11	1.50
IAAP25028	1.35	-0.02	1.27
IAAP25028-1	1.15	0.03	1.28
IAAP25028-2	0.69	0.06	1.06
IAAP25029	0.84	0.02	0.91
IAAP25030	1.46	0.03	1.42
IAAP25031	1.50	0.13	1.49

1) Field duplicate
2) Field split

4.4.4 Obtaining a Soil Sample

Sampling Methods

Soil Coring Method or Scoop - Surface Soil Samples [to 15 cm (6 in.) bgs]

- Using a precleaned or decontaminated stainless steel soil coring tool (or stainless steel scoop) collect a grab sample and composite it in a stainless steel bowl.
- Label the sample using a unique identification number. A sequential Sample Number will follow the Site Designator code to identify the samples for collection and delivery to the laboratory.
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after use and between sampling locations.

Hand Auger/Tube Sampler – Subsurface Soil Samples [0.15cm to 60 cm (6 in to 24 in) below ground surface (bgs)]

- Assemble a decontaminated auger and advance the auger bit into the soil to the depth desired.
- Withdraw auger
- If a sample is not desired, remove soil from auger. If a sample is to be taken in the next interval, replace the auger bit with a precleaned or decontaminated bit and repeat the above steps.
- Remove the auger and collect the soil sample.
- Label the sample using a unique identification number. A sequential Sample Number will follow the Site Designator code to identify the samples for collection and delivery to the laboratory.
- Complete all chain-of-custody documents and record the sampling event in the field logbook.
- Decontaminate sampling equipment after use and between sampling locations.

Decontamination of Equipment-

- Remove all visible dirt/debris or sample residue from sampling equipment.
- Wipe sampling equipment with dry towel or baby wipe.
- Perform a loose surface contamination measurement on sampling equipment.
- Insure loose surface contamination levels are less than 20 dpm/swipe.
- Return sampling equipment for use.

4.4.5 Sample Analysis

All samples collected will be dried, homogenized, and analyzed for gamma emitting isotopes using Marinelli beaker geometry and a Canberra gamma spectroscopy system equipped with HPGe detectors. Sample results will be reported for actinium (Ac)-227, americium (Am)-241, Cs-137, potassium (K)-40, protactinium (Pa)-231, radium (Ra)-226, Ra-228, Th-228, Th-230, Th-232, U-235, U-238 and all other peaks identified during the analysis.

As a QC measure, ten percent of soil samples will also be processed for alpha spectroscopy analysis to determine the isotopic concentrations of all three uranium isotopes present in DU (U-238, U-235, and U-234). Prepared samples will be chemically processed using the Claude Sills method of chemical separation and counted on a Canberra alpha spectroscopy system. The typical detection sensitivity for this analysis is approximately 0.1 pCi/g for each isotope. The *FUSRAP St. Louis Laboratory Quality Assurance Plan* will be followed for all analytical activities.

4.5 STUDY BOUNDARIES

The geographical boundaries for each specific area have been generally defined. The area boundaries were defined using physical landmarks, as appropriate, in the field. Examples of physical landmarks are railroads, roads, buildings, streams, ditches, or other easily identifiable land features. The radiological screening survey will be initiated at the location of the area that has the highest probability of containing radiological contamination and progress outward toward the physical boundaries of the area. If evidence of radiological contamination is identified at or near the physical boundaries of the area, an additional screening investigation will be performed, as appropriate.

4.5.1 Radiological Contaminants of Concern

Depleted uranium (DU) has been identified as the FUSRAP radiological contaminant of concern at IAAAP. DU includes multiple uranium isotopes (i.e., U-238, U-234, U-235) and is signified by the reduction of the U-235 isotope below its natural abundance of 0.7%. In DU, the abundance of U-235 in DU is typically on the order of 0.2 to 0.3%. The specific activity of DU is 3.637×10^{-7} curies per gram (Ci/g) with an activity abundance of 92.18%, 1.49%, and 6.36% for U-238, U-235, and U-234, respectively.

4.5.2 Depth Boundaries

Surface soil is defined as the top six inches of soil. Subsurface soils are defined as the soil media from six inches below the ground surface to the top of the water table. The majority of the investigation will focus on surface soils. Subsurface soils will only be investigated if historical evidence indicates that sufficient mixing or remediation has occurred that may have transferred radiological contamination to depth such that the surface soils are no longer representative of the radiological status of the soils that exist within the study boundaries.

4.6 DEVELOPMENT OF DECISION RULE

In order to evaluate the need for future action after reviewing collected data, a preliminary screening level will be established for both soil and structures. Such screening levels are typically conservative values (i.e., based on residential-use scenarios) used by facilities and regulatory agencies as screening tools to determine if the magnitude of residual contamination that exists at a facility requires further action to be taken. If it is determined that further action is warranted these screening levels will be adjusted using site-specific information.

4.6.1 Soil Screening Level

In many instances, the establishment of a radiological screening level is limited by the ability to detect the contaminant of concern using reasonable detection methodologies. NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC, 1998) lists the MDC for scanning with a 2" x 2" NaI detector for soil contaminated with DU at 56 pCi/g. It has been determined that this level of contamination will be detected at least 95% of the time by the average survey technician walking at a rate of 0.5 meters per second (m/sec). This scan MDC value is based on the assumption that instrument background is at or near 10,000 cpm. Site-specific background for instruments used during the walkover survey should be within ± 20% of this value to validate the use of the stated scan MDC. If instrument backgrounds fall outside this value, a site-specific scan MDC should be calculated.

Conservative risk and dose assessment calculations were performed using the residual radiation code (RESRAD) 6.0 to model a residential scenario with DU soil contamination at 56 pCi/g. The resulting risk and dose to the maximum exposed individual from this evaluation is 5 E-5 and 8 millirem per year (mrem/yr), respectively, as described in Appendix A, *IAAAP Survey Screening Level DCGL Risk/Dose Assessment.*

The use of 56 pCi/g as a screening level for DU is applicable to IAAAP since it is expected that the soil at these sites is potentially contaminated with micron-size DU particles. In this situation, it is expected that the activity per gram of soil is much less than the known specific activity of solid DU (i.e., 3.637 E-7 Ci/g). For solid DU (i.e., visible DU fragments), the specific activity is known and the appropriate parameter to define the minimum detectable quantity is the size of the fragment, not its activity.

The presence of DU in excess of 56 pCi/g in any sample from a specific area will require additional investigation for that area or the affected parts of that area. If no samples from a specific area contain DU in excess of 56 pCi/g, no further action will be required in that area.

4.6.2 Structure Screening Level

The established screening levels for the structures for total gross alpha and beta activity have been selected from Table 1, *Surface and Volume Radioactivity Standards for Clearance* (ANSI 1999). The screening levels for gross alpha and beta removable activity have been set at 10% of the limit for total alpha and beta activity, respectively. The screening levels used for this site screening survey are listed in Table 4-2.

Table 4-2 Selected Screening Levels

	Total Contamination dpm/100cm2	Removable Contamination dpm/100cm2	Investigation Level for Scanning
Gross alpha	600	60	not applicable
Gross beta	6,000	600	4,800

4.7 SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Although the possibility of decision errors can never be totally eliminated, it can be minimized and controlled. The potential decision errors for the investigation of the potentially affected sites at the IAAAP will be due to sampling design and/or measurement errors. The sample collection design, the number of samples collected, and the actual variability of the contaminant in the population influence sampling design error. Measurement error is influenced by the imperfections in the measurement and analysis system. In an effort to control these errors the following limits have been established:

- Quality Assurance/Quality Control (QA/QC) split and duplicate soil samples will be collected at an average frequency of at least 1 in 20.
- Precision will be determined by comparison of split and duplicate sample values with an objective of a relative percent difference of 30% or less at 50% of the criterion value when reported activities are greater than 5 times their minimum detectable activities (MDAs); if sample results are less than 5 times their respective MDA, the normalized absolute difference (NAD) will be used with an objective of NAD less than 1.96.
- Soil sample data generated by the analytical laboratory will undergo a third party data verification and validation with a project goal of 95% data usability.
- Target MDA for gamma spectroscopy will be less than 1 pCi/g K-40, less than 5 pCi/g U-238, and less than 2 pCi/g U-235.
- Target MDA for alpha spectroscopy will be 1.0 pCi/g for U-238, U-235 and U-234.
- To validate scan minimum detectable concentration (MDC) values used for the survey 2"x2" NaI detectors used for gamma walkover surveys will have site-specific instrument background values ±20% of background values used in scan MDC modeling. If background values fall outside this range, new site specific scan MDCs will be calculated.
- Radiological field instruments used for gamma walkover surveys will be performance checked at the beginning and end of each survey day to determine acceptance and usability of data collected. The established acceptance criteria will be instrument background within ±3 standard deviations of the mean site background and source checks within ±10% of the known value.
- The number of required samples to perform the Wilcoxen Rank Sum (WRS) Test will be calculated for each individual area. This will account for the actual standard deviation of the contaminant across the individual areas. An alpha error of 0.05 and a beta error of 0.10 have been established as the decision errors applicable for calculating the required number of samples.

4.8 OPTIMIZATION OF DESIGN FOR OBTAINING DATA

The following actions, methods, and techniques will be utilized throughout the data collection process to minimize cost, field effort, and impacts to future associated work.

- Area-specific data collected to date will be evaluated to limit the extent of the study area. The previously collected data will be used to identify the initial target areas where contamination is likely to exist. Radiological surveys and collected samples will be obtained in a defensible manner. Data will be collected and managed so that it will be usable in future area evaluations or investigations, as appropriate.
- Investigations will utilize the graded approach of site investigations. Areas of highest potential will be scrutinized the most, with less effort expended in areas less likely to contain the target contaminants.

- If radiological contamination is detected during the field investigation that is obviously above the radiological screening level, the survey team will collect only enough data to establish the rough magnitude and extent of the contamination. The survey team will concentrate their efforts in determining whether the entire area or portions of the area have radiological contamination in excess of the radiological screening levels.
- Anomalies identified during the field investigation will be relayed to the management team. The actions required to investigate identified anomalies will be agreed upon by the management and survey team and performed prior to demobilization if practical.

4.9 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs)

- 5% QA/QC samples (duplicates and splits).
- Precision within 30%
- 95% usable data after validation
- MDA for gamma spectroscopy will be less than 1 pCi/g K-40, less than 5 pCi/g U-238, and less than 2 pCi/g U-235
- MDA for alpha spectroscopy will be 1.0 pCi/g for U-238, U-235 and U-234
- Randomly located samples will be collected in each designated area
- All radiological survey instruments will be operated and maintained by qualified personnel, in accordance with SAIC's Health Physics Program procedures
- Gamma walkover data will be electronically recorded and visually displayed in color-coordinated maps.
- Beta scan data will be recorded on standard survey forms in accordance with SAIC's Health Physics Program procedures
- Beta fixed point MDCs will be 3000 dpm/100 cm2 or less than 50% of the screening level.
- Alpha fixed point MDCs will be 300 dpm/100 cm2 or less than 50% of the screening level.
- Beta scan MDCs will be 4000 dpm/100 cm2 or less than 80% of the screening level.
- Ludlum 2929 alpha removable contamination MDA will be 60 dpm/100 cm2 or less than 10% of the screening level.
- Ludlum 2929 beta removable contamination MDA will be 600 dpm/100 cm2 or less than 10% of the screening level.

5 SURVEY IMPLEMENTATION

Five areas within the IAAAP have been selected for radiological screening at this time. The areas are Yard C, Yard G, Yard L, Building 3-01, and Line 1. Steps to perform the radiological screening survey on each of the five areas to arrive at a correct decision are outlined below.

5.1 YARD C

5.1.1 Historical Information and Data Review

Yard C is located in the eastern portion of the IAAAP, and is bounded by the Boxcar Unloading Area and the Explosive Waste Incinerator to the north, Line 2 to the west and Yard D to the south. The location and topography of Yards C is depicted on Figure 5-1. Yard C, consists of 43 igloos, and was constructed in 1941-1942 to serve as a storage yard. In 1947, Yard C came under the control of the AEC. The AEC utilized Yard C for the storage of raw explosive materials. These raw materials were transported to Yard C by rail in cardboard boxes with plastic liners. From Yard C, the raw explosives were transported to Building 1-50 on Line 1. Building 1-50 served as a central transfer point prior to delivery to the Line 1 melt buildings. At an unknown date probably prior to 1954, the necessary security was added to Yard C so that it became the only storage facility for both raw materials and finished products. Currently, only rows 1 and 2, and the western half of rows 3, 4, and 5 have lighting consistent with AEC security operations with no visible indication of lighting elsewhere in the Yard. The AEC discontinued use of Yard C in 1975.

Yard C consists of (eight) rows of bunkers. Each row of bunkers is adjacent to a rail line and an access road. Each bunker has a loading dock that can be accessed from the rail or an access road off the main access road. The bunkers were built into the surrounding soil area resulting in the low point of Yard C being the adjacent rail line along each bunker row. The rail lines are ditched for water drainage. The majority of the land in Yard C is basically an open field that is currently being used for hay production. The elevated land behind each bunker row and the access road for the next row of bunkers have all been mowed this year.

The AEC performed a closeout radiological survey of all 43 igloos in Yard C, finding no detectable contamination above background levels. In 2000, DOE performed limited radiological surveys of Yard C Building 23-53, and Igloos 23-1, 23-2 and 23-3. No radioactive contamination was found during this survey. Based on these results, DOE recommended that appropriate activities be conducted to complete a MARSSIM Class 3 building survey at Yard C.

After reviewing the PA and the Project Histories, it was determined that the investigation of Yard C should focus on an area known as Yard CC. However, no reference identifying exactly which igloos were contained within Yard CC was identified. Based on the topography of Yard C, the radiological survey of all 43 igloos by AEC and limited historical evidence of any radiological release at Yard C, the investigation of Yard C will initially concentrate on the soil areas surrounding the loading docks of all igloos and drainage ditches along the adjacent rail lines and bunker specific access road.

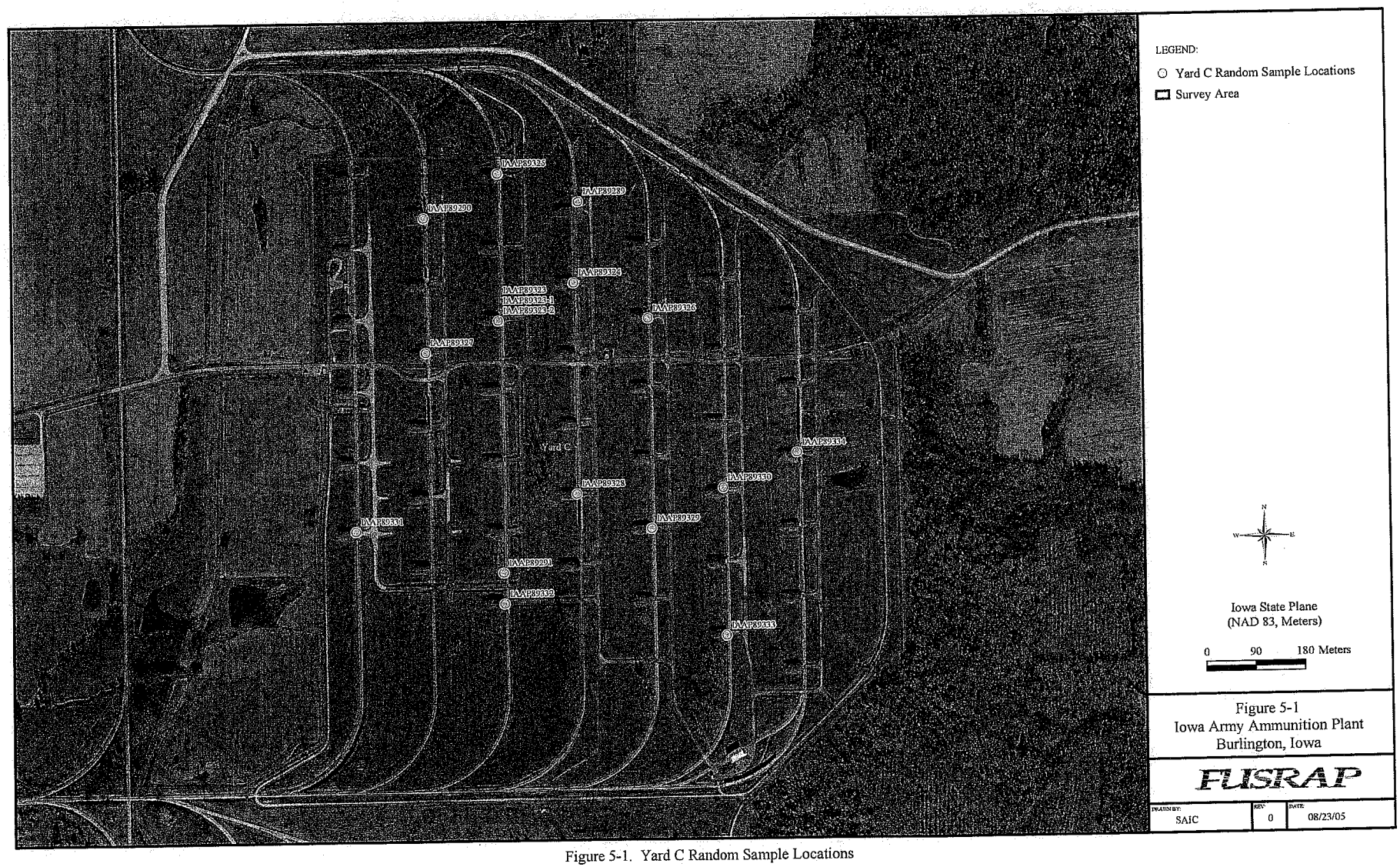


Figure 5-1. Yard C Random Sample Locations

5.1.2 Gamma Walkover Surveys

In general, all areas immediately north and south of each loading dock will receive 50-100% scan coverage. The drainage ditches along adjacent rail line and each igloos driveway will receive 50-100% coverage. If elevated radiological activity is identified due to the presence of increased gamma readings, the survey will either attempt to determine the extent of the elevated activity or gather enough additional information for proper planning of additional surveys to be performed during the planned Remedial Investigation.

5.1.3 Radiological Survey of Structures

AEC surveys of each igloo were performed and revealed no readings above background. The later DOE survey reported no anomalous readings in three igloos and the one building on Yard C. Therefore, the presence of radiological contamination in excess of the screening levels within the Yard C igloos is not expected. However, as part of this survey effort, the accessible portions of 5 available igloos (10% of the igloos) will be surveyed.

A beta scan will be performed in accessible areas of the surveyed igloos to check for the presence of radiological contamination. It is possible that the initial survey will indicate the presence of radiological contamination resulting from naturally occurring radon and its progeny. The presence of radon will be confirmed or denied due to the decrease in count rates after ventilation of the building and/or the confirmation of the identified contamination having a short half-life. The short half-life will be verified by periodic counts of loose surface contamination swipes over a given time period.

If the presence of radiological contamination, excluding radon, is identified and confirmed during the beta scans, the structures will be considered impacted and will be addressed at a later date as a part of the Remedial Investigation. Since the beta scan MDA (721 dpm/100 cm^2) is well below the structure screening level (6000 dpm/100 cm^2), a minimum of two fixed-point alpha/beta and loose surface contamination measurements will be obtained in each building regardless of the results of the scan for quantitative purposes.

5.1.4 Soil Sample Collection

Twelve random samples will be obtained within Yard C. Biased soil samples will be obtained as determined by the survey supervisor based on the results of the assessment and the gamma walkover survey. Sampling locations have been placed over Yard C adjacent to randomly chosen igloo loading docks as shown on Figure 5-1.

It is expected that the soil samples will be limited to surface soil samples. A radiological screening will be performed on each soil sample and the soil exposed during sample collection. It is possible that this screening would indicate the presence of higher radiological activity in the subsurface. Subsurface sampling may occur at this time.

5.2 YARD G

5.2.1 Historical Information and Data Review

Yard G is located in the southern portion of the IAAAP, and is bounded by the Construction Debris Landfill to the north, Yard K to the west and Yard E to the east. The location of Yard G is depicted on Figure 5-2. Yard G was constructed in 1942 to serve as a storage area for the finished castings of classified shapes. In 1947, Yard G came under the control of the AEC.

5.1.2 Gamma Walkover Surveys

In general, all areas immediately north and south of each loading dock will receive 50-100% scan coverage. The drainage ditches along adjacent rail line and each igloos driveway will receive 50-100% coverage. If elevated radiological activity is identified due to the presence of increased gamma readings, the survey will either attempt to determine the extent of the elevated activity or gather enough additional information for proper planning of additional surveys to be performed during the planned Remedial Investigation.

5.1.3 Radiological Survey of Structures

AEC surveys of each igloo were performed and revealed no readings above background. The later DOE survey reported no anomalous readings in three igloos and the one building on Yard C. Therefore, the presence of radiological contamination in excess of the screening levels within the Yard C igloos is not expected. However, as part of this survey effort, the accessible portions of 5 available igloos (10% of the igloos) will be surveyed.

A beta scan will be performed in accessible areas of the surveyed igloos to check for the presence of radiological contamination. It is possible that the initial survey will indicate the presence of radiological contamination resulting from naturally occurring radon and its progeny. The presence of radon will be confirmed or denied due to the decrease in count rates after ventilation of the building and/or the confirmation of the identified contamination having a short half-life. The short half-life will be verified by periodic counts of loose surface contamination swipes over a given time period.

If the presence of radiological contamination, excluding radon, is identified and confirmed during the beta scans, the structures will be considered impacted and will be addressed at a later date as a part of the Remedial Investigation. Since the beta scan MDA (721 dpm/100 cm^2) is well below the structure screening level (6000 dpm/100 cm^2), a minimum of two fixed-point alpha/beta and loose surface contamination measurements will be obtained in each building regardless of the results of the scan for quantitative purposes.

5.1.4 Soil Sample Collection

Twelve random samples will be obtained within Yard C. Biased soil samples will be obtained as determined by the survey supervisor based on the results of the assessment and the gamma walkover survey. Sampling locations have been placed over Yard C adjacent to randomly chosen igloo loading docks as shown on Figure 5-1.

It is expected that the soil samples will be limited to surface soil samples. A radiological screening will be performed on each soil sample and the soil exposed during sample collection. It is possible that this screening would indicate the presence of higher radiological activity in the subsurface. Subsurface sampling may occur at this time.

5.2 YARD G

5.2.1 Historical Information and Data Review

Yard G is located in the southern portion of the IAAAP, and is bounded by the Construction Debris Landfill to the north, Yard K to the west and Yard E to the east. The location of Yard G is depicted on Figure 5-2. Yard G was constructed in 1942 to serve as a storage area for the finished castings of classified shapes. In 1947, Yard G came under the control of the AEC.

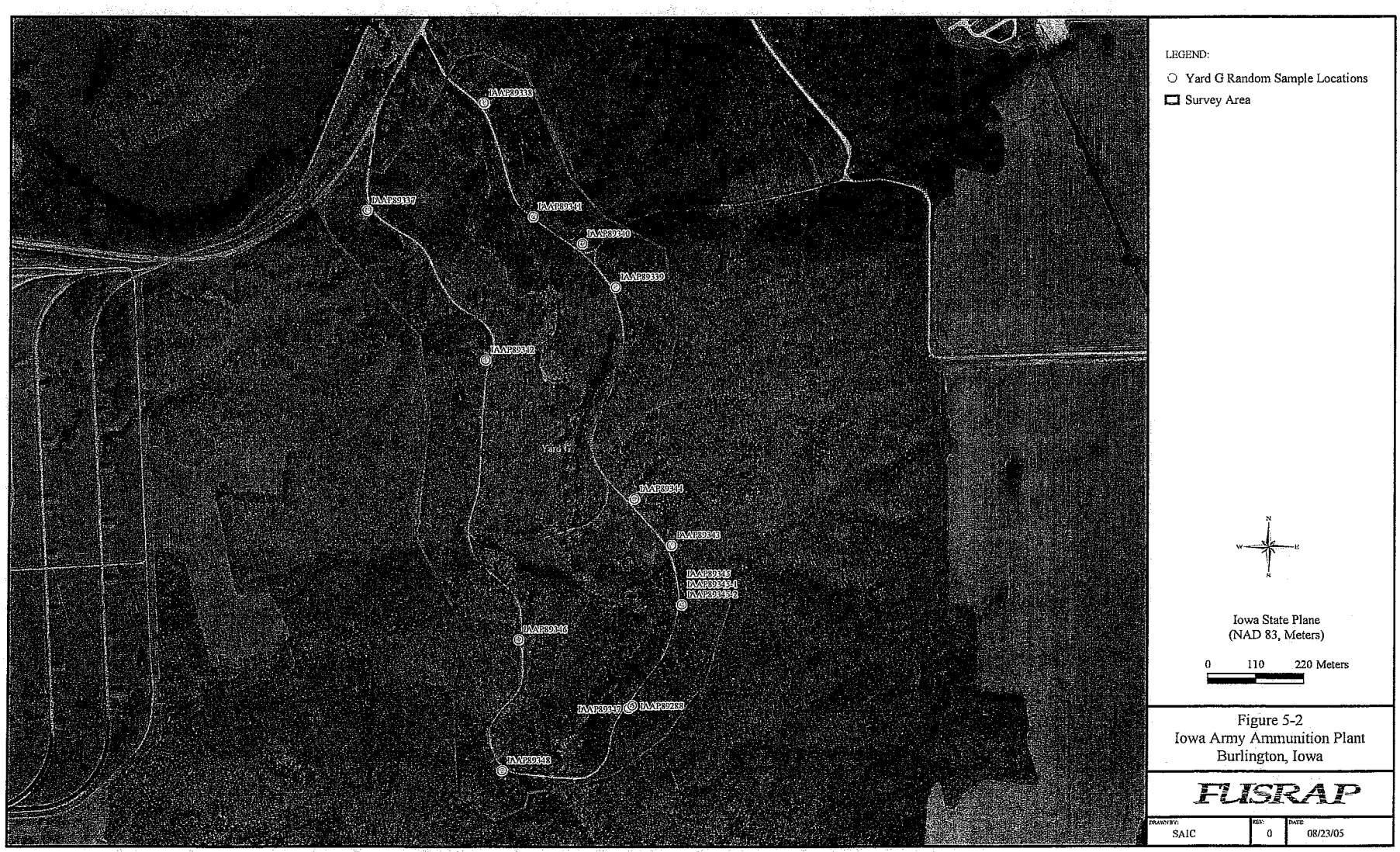


Figure 5-2. Yard G Random Sample Locations

Historical records indicate that only seven igloos were used for this purpose. AEC used the secured, fenced facility from 1948 until 1954 to store classified finished products. Yard G returned to Army control in 1975. No radioactive components were reportedly stored at Yard G. Although historical records do not indicate that Yard G was radiologically impacted by AEC operations, radiological surveys will be used to validate previous fly-over data by confirming the absence of radiological contamination.

Yard G is located within a heavily forested valley. The access road of Yard G runs in a horseshoe like shape along the valley wall. The igloos appear to have been constructed into the valley walls adjacent to the access road. In general, the land rises rapidly behind the igloos, consists of a small relatively flat area around the access doors and road, and then drops steeply from the edge of the access road towards Long Creek at the bottom of the valley.

After reviewing the PA and project history, it was determined that the investigation of Yard G should focus around the igloos used to store AEC materials and the transportation routes into and out of Yard G. However, no historical records were discovered that could identify which igloos were used for storage of AEC materials. Based on the topography of Yard G and historical references that no radiological material was stored at Yard G, the investigation of Yard G will initially concentrate on the soil areas surrounding the access doors of all igloos and upper drainage ditch along the adjacent access road.

5.2.2 Gamma Walkover Surveys

In general, the flat areas immediately in front of and adjacent to each igloo access door will receive 50-100% scan coverage. The upper drainage ditch adjacent to the access road will also receive 50-100% coverage. Surveys will also be performed at additional drainage features near the igloos or main roadway such as culverts and secondary swales or ditches. If elevated radiological activity is identified due to the presence of increased gamma readings, the survey will either attempt to determine the extent of the elevated activity or gather enough additional information for proper planning of additional surveys to be performed during the planned Remedial Investigation.

5.2.3 Structure Radiological Survey

The presence of radiological contamination in excess of the screening levels in the igloos within Yard G is not expected. However, as part of this survey effort, the accessible portions of 3 available igloos (10% of the igloos) will be surveyed. Beta scans will be performed in both selected bunkers to check for the presence of radiological contamination. It is possible that the initial survey will indicate the presence of radiological contamination due to naturally occurring radon and its progeny. The presence of radon will be confirmed or denied due to the decrease in count rates after ventilation of the bunker/building and/or the confirmation of the identified contamination having a short half-life. The short half-life will be determined by periodic counts of loose surface contamination swipes.

If the presence of radiological contamination, excluding radon, is identified and confirmed during the beta scans the structures will be considered impacted and will be addressed at a later date as a part of the Remedial Investigation. Since the beta scan MDA (721 dpm/100 cm^2) is well below the structure screening level (6000 dpm/100 cm^2), a minimum of two fixed-point alpha/beta and loose surface contamination measurements will be obtained in each building regardless of the results of the scan for quantitative purposes. The number of points is consistent with the size of the buildings.

5.2.4 Soil Sample Collection

Twelve random samples will be obtained within Yard G. Biased soil samples will be obtained as determined by the survey supervisor based on the results of the assessment and the gamma walkover survey. Randomly placed samples have been placed over this area as shown on Figure 5-2.

The soil samples will be limited to surface soil samples unless the screening investigation identifies evidence to suggest subsurface deposits of radiological contamination statistically different than the radiological contamination present in the surface soils.

5.3 YARD L

5.3.1 Historical Information and Data Review

Yard L is located along the northern boundary of the IAAAP, and is bounded by administrative buildings to the west, Lines 5A and 5B to the south, and the Roundhouse Transformer Storage Area to the east. The location of Yard L is depicted on Figure 5-3. Historical information indicates that, beginning in 1960, a portion of Yard L (Warehouses L3-71, L3-72, and L3-73) was used by the AEC to provide Line 1 storage space for classified component parts. This portion of Yard L has double security fencing. Radiation signs were posted in some buildings in Yard L. Information from a former employee indicated that Warehouse 21 was used for inert storage. Although historical records do not indicate that Yard L was radiologically impacted by AEC operations, radiological surveys will be used to validate previous fly-over data by confirming the absence of radiological contamination.

5.3.2 Gamma Walkover Surveys

In general, the areas immediately adjacent to rail line will receive 50-100% scan coverage. The drainage ditches that drain the rail line will receive 50-100% coverage. The main drainage located south of the main road will receive limited biased survey coverage, concentrating on the potential areas of sedimentation buildup. If elevated radiological activity is identified due to the presence of increased gamma readings, the survey will either attempt to determine the extent of the elevated activity or gather enough additional information for proper planning of additional surveys to be performed during the planned Remedial Investigation.

5.3.3 Structure Radiological Survey

The interiors and loading docks of Warehouse L3-71, L3-72, and L3-73 were surveyed by FUSRAP in 2003. No contamination was found (USACE, 2003).

5.3.4 Soil Sample Collection

Six random samples will be obtained within Yard L. Biased soil samples will be obtained as determined by the survey supervisor based on the results of the assessment and the gamma walkover survey.

Randomly placed samples have been established across this area as shown on Figure 5-3. Six samples were randomly distributed across Yard L drainage ditches. The soil samples will be limited to surface soil samples unless the screening investigation identifies evidence to suggest subsurface deposits of radiological contamination statistically different than the radiological contamination present in the surface soils. Currently, there is no evidence to suggest that the surface soils would not be representative of the radiological contamination concentration of the subsurface soils outside.

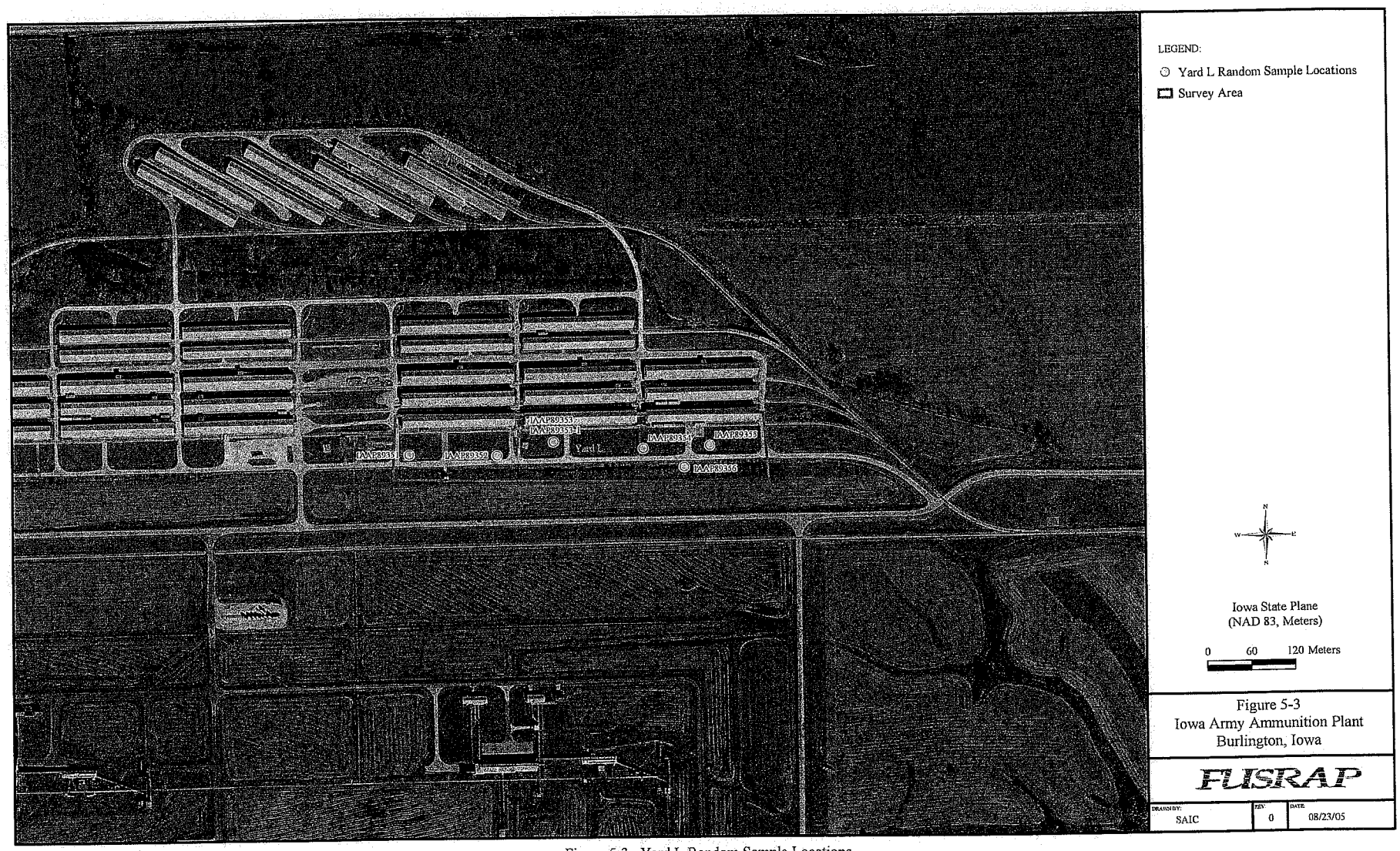


Figure 5-3. Yard L Random Sample Locations

5.4 BUILDING 3-01

5.4.1 Historical Information and Data Review

Warehouse 3-01 is located along the north-central border of Line 3 as shown in Figure 5-4. Line 1 history reports indicate the use of Warehouse 3-01 for storage of items from Line 1. Information obtained from a former employee at the site indicates that the warehouse was used as part of AEC operations. No radiological investigations specific to Warehouse 3-01 are known to have been conducted.

After reviewing the PA and the project history, it was determined that the investigation of this area should focus on the building itself.

5.4.2 Structure Radiological Survey

The presence of radiological contamination in excess of the screening levels within Warehouse 3-01 is not expected. However, a beta scan will be performed in areas of the warehouse that can be accessed safely to check for the presence of radiological contamination. It is possible that the initial survey will indicate the presence of radiological contamination resulting from naturally occurring radon and its progeny. The presence of radon will be confirmed or denied due to the decrease in count rates after ventilation of the building and/or the confirmation of the identified contamination having a short half-life. The short half-life will be verified by periodic counts of loose surface contamination swipes over a given time period.

If the presence of radiological contamination, excluding radon, is identified and confirmed during the beta scans, the structures will be considered impacted and will be addressed at a later date as a part of the Remedial Investigation. Since the beta scan MDA (721 dpm/100 cm^2) is well below the structure screening level (6000 dpm/100 cm^2), a minimum of two fixed-point alpha/beta and loose surface contamination measurements will be obtained in each building regardless of the results of the scan for quantitative purposes.

5.4.3 Soil Sample Collection

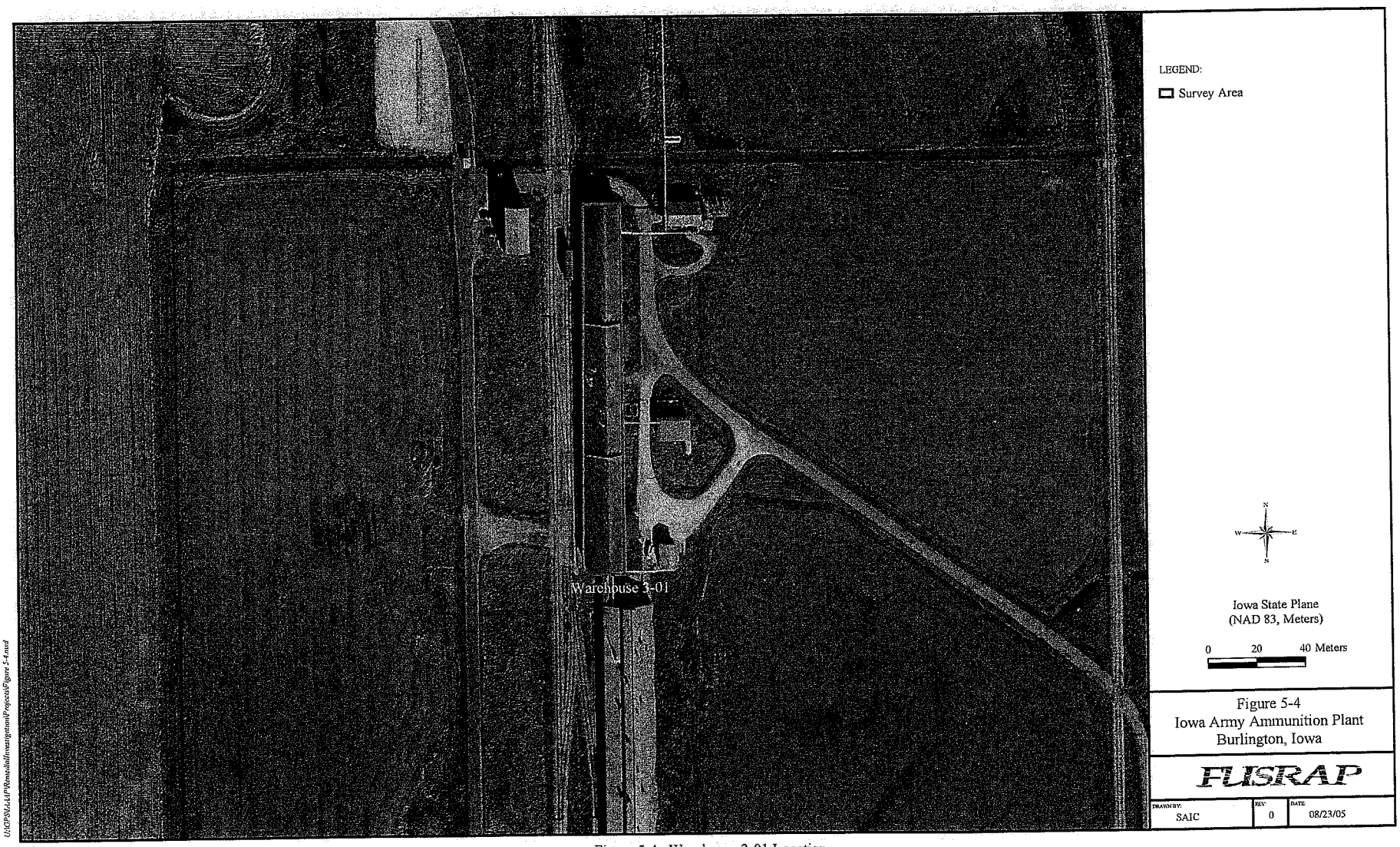
No soil sampling will be conducted at this time.

5.5 LINE 1

5.5.1 Historical Information and Data Review

The Line 1 site is located on 190 acres in the northeastern portion of the IAAAP, approximately one-half mile from the plant boundary as shown on Figure 5-5. It is bordered on its northwestern corner by the Abandoned Coal Storage Yard and on its southwestern corner by the Line 1 Former Wastewater Impoundment area (USACE, 2001). Line 1 is surrounded by a fence which serves as its boundary.

The main body of Line 1 buildings presently on-site were constructed prior to 1941. Operating buildings were built to be long lasting, with concrete foundations and floors, steel frames, and roof trusses, hollow tile walls, and asbestos roofing. Sewer tiles were constructed and connected to a central sewage treatment plant located south of Line 1 (TN&A, 2002). The AEC took over operations of the Line 1 facilities in 1947. AEC hired a contractor to design the facilities needed for nuclear weapon production. Notable changes were made to Buildings 1-03, 1-04, and 1-10. Building 1-08-2 was removed and replaced by Building 1-60 for barium nitrate preparation (TN&A, 2002). In 1975, AEC turned over operations of Line 1 to the US Army.



U:\OPS\Ia\IAP\Remedial\Investigation\Projects\Figure 5-4.mxd

Figure 5-4. Warehouse 3-01 Location

Figure 5-5. Line 1

- After reviewing the PA and the Line 1 project histories, it was determined that the investigation of this area should focus on areas around the buildings that were known to have AEC radiological operations. Figure 5-6 shows the buildings surveyed by AEC upon departure from the site and the buildings surveyed during a site investigation by DOE at a later date. Line 1 is relatively large with many industrial, access, and environmental conditions that limit access and survey efficiencies. The intent of this survey will be to establish the relative magnitude and extent of radiological contamination in the soils adjacent to the buildings with the highest potential.

5.5.2 Operational History of Line 1

5.5.2.1 General Line 1 Activities

The main body of Line 1 buildings presently on-site were constructed prior to 1941. Operating buildings were built to be long lasting, with concrete foundations and floors, steel frames, and roof trusses, hollow tile walls, and asbestos roofing. Sewer tiles were constructed and connected to a central sewage treatment plant located south of Line 1 (TN&A, 2002).

Where large quantities of explosives were to be loaded, remote controls were used behind strong barricades. There were many hand-operated devices for assembling inert or non-hazardous parts. Automated loading and assembling machinery were installed only where necessary, some of the equipment was semiautomatic for expediency. Construction of Line 1 was completed in September 1941 and loading operations began immediately thereafter (TN&A, 2002).

- Materials for ammunition production were shipped to Line 1 by train and stored in on-site storage buildings. These materials were then conveyed from the storage buildings to the melt buildings. Shells produced at Line 1 during this time contained a mixture of trinitrotoluene (TNT) and ammonium nitrate (amatol). TNT was melted and incorporated with ammonium nitrate long enough to ensure that each grain of ammonium nitrate was thoroughly coated with TNT (TN&A, 2002).
- Melt Buildings 1-05-01 and 1-05-02 were reportedly the primary source of explosive contamination during this time period. The drainage ways outside of almost every building was most likely used to convey wastes produced during the process toward Brush Creek.
- Production of ammunition was terminated in August of 1945. Operations after that date consisted only of completing work in process and renovating rejected ammunition. The government took over operation of long-term storage, surveillance, demilitarization, and reconditioning activities from the contractor in January of 1946 (TN&A, 2002).
- The AEC took over operations of the Line 1 facilities in 1947. AEC hired a contractor to design the facilities needed for nuclear weapon production. Notable changes were made to Buildings 1-04, 1-03, and 1-10. Building 1-08-2 was removed and replaced by Building 1-60 for barium nitrate preparation (TN&A, 2002).
- The first item of production after AEC took over operations at Line 1 was baratol (75:25 mixture of barium nitrate and TNT) and cyclotol (varying mixtures of RDX and TNT) castings. The buildings used in baratol production were:
- Building 1-60: for barium nitrate preparation
- Building 1-04: baratol lab
- Building 1-03: sample casting preparation and crusher building
- Building 1-10: baratol machining bay

Figure 5-6. Line 1 Previously Surveyed Buildings

- Building 1-05-1 and 1-05-2: melting and casting
- Buildings 1-06-1, 1-06-02, and 1-08-1: TNT storage and preparation
- Building 1-50: TNT inspection and transfer
- Buildings 1-71, 1-72, 1-74, 1-75, and 1-76: explosive components rest houses
- Building 1-73: X-ray services
- Building 1-12: X-ray training

Baratol and boracitol (60:40 mixture of boric acid and TNT) were utilized as thermonuclear primaries, whereby multi-stage nuclear weapons require a first stage fission bomb primary or trigger. After many practice runs, baratol casting production began November 1948. In January 1950, ortho and para nitrotoluene were introduced as casting crack preventatives.

In 1951, construction of new processing facilities began in order to accommodate a variety of different nuclear weapon models that had to be produced at the same time. Construction continued until 1952 or later. A new x-ray building was built, Building 1-100. This building also contained machining bays to complete machining operations required prior to x-ray. Contaminated water from machining operations flowed through aluminum-lined gutters to the Filter Building 1-70 clarifier for solids removal prior to discharge into Brush Creek (TN&A, 2002).

Another Component Rest House was built, Building 1-07 to provide additional bays for machining and assembly and shipping. Solids collected in the clarifiers were burned in the West Burn Pad Area (TN&A, 2002).

Anthracene was introduced as an anti-cracking agent in Composition B in 1953. Also, at this time, fly ash was added to the effluent discharged to Brush Creek for TNT removal.

Production schedules were reduced in 1954 which caused a number of buildings to go to layaway status, including: Machining buildings 1-10 and 1-12 one Melt Building 1-05-1 three Rest Houses 1-74, 1-75, and 1-76; and a Filter House 1-70 (TN&A, 2002).

In 1954, Vythene C was used as a solvent for cleaning instead of TCE and acetone. Use of this product was primarily in Building 1-01 (TN&A, 2002).

From 1954 to 1975, published historical information of activities at the facility is limited due to the secretive nature of operations. It is known that AEC continued explosive machining operations by production of explosive casts for nuclear weapons until pressing of plastic explosives into molds replaced them. A plastics lab was established in Building 1-60 in 1962. Also, at this time, the effluent waste system was upgraded to collect waste at its source and transfer it via piping systems to an effective treatment system and the installation of cooling towers began (TN&A, 2002).

An investigation to document the presence of beryllium was conducted from 1970 to 1973. Beryllium was thought to have originated as dust on incoming component parts that had not been adequately cleaned prior to shipment. An investigation to document the presence of methylene-bio-orthochloraniline (MOCA) began in 1971 (TN&A, 2002).

In 1975, AEC turned over operations of Line 1 to the US Army which began the production of 155 mm artillery ammunition. Prior to turning over Line 1 to the US Army the AEC surveyed the following buildings; 1-11, 1-12, 1-13, 1-19, 1-40, 1-63, 1-64, 1-65, 1-66, 1-67, 1-77, and 1-137-2, in addition to 43 igloos in Yard C. Production of the 155 mm artillery ammunition was later moved to Line 3. In 1977, Line 1 acquired the ability to produce grenades, and warheads. A new x-ray unit was installed in Building 1-100 to radiograph warheads (TN&A, 2002).

From 1978 to 1988, munitions production was steady. Weapons produced included warheads. Waste releases were regulated and controlled during this time period (TN&A, 2002).

5.5.2.2 Detailed Description of Activities Performed in Individual Buildings of Line 1

A significant portion of the environmental investigations at Line 1 are with respect to the individual buildings because the activities performed or chemicals used/stored in these buildings are the sources or potential sources of contamination of environmental media. The subsections below describe the historical activities of the individual buildings of Line 1, grouped with respect to function. Specific information regarding the chemicals used, produced, and/or stored in them is also provided in order to develop a sampling and analysis strategy for soil samples collected in the vicinity of each building. In some instances, buildings are presented in more than one section as they may serve more than one function.

Wood and Metal Shops: Building 1-01 and 1-148

Building 1-01 was used primarily for Inert Pour and Inert Storage, as well as for a number of wood and metal shops, including: sheet metal, carpenter, electric, pipe, and machine. This building was also used for battery charging. Chemicals which may have been used in some capacity for these activities would likely include oils, degreasers, solvents, solders, paints, machine coolants, acids, and detergents, for example.

Building 1-148 was used for tool maintenance. Little else is known about this structure.

Fuel Storage Buildings/Structures: Building 1-02, 1-36, 1-152-1, 1-152-2, 1-152-9 through 1-152-13

Building 1-02 was used as a powerhouse building and compressed air plant with heating oil storage. Fuel oils may have been used.

Building 1-36 was used for flammable materials storage.

Building 1-152-1, 1-152-2, and 1-152-9 through 1-152-13 were used for fuel storage.

Chemicals stored in these buildings appear to be primarily oils and fuels.

Research and Development Buildings: 1-03, 1-04, 1-53, 1-60

Research and development activities at the IAAAP included the electrolytic disposal of lead azide, activated carbon regeneration for red water control, and explosives development involving barium nitrate and TNT. Specific activities for these buildings are presented below:

Building 1-03 was used for paint storage and mixing; explosive cast sample crushing; and equipment testing.

Building 1-04 was used for receiving, storage, and painting, and later for general administrative purposes. This building also housed a chemistry lab and one of its functions was to test nitrocellulose and stearoxyacetic acid. It has also been suggested that MOCA was used in the lab of Building 1-04.

Building 1-53 was used for scrap recovery and storage of chemical equipment and materials. This building also housed a plastics lab where MOCA was prepared.

Building 1-60 housed a barium nitrate lab for the production of baritol and was converted into a plastics lab in 1962. It was noted that MOCA and boric acid was used in this building.

Solvent Storage Buildings: 1-03-1 through 1-03-7

Buildings 1-03-1 through 1-03-5 were used for solvent storage.

Building 1-03-6 was used for flammable material storage.

Building 1-03-7 was used for chemical storage.

Melt Buildings: 1-05-1 and 1-05-2

The melt buildings were among the first buildings to be constructed on Line 1. The melt buildings were used to produce explosive components for shell munitions and nuclear weapons. Explosive melts consist of: ammonium nitrate, TNT, boron-based explosives, barium-based explosives, RDX, HMX, and PBX. Baritol was the primary explosive compound produced.

Explosives Storage Buildings: 1-06-1, 1-06-2, 1-08-1, 1-08-2, and 1-50

The explosives storage buildings were used for the storage of TNT, ammonium nitrate, nitrocellulose, and stearoxyacetic acid.

Component Rest Houses: 1-71, 1-72, 1-74, 1-75, 1-76, and 1-77

Temperature controlled buildings used to allow munitions time between operations to reach thermal equilibrium. In addition, AEC constructed Building 1-77 to apply thermal coating and drying of components

Machining Buildings: 1-10, 1-12, 1-40, and 1-100

Machining activities primarily consisted of machining an explosive cast that would be designed to fit around the core of a nuclear weapon. Solvents were utilized in cleaning and maintenance of the machining equipment. MOCA was also detected in air samples collected from Buildings 1-10, 1-12, and 1-40.

Receiving and Storage: Building 1-11 and 1-85-2

Building 1-11 was constructed by the AEC, in 1957, for the purpose of shipping and receiving raw materials used in ordnance assembly. Materials included DU, tritium bottles, and beryllium-containing components. Building 1-85-2, built in 1974 by AEC, was designated for project assembly shipping and receiving.

Radiological Materials Storage Buildings: 1-11, 1-12, 1-13, 1-61, and 1-40

Depleted uranium and tritium were stored in these buildings prior to their use in the production of nuclear weapons.

Former AEC Assembly Buildings: 1-61 and 1-63-1 through 1-63-7

Building 1-61 was built during AEC operations at Line 1 in 1051. Six AEC Assembly Buildings, 1-63-1 through 1-63-6, were built in 1957 on the northeastern side of Line 1. Building 1-63-7 was built in 1974 on the southwest side of Line 1.

Former AEC Storage Buildings: 1-64-1 through 1-64-5; 1-65-3 through 1-65-7; and 1-66-1 and 1-66-2

These storage buildings were built to either support AEC operations or were added after AEC operations at Line 1. Explosives or components needed in munitions assembly were stored in these buildings. It is also possible that other chemicals such as solvents or adhesives were also stored here.

Filter Buildings: 1-70 and 1-71

Explosives contaminated waste waters were treated in these buildings during AEC operations. Treatment consisted of clarifiers for suspended explosive particle removal and carbon filtration systems to remove dissolved explosive compounds. Treatment processes resulted in waste sludge and filters, which were incinerated in burning areas of the IAAAP.

X-ray Buildings: 1-73 and 1-100

Housed equipment used to take x-rays of completed components to find flaws and collect data. Materials used and waste from typical x-ray facilities typically include silver containing solutions (silverthiosulfonate), chromium containing system cleaners, and lead foil.

Transformers and Substations: 1-169-1, 1-169-3 through 1-169-17, and 1-169-19 through 1-169-31, 1-169-A through 1-169-D

The primary chemical concern for soils in the vicinity of the transformers and substations would be PCBs.

Cooling Towers: 1-155-1 through 1-155-4

Cooling towers were installed by AEC to provide water recovery when water consumption was high. Cooling towers have not been used for many years, or decades. Chromium was used to inhibit corrosion.

5.5.3 Previous Environmental Investigations at the IAAAP and Line 1

The USEPA Region 7 performed an assessment at the IAAAP in 1987 under the Resource Conversation and Recovery Act (RCRA) and concluded that chemical contaminant releases had occurred (TN&A, 2002). A Federal Facility Agreement (FFA) was signed in 1988 between the USEPA and the US Army Installation Restoration Program (IRP). The USEPA proposed IAAAP for the National Priority List (NPL) and the site was added to the NPL in 1990. In 1991, the US Army IRP conducted Preliminary Assessments/Site Investigations (PA/SIs) to identify areas of potential contamination. Forty-three areas of known or suspected contamination were identified during the PA/SIs and based on this information, the USEPA and the Department of Defense (DOD) entered into an interagency agreement that the site was to be investigated and remediated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

In 1992 and 1993, a Remedial Investigation/Feasibility Study (RI/FS) was conducted under the management of the US Army Environmental Center, with results presented in the *Revised Draft Final Remedial Investigation/Risk Assessment, Iowa Army Ammunition Plant, Middleton, Iowa* (JAYCOR, 1996).

In 1994, the Omaha District of the USACE, through the IRP, was tasked with the Remedial Design/Remedial Action (RD/RA) based on the US Army Environmental Center RI data. In 1997, the US Army Environmental Center was tasked with the remedial action for soil and groundwater based on chemical contamination. The US Army Environmental Center contractor, Harza Engineering Company, performed IRP work at the IAAAP that resulted in the production of the following site documents:

- Basewide Groundwater Data Gap Work Plan (1996)
- Supplemental RI Basewide Groundwater Data Gaps (1997)
- Ecological Risk Assessment Addendum, Feasibility Study, Proposed Plan and Record of Decision for the Basewide Groundwater (1997)
- Supplemental Ecological Risk Assessment Addendum, Long-Term Monitoring for FY00 and the Long-Term Monitoring Plan (1999)

Based on the RI (JAYCOR, 1996) and the Human Health Baseline Risk Assessment (ICAIR, 1996), an Interim Record of Decision (ROD) that encompasses IAAAP site soils as Operable Unit (OU) 1 was signed September 1998 by the EPA and the Army IRP. The Interim ROD addresses one of the principal threats posed by the soil OU by temporarily stockpiling, for future treatment, the most highly contaminated soils, and permanently disposing of the remaining contaminated soils. The most highly contaminated soils were to be stockpiled in the on-site

Corrective Action Management Unit (CAMU), with construction specifications to meet RCRA Subtitle C landfill requirements. Soil was deemed to be contaminated if measured chemical concentrations exceeded the remediation goals (RGs) established for specific chemicals based on their assessment in the Baseline (Human Health) Risk Assessment.

The Interim ROD noted that at Line 1, there were 25 separate areas from which contaminated soils should be removed. Soils contaminated with explosives, metals, and semivolatile organics (SVOCs) were found adjacent to explosives production buildings, a vacuum pump house, and a cooling tower. The bulk of the contaminated soil volume at Line 1 was deemed to be due to explosives and lead. RDX and TNT in soil were found to be near 1,000 mg/kg, and in some areas as high as 9,000 mg/kg. Lead in soils of Line 1 was reported to range form 2,000 to 5,000 mg/kg (US Army Environmental Center, 1997).

At the request of the DOE, Oak Ridge National Laboratory (ORNL) conducted an indoor radiological survey which included all the buildings surveyed by AEC in 1975 including five additional buildings denoted below at the IAAAP in 2000 and published their findings in *Results of the Indoor Radiological Survey of the Iowa Army Ammunition Plant, Middletown, IA*, July 2001. The objective of the survey was to determine if radioactive residuals from previous AEC activities were present inside selected Line 1 buildings and to conduct sampling in those areas of previous AEC operations that utilized radioactive components in order to evaluate any possible immediate health hazards and to collect sufficient information to determine the next type of survey required (ORNL, 2001). The Line 1 building survey included a surface beta-gamma scan of accessible areas inside buildings, a scan of greater than 80% of floor surfaces with a floor monitor probe, a scan of less accessible areas with a beta/gamma pancake probe, and direct measurement of gamma, alpha, and beta-gamma radiation levels inside the buildings. About 1% of the wall surfaces in each room were scanned for both alpha and beta-gamma radiation using portable instrumentation where areas of floor contamination were found. A small percentage of the overhead structures were also surveyed for both alpha and beta-gamma radiation, depending upon how much contamination was detected on floor areas. Measurements were also made on miscellaneous structures, including air ventilation systems, floor drains, equipment, and window sills. Special attention was given to areas where contamination typically collects (i.e., cracks, joints, and corners). Surveyed buildings include those on the list below (ORNL, 2001):

1-11	1-63-2	1-65-4
1-19-4	1-63-3	1-65-5
1-12	1-63-4	1-65-6
1-13	1-63-5	1-65-7
1-18*	1-63-6	1-66-1
1-19-6	1-63-7	1-66-2
1-19-7	1-64-1	1-67-1
1-19-1	1-64-2	1-67-2
1-19-2	1-64-3	1-67-3
1-19-3	1-64-4	1-77
1-19-5	1-64-5	1-100-1*
1-40	1-65-1	1-100-2*
1-61*	1-65-2	1-137-4*
1-63-1	1-65-3	1-148*

* Denotes Building Surveyed By DOE Only

In addition to the walkover surveys, on-site and subsequent radionuclide analyses were performed on samples. Systematic air samples, in addition to biased debris and smear samples, were collected from some buildings for radionuclide analysis. Systematic samples were

collected without regard to radiation level; biased samples were collected at locations of elevated beta-gamma levels. Residual radioactive materials were found in the following buildings (ORNL, 2001):

- Building 1-11. Contamination was limited to the northwest corner of the building. A soil sample collected outside the exit door in the northwest corner was found to contain only DU and a trace amount of cesium-137, consistent with fallout from aboveground weapons tests. It was concluded that based on historical records and site conditions, the contamination in Building 1-11 is likely the result of AEC activities.
- Building 1-12 Contamination was found to be limited to the concrete seam of Bay CC in Building 1-12, with the maximum measurement of 13,000 dpm/100 cm^2. Analysis by gamma spectroscopy of a sample collected from this seam indicated the contamination to be DU. The source of contamination found at Building 1-12 was not determined as both AEC and the Army have conducted operations in this building.
- Building 1-61. Contamination was found inside a plastic storage pan (removed and disposed of) located in Bay R and it was identified by gamma spectroscopy as DU. It was found to be readily transferable. A smear sample of the pan was analyzed showing 2,500 dpm/1100 cm2. Direct measurements were as high as 1000 dpm/100 cm2 alpha and 30,000 dpm/100 cm2 beta. The contaminated plastic storage pan found in Building 1-61 was relatively new, suggesting that the contamination was likely due to Army operations.
- Building 1-63-6. Contamination was found in four locations of Building 1-63-6. All contamination found was identified by gamma spectroscopy as DU. A small spot (<50 cm2) of loose contamination was found near the entrance; however, a smear sample indicated the material was not readily picked up by conventional smear sampling. Another sample collected from the debris was analyzed and found to have 39,000 pCi/g DU. Direct measurements revealed 150,000 dpm/100 cm2 alpha, and 14 μR/h gamma at the spot. Samples taken from a sump and floor drain were analyzed and results showed 2.0 pCi/g and 86 pCi/g DU, respectively. The most significant contamination found was on the return air filters in the round process area of Building 1-63-6. Air filters were found to be contaminated at levels of 20,000 to 30,000 dpm/100 cm^2 beta-gamma. A portion of one of the filters was analyzed by gamma spectroscopy and showed 2,600 pCi/g of DU. Because of the newness of the air filters and radiation protection signs posted at the building, contamination is most likely due to Army operations at IAAAP.

In 2000, TN&A was tasked by the Omaha District USACE supporting IRP to further delineate the nature and extent of chemical contamination in and around Line 1 of the IAAAP. Their efforts included a five-month long search of the historical operation and production activities and chemicals used at Line 1. In addition to the historical research, the analytical results from the previous environmental investigation conducted by JAYCOR (1996) were used in developing the rationale behind sample collection and chemicals to be measured. Areas of potential chemical releases were determined, soil samples were collected from these areas and chemically analyzed, and chemical results were evaluated and reported in the *Line 1 and Firing Site Supplemental RI Report, IAAAP, Middletown, Iowa* (TN&A, 2002). Much of the history of Line 1 presented herein has been taken from TN&A's *Supplemental RI Work Plan* (TN&A, 2001) and *Supplemental RI Report* (TN&A,2002).

To perform the RI of Line 1, TN&A divided the area in building groups based on their historical operations. The building groups were then further broken down by individual buildings. The

building groups investigated at Line 1 by TN&A are presented in subsections below including a brief summary of the environmental samples collected, sample locations, and chemicals detected.

Melt Buildings: 1-05-1 and 1-05-2

Currently Buildings 1-05-1 and 1-0502 are in layaway status, but previously, explosives-contaminated wastes had migrated from these buildings toward Brush Creek through drainage ways. Twenty-six soil samples were collected in and around Building 1-05-1. Samples were collected at the following exterior locations: the southeast corner doorway, the south doorway, the southwest corner doorway, at a location northwest of the building, at the north section of the building along the west wall, and at a location northeast of the building. At each of these locations, four samples were collected at the discrete intervals of: 0-1, 1-2, 2-4, and 4-6 ft. Surface soil samples were analyzed for only metals, and the remaining subsurface soil samples were analyzed for only explosives. Three samples were collected from the basement inside Building 1-05-1 from two dirt floor at locations described as wash water overflow. One sample was collected at the right bay at a depth of 0-1, and two samples were collected from the middle bay at depths of 0-1 and 4-6 ft. These three interior samples were analyzed for explosives only.

TN&A reported a small pool of pink-colored water in the basement of Building 1-05-1 which they suspected to be explosives-contaminated and suggested that explosives could be moving to the surrounding subsurface areas outside of the building basement. However, none of the soil sample analytical results reported metals or explosives at concentrations greater than their respective RGs or PRGs (TN&A, 2002).

Fifteen soil samples were collected in and around Building 1-05-2. Samples were collected at the following exterior locations: northwest and southwest of the building. At each of these locations, four samples were collected at the discrete intervals of 0-1, 1-2, 2-4, and 4-6 ft. Surface samples were analyzed for metals only and subsurface samples were analyzed for explosives only. Three samples were collected inside the building from the dirt floor at locations described as wash water overflow areas of the right bay, the middle bay and the left bay of the basement at a depth of 0-1 ft. These three interior samples were analyzed for explosives only.

TN&A reported that RDX was found at concentrations greater than the RG from samples collected on the northwest side of Building 1-05-2 and have concluded that this is an area of concern (TN&A, 2002). All three samples collected from inside Building 1-05-2 reported RDX and TNT concentrations greater than their respective RGs. TN&A also report visual observations of a pool of red-colored water suspected to be explosives-contaminated and a potential source of contamination of the surrounding subsurface areas of the building. One sample collected from the northern end of the building was reported to have a lead concentration greater than the RG. They reported that the southwest portion of Building 1-05-2 should be considered an area of concern (TN&A, 2002).

Machining Buildings: 1-10, 1-12, and 1-40

Fourteen soil samples were collected from the exterior locations of Building 1-10 at the following locations: the northeast, northwest and southwest corners of the building. At each of these locations, four samples were collected at the discrete intervals of 0-1, 1-2, 2-4, and 4-6 ft. Surface samples were analyzed for metals only and subsurface samples were analyzed for explosives and VOCs. The soil sample collected from the 2-4 ft depth at the northwest corner of the building, reported an RDX concentration greater than its RG. All other sample results were found to be lower than their respective RGs.

Thirty one soil samples were collected from the following exterior locations of Building 1-12: West of the building on the north end, northwest corner on the north side, the northwest corner of

Building 1-10, and the east, southeast, southwest, and west sides of Building 1-10. Samples were collected from the discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. At two locations, the northwest and northeast corner of the building, soil sample results reported concentrations of RDX greater than the RG.

Eight soil samples were collected from two exterior locations of Building 1-40. Discrete soils samples were collected at depths of: 0-1, 1-2, 2-4, and 4-6 ft. The surface soil samples were analyzed for metals only and all subsurface samples were analyzed for explosives. For one sample location, 104007, additional analytical testing included VOCs and SVOCs. No metals, explosives, VOCs, or SVOCs were found at concentrations greater than their respective RGs (TN&A, 2002).

Research and Development Buildings: 1-03, 1-04, 1-53, and 1-60

Soil samples were collected from four locations exterior to Building 1-03, including: the west and east sides of the building and two doorways. Samples were collected at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. Only surface soil samples were analyzed for metals and subsurface samples were analyzed for explosives, VOCs, and SVOCs. There were no analytical results reported at concentrations greater than their RGs(TN&A, 2002) .

Four soil samples were collected at one location on the west side of Building 1-04 at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. The surface soil sample was analyzed for metals only and subsurface samples were analyzed for explosives, VOCs and SVOCs. One sample result showed a detection of one SVOC [1,2,3-cd (pyrene)] at a concentration above the PRG (TN&A, 2002) .

Soil samples were collected from two locations exterior to Building 1-53, including: the southeast corner of the building and the doorway on the northeast corner of the building. Samples were collected from four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. The surface sample was analyzed for metals only and the subsurface samples were analyzed for explosives, VOCs, and SVOCs. No analytical sample results were reported for any chemicals at concentrations greater than their RGs (TN&A, 2002).

Six samples were collected at two exterior locations of Building 1-60, at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. Sample locations included the east and north side of the building. Surface soil was analyzed only for metals and subsurface samples were analyzed for explosives, VOCs, and SVOCs. Barium and arsenic were detected at concentrations greater than their RGs and (1,2,3-cd)pyrene was detected at a concentration greater than its PRG from the samples collected from the area north of the building. Of note, the barium concentration (12 mg/kg) was the highest concentration detected during this investigation. Chromium was detected at a concentration above background levels at the location to the east of the building (TN&A, 2002).

Material Storage Buildings/Structures:

Explosives Storage Buildings: 1-06-1, 1-06-2, 1-08-1, 1-08-1A, and 1-50

Four samples were collected from one exterior location of Building 1-06-1, southwest of the building, at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. The surface sample was analyzed for metals and the subsurface samples were analyzed for explosives. No analytical results were greater than the RGs for these analytes (TN&A, 2002).

Samples were collected from the eastern and western sides of Building 1-06-2 from four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. The surface sample was analyzed for metals and the subsurface sample was analyzed for explosives. Chromium was detected at a concentration greater than its background level in a sample collected near a door on the eastern side of the

building, however, no analytical results indicated any chemicals at concentrations greater than their RGs (TN&A, 2002).

TN&A collected samples from three locations around drainage ad doorway areas on the western and southern sides of Building 1-08-1. Surface samples were analyzed for metals and subsurface samples were analyzed for explosives. No sample analytical results were reported for any chemical at a level greater than its RG. TN&A collected soil samples in the drainage ditch at Building 1-08-1A and analyzed them for explosives. No concentrations were reported at levels greater than their RGs (TN&A, 2002).

TN&A collected samples for explosives and metals analyses at three locations around Building 1-50. Two samples were collected from the northeast and southeast sides of the building and one sample location was on the western side of the building. No explosives or metals were detected at any of these locations (TN&A, 2002).

Solvent Storage Buildings: 1-03, and 1-03-1 through 1-03-7

TN&A collected soil samples from the berm areas just outside the doorways of the solvent storage buildings for the purpose of analyzing them for VOCs only. At one sample location on the east side of building 1-03-4, samples collected were analyzed for metals, explosives, VOCs, and SVOCs. Additional samples were collected from the drainage ditch outside the doorway of Building 1-03-7. No sample analytical results reported concentrations of chemicals greater than their respective RGs (TN&A, 2002).

AEC Receiving and Storage Buildings: 1-11 and 1-85-2

TN&A collected soil samples from six locations around the doorways and drainage ways of Building 1-11 and analyzed them for explosives, metals and VOCs. No chemicals were found at concentrations greater than their RGs (TN&A, 2002).

TN&A collected samples for two locations exterior to Building 1-85 and analyzed them for explosives, metals, and VOCs. One sampling location was located by a door on the south side of the building and the other location was beside the main loading dock. No chemicals were detected at levels greater than their RGs (TN&A, 2002).

Fuel Storage Buildings/Structures: 1-02, 1-36, 1-152-1, 1-152-2

TN&A collected samples for VOCs and SVOCs analyses at the 1-2 and 2-4 ft depth intervals from six locations exterior to Building 1-02. No chemical concentrations were detected at levels greater than their RGs (TN&A, 2002).

TN&A collected samples from three exterior locations of Building 1-36. One location was directly below the south loading dock and the other locations were on the northern and western sides of the building. Samples were analyzed for metals, VOCs, and SVOCs. No chemicals were detected at levels greater than their RGs (TN&A, 2002).

TN&A collected soil samples from two depth intervals (1-2 ft and 2-4 ft) at seven locations in areas around all fuel tanks 1-152-1 and 1-152-2. Samples were analyzed for VOCs and SVOCs. No chemicals were detected at levels greater than their RGs (TN&A, 2002).

Transformer Stations

Transformer stations support the electrical needs of building operations across Line 1. TN&A collected soil samples from 24 transformer stations at two depth intervals, 0-1 and 1-2 ft. Samples were analyzed for PCBs. One PCB, Aroclor 1260, was detected in a sample collected from one station, 1-169-15, but at a concentration below action levels. No PCBs were detected in soil samples collected from any of the other transfer station locations (TN&A, 2002).

Component Rest Houses: 1-71, 1-72, 1-74, 1-75, 1-76, and 1-77

Soil samples were collected at locations near doorways and in drainage ways fro each of the rest houses 1-71, 72, 74, 75, 76, and 77. Samples were collected at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft and analyzed for metals and explosives. Analytical results did not show any chemicals detected above RGs (TN&A, 2002).

X-ray Buildings: 1-73 and 1-100

TN&A collected soil samples from four locations in doorways and drainage ways around Building 1-73 at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft and analyzed for metals and explosives. Surface soil samples were analyzed for metals and subsurface soil samples were analyzed for explosives. RDX was detected in one sample collected from the drainage ditch east of Building 1-73 at a concentration greater than the RG. It cannot be determined that Building 1-73 was the source of this contamination however because this drainage ditch serves multiple site buildings. At the sample location near the doorway of Building 1-73, RDX was also detected and at this location, RDX was shown to increase in concentration with depth (TN&A, 2002).

Samples were collected at three locations exterior of Building 1-100, and analyzed for metals, explosives, and VOCs. Analytical results for a sample collected from the area of the former wastewater discharge pipe outfall showed a silver detection at a concentration greater than its PRG. At another sample location on the south side of the building, arsenic was reported at a concentration greater than its RG (TN&A, 2002).

Wood and Metal Shops: Building 1-01

Samples were collected at four exterior locations of Building 1-01 around the doorways and drainage ways, including: an area west of the building, at the northwest corner of the building, and at two locations between Buildings 1-01 and 1-148. Samples were collected at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. Surface samples were analyzed for metals and subsurface samples were analyzed for explosives and VOCs. No chemical analytical results reported detections at concentrations greater than their respective RGs (TN&A, 2002).

Former AEC Assembly and Storage Buildings: 1-61 and 1-63-1 through 1-63-7

TN&A collected soil samples at five locations around doorways and drainage ways of Building 1-61, including: the dumpster pad at the northwest corner of the building, the ditch north of the building, on the north side of the building, and the southwest and southeast corners of the buildings. Samples were collected at four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. Surface samples were analyzed for metals and subsurface samples were analyzed for explosives and SVOCs. One sample collected from the southeast corner of the building had a detection of arsenic at a concentration just above the RG (TN&A, 2002).

Samples were collected from the nearest doorways from each of the assembly cells along a nearby drainage ditch and analyzed for metals and explosives. No samples reported chemical detections at concentrations greater than their RGs (TN&A, 2002).

Filter Buildings: 1-70 and 1-70-1

Samples were collected from three locations in drainage ways around Building 1-70. All locations had samples that showed detections of explosives, RDX and TNT, however at two locations, RDX was found at concentrations greater than the RG. At the sample location of the drainage ditch east of the building RDX was found at the highest concentration of all samples analyzed during this investigation. The 1-2 ft depth RDX concentration was found to be 660 mg/kg, the 2-4 ft depth was found to be 110 mg/kg, and the 4-6 ft depth sample was found to be

3.7 mg/kg; all results being greater than the RG for RDX. At one other sample location, 107001, RDX was found to be greater than the RG at the 2-4 ft depth (TN&A, 2002).

Soil samples were collected from three locations around Building 1-70-1 and in the nearby drainage ditch. Samples were analyzed for explosives and metals. While some explosives and metals were detected, none were found at concentrations greater than their RGs (TN&A, 2002).

Cooling Towers: 1-155-1, 1-155-2, 1-155-3, and 1-155-4

TN&A collected soil samples from around each of the cooling towers for explosives and metals analyses. No samples were found have metals or explosives at concentrations greater than their RGs (TN&A, 2002).

Drainage Ways and Impoundments

TN&A collected soil samples from 27 locations in drainage ways of Line 1. At each location, samples were collected from four discrete depths of 0-1, 1-2, 2-4, and 4-6 ft. Surface samples were analyzed for metals and subsurface soil samples were analyzed for explosives. At only one location, 10DD19, barium was detected at a concentration greater than its PRG. No other soil sample analyses resulted in detections of metals or explosives greater than RGs or PRGs (TN&A, 2002).

Based on review of historical information, this radiological survey will focus on soil areas around Line 1 buildings that historical records indicate have been, or might have been, used for AEC radiological operations as shown on Figure 5-6. Line 1 in its entirety will be further assessed for chemical contamination during the RI.

5.5.4 Topography and Surface Water Features of Line 1

The location and topography of the Line 1 Area are depicted on Figure 5-7. Line 1 topography is primarily flat with an average elevation of approximately 700 ft above mean sea level. Several sloped areas and storm water drainage ditches convey storm water runoff from the site to storm water outfall 001. The storm water eventually discharges to Brush Creek. Brush Creek exits along the southeastern boundary of the site and then flows in a southeasterly direction for approximately 6.44 km before entering the Mississippi River (TN&A, 2002).

Five watercourses drain IAAAP (Figure 5-7). Little flint Creek drains a small area in the north of the site. The rest of the installation is drained by, west to east, the Skunk River, Long Creek, Brush Creek, and Spring Creek. Long Creek is a tributary of the Skunk River, which flows to the Mississippi River. Brush and spring Creeks are tributaries of the Mississippi River (TN&A, 2002).

5.5.5 Hydrogeology

The two main aquifers affected at the IAAAP are the loess/till aquifers (drift aquifer) and the underlying upper bedrock aquifer. The majority of contaminant movement takes place in the drift aquifer. The top of groundwater in the drift aquifer generally occurs within 10 ft of the

Figure 5-7. IAAAP Topgraphy and Water Courses

ground surface and often less. Shallow groundwater flow closely parallels the ground surface. Thus, shallow groundwater flow throughout the installation is from high points, including most of the Line 1 and Yard areas, toward surface drainages, particularly the larger streams such as Spring, Brush, and Long Creeks and the Skunk River. The water in the upper bedrock aquifer generally flows to the south and east, toward the Skunk and Mississippi Rivers. In some on-site areas, including the southwestern part of IAAAP, the upper bedrock aquifer is exposed at ground surface and discharges into surface waters. Elsewhere at IAAAP, the upper bedrock aquifer lies at depths of more than 50 or 100 ft (ATSDR, 1999).

5.5.6 Gamma Walkover Surveys

The gamma walkover scan will be concentrated in the two focus areas shown on Figure 5-6. In general, the areas immediately adjacent to potentially impacted buildings, adjacent rail lines, drainage ditches in the immediate vicinity and obvious low points will receive 50-100% scan coverage. Court yards and other open areas located in the near vicinity of the target buildings will receive limited biased coverage of at least 10%. If radiological contamination is identified due to the presence of increased gamma readings, the survey will either attempt to determine the extent of the contamination or gather enough additional information for proper planning of additional surveys to be performed during the planned Remedial Investigation.

5.5.7 Structure Radiological Survey

Structures will be surveyed during the RI, to be performed at a later date.

5.5.8 Soil Sample Collection

Twenty four random samples will be obtained within this area. Twelve of the twenty-four random samples will be obtained from the targeted west side of line 1 with the remaining twelve samples being obtained from the area targeted on the east side of Line 1. Biased soil samples will be obtained as determined by the survey supervisor based on the results of the assessment and the gamma walkover survey. Randomly established sampling locations have been established over this area as shown on Figure 5-8 and Figure 5-9.

The soil samples will be limited to surface soil samples unless the screening investigation identifies evidence to suggest subsurface deposits of radiological contamination statistically different than the radiological contamination present in the surface soils. Currently, there is no evidence to suggest that the surface soils would not be representative of the radiological contamination concentration of the subsurface soils.

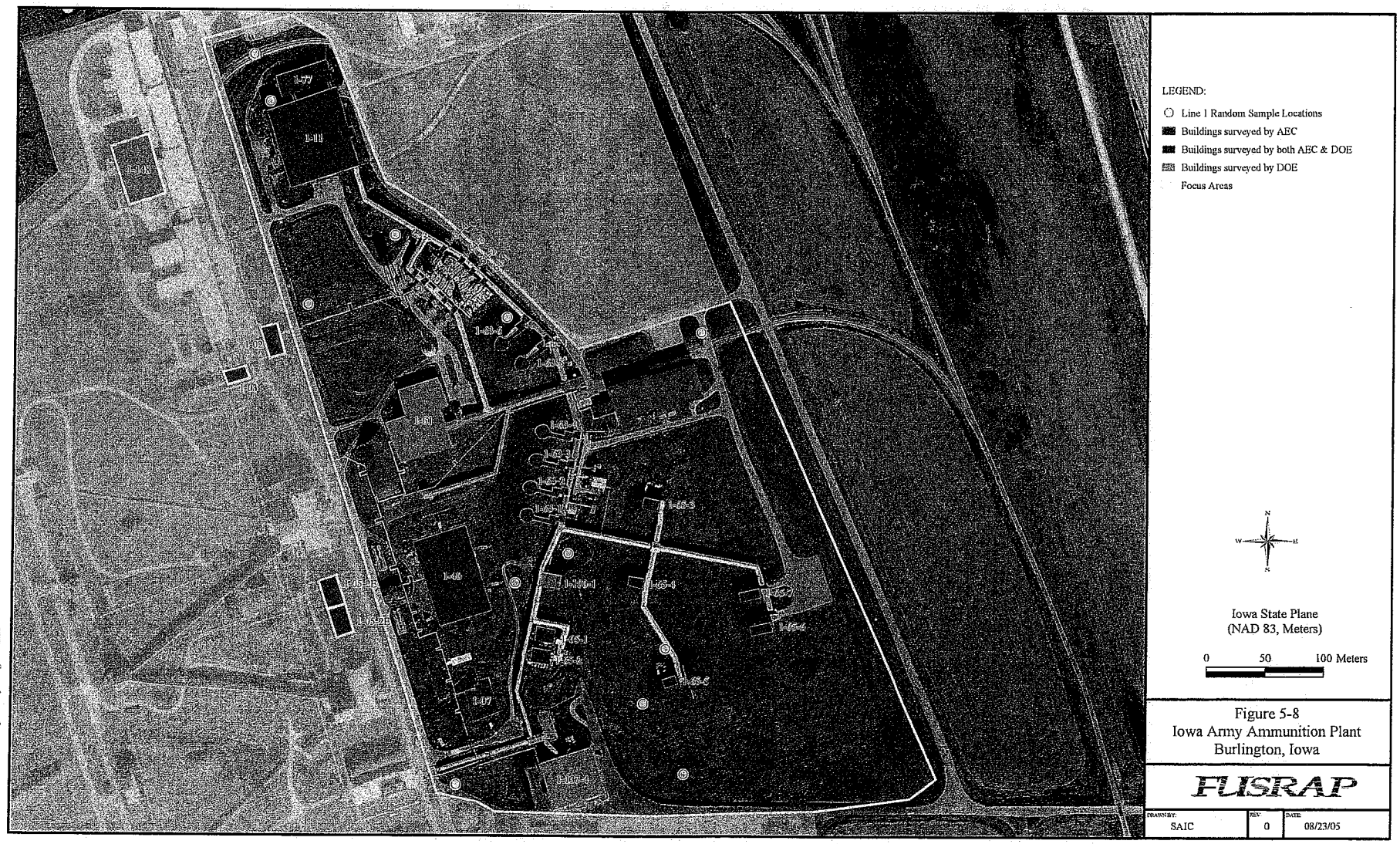


Figure 5-8. Line 1 Random Sample Locations East

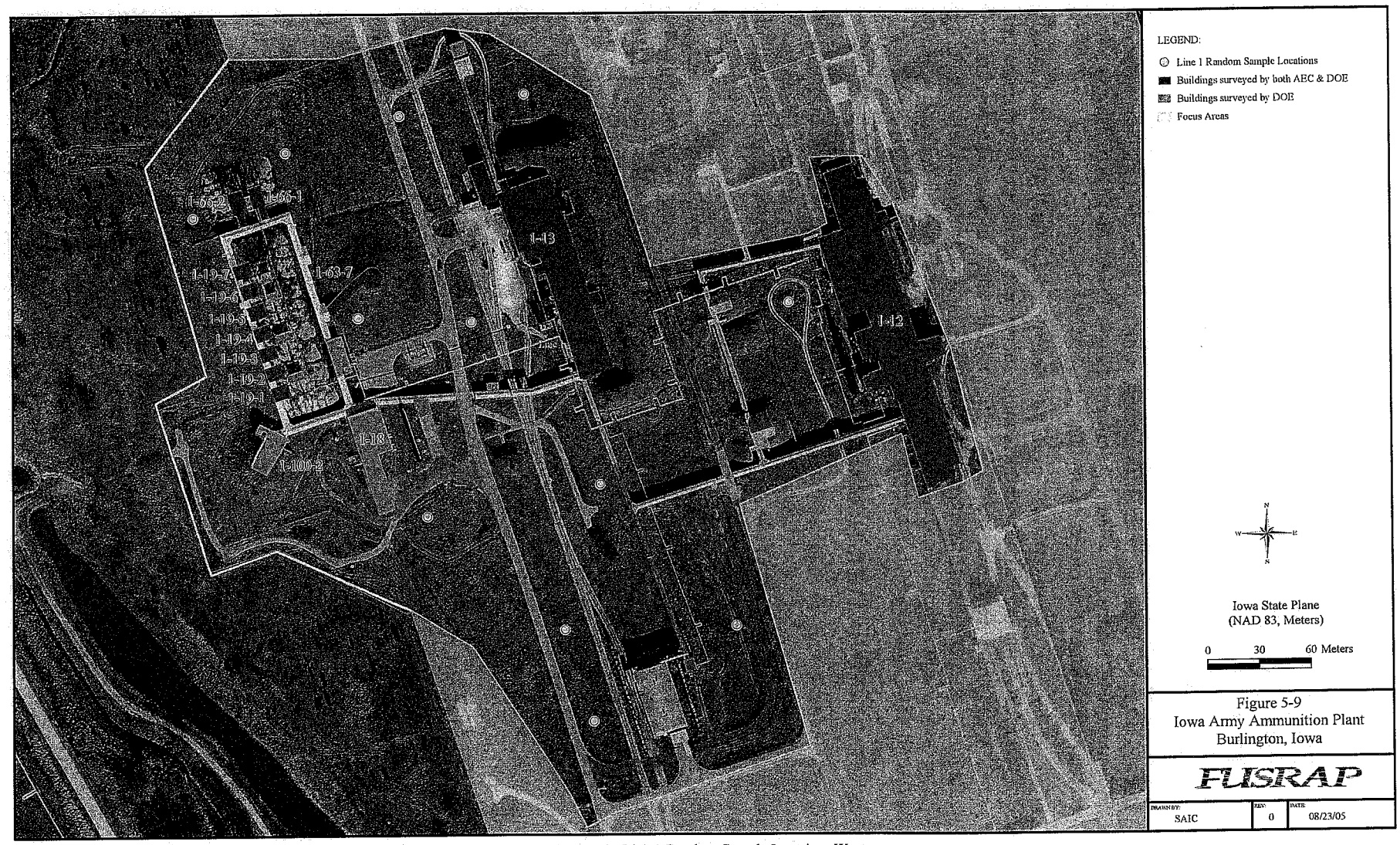


Figure 5-9. Line 1 Random Sample Locations West

6 SAFETY AND HEALTH

6.1 SITE SAFETY AND HEALTH

Site safety and health requirements for site tasks are based on potential physical, radiological, and chemical hazards. The survey team will follow the general site safety and health requirements documented in the SAIC *Site Safety and Health Plan for the St. Louis FUSRAP Sites, (USACE, 2000a) St. Louis Health Physics Manual* (SAIC, 1998), and *St. Louis Environmental Compliance and Health and Safety (EC&HS) Procedures Manual* (SAIC, 1999c). These documents/procedures are written to comply with the Nuclear Regulatory Commission (NRC), Occupational Safety and Health Administration (OSHA), and USACE regulations and have been approved for use by the St. Louis District USACE.

The Project Manager is the designated onsite Site Safety and Health Officer/Radiation Safety Officer (SSHO/RSO) for the radiological screening survey and maintains the responsibility for compliance with these requirements. Specific health and safety requirements will be documented on task-specific activity hazard analyses (AHAs) and health and safety work permits (HSWP) for survey and sampling activities detailed in this plan. The task-specific AHAs will be submitted to the St. Louis USACE for approval prior to the start of field activities.

6.2 SAFETY AND HEALTH TRAINING

All survey team personnel are required to meet the training requirements stated in the Site Safety and Health Plan for the St. Louis FUSRAP Sites (USACE, 2000a) to include Hazardous Waste Operator Training (HAZWOPER) (40-hour and current 8-hour refresher), medical surveillance, health and safety orientation, and radiation awareness training

Prior to conducting work on site, all members of the survey team will be required to attend the IAAAP safety briefing conducted by the IAAAP Safety Officer. At a minimum, this training will cover site access requirements, installation rules and regulations, and emergency response procedures for on-site personnel. Survey team personnel will follow the emergency response procedures in effect for the IAAAP.

The survey supervisor will verify completion of training requirements and proof of required training will be maintained on site during the survey. Records will be kept and maintained according to SAIC procedures.

6.3 TASK-SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

The minimum level of protection that will be used for non-intrusive survey activities at this site is Level D Protective Equipment (safety boots and safety glasses). For intrusive activities such as soil sampling and for activities that involve the handling of DU fragments, the minimum level of protection will be Modified Level D Protective Equipment. Modified Level D Protective Equipment is defined as:

- impermeable disposable inner gloves (i.e., nitrile, polyvinyl chloride, or equivalent)
- safety boots (ANSI Z41)
- safety glasses with side shields (ANSI Z87.1)

Additional personal protective equipment (PPE) such as Tyvek® coveralls, boot covers, or cotton/leather gloves may be required based on conditions encountered during the survey or new information on site contaminants not yet presented. The designated on-site SSHO/RSO has the responsibility for determining if an upgrade in PPE requirements is required once the survey team has mobilized to the site.

6.4 PERSONNEL MONITORING REQUIREMENTS

Due to the low probability of contamination being identified during this radiological screening survey, survey team members are not likely to incur greater than 10% of a regulatory dose limit (i.e., 100 mrem) from external sources of radiation and therefore dosimetry is not required.

It is not likely that any personnel will receive an intake of radioactive material that results in an internal exposure exceeding the monitoring threshold of 100 millirem (mrem) during survey activities; therefore, routine surveillance monitoring of the work environment will not be conducted.

There is a slight potential for the transfer of residual contamination from the soil to the hands and/or boots of the investigation team. A frisk of hands and feet, will be performed upon personnel at the completion of soil sampling and prior to departure from the field.

6.5 FIELD LOGBOOK ENTRIES

The survey supervisor (or designee) will maintain logbooks to document project information and a daily written record of survey and sampling activities. Logbooks will be maintained in accordance with the *Sampling and Analysis Guide for the St. Louis Sites* (USACE, 2000b) and SAIC *Field Technical Procedure-1215, Use of Field Logbooks* (SAIC, 1999a). Logbook entries will include, but are not limited to:

- Project personnel;
- Personnel contacts;
- Training activities;
- Daily tailgate meetings;
- Samples collected;
- Sample description;
- Sample IDs;
- Radiological screening parameters of sample;
- Instrument S/N and Surveyor performing radiological screen;
- Sample/Surveyor Signature;
- Chain of Custody numbers;
- Weather conditions; and
- Nonconformances, issues and concerns.

6.6 IAAAP SITE COORDINATION

The USACE will coordinate with the IAAAP to meet all security and access requirements. All IAAAP security, access requirements, and site-specific policies will be followed and implemented as directed by site personnel. USACE will coordinate special access to any restricted areas with on-site personnel. It is not anticipated that any hazardous materials will be brought on site for this evolution; however, USACE will inform IAAAP if any hazardous materials are encountered or brought on site.

7 SAMPLE AND WASTE DISPOSITION

The USACE or USACE contractor will be responsible for proper handling of all collected samples. Samples will be surveyed, packaged, sealed in strong, tight containers and shipped from the IAAAP to the appropriate laboratory. Samples are not expected to exceed the 70 Bq/gm limit that requires the application of Department of Transportation (DOT) requirements for radioactive materials. If the sample manager determines that the sample activity has the potential to exceed 70 becquerels per gram (Bq/gm), the samples will be surveyed, packaged, sealed, and shipped as a Limited Quantity shipment in accordance with SAIC procedure HP-51, *Limited Quantity Radioactive Material Shipping*. Sample containers will be verified free of loose contamination and the dose rate to the outside of the shipping container will be verified as being less than 0.5 mrem/hr. No samples will be obtained from soils that would require a manifest due to the radiological contamination. If an area is identified with sufficient radiological contamination to potentially require a manifest, the area will be noted, not sampled, and re-addressed at a later date under a different sampling plan.

Decontamination will be performed at each survey area following sampling. This will include removal of all visible soils followed by a wipe down. After dry decontamination is complete, sampling equipment will be radiologically surveyed.

Radioactive waste generated during the screening survey will be minimized. The anticipated waste will be limited to sampling gloves and decontamination wipes. Radioactive materials generated during the radiological screening survey will be bagged/contained and relinquished, at the end of survey activities, to IAAAP for dispositioning in accordance with their required procedures and licenses.

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APPENDIX A

IAAAP SURVEY
SCREENING LEVEL DCGL RISK/DOSE ASSESSMENT

A.1 IAAAP SURVEY SCREENING LEVEL DCGL RISK/DOSE ASSESSMENT

The residual radioactivity dose/risk assessment considers a future residential property at the location of the current Iowa Army Ammunitions Plant firing site area. Although current land use is not residential, the residential scenario is utilized in the dose/risk assessment as it will provide the most conservative assessment to a public receptor and is thus, fully representative of likely future site conditions. The residential property is estimated at 10,000 m^2. This area is equivalent to 2.5 acres, which would equate to a relatively large property in a typical residential subdivision. It should be noted that the residual contamination on the property may cover only a small surface area (that would lower risk estimates); however, the contamination will be assumed to be homogenously mixed throughout the surface of the property for this assessment.

The intent of this assessment is to illustrate that the concentration of depleted uranium (56 pCi/g) that is readily detectable with field instrumentation is also protective of human health and the environment. In the event that risk based remedial goals are to be developed through the CERCLA process, the risk assessment will incorporate site-specific parameters based on the anticipated future land use. The risk assessment presented in this document is not intended to serve as the basis for site release or the determination of risk or dose-based remediation goals.

The exposure pathways considered for the resident in this assessment include external gamma, inhalation of dust, radon exposure, plant ingestion, meat ingestion, milk ingestion, aquatic food ingestion (excluding seafood ingestion), drinking water ingestion, and soil/sediment ingestion. RESRAD Version 6.0 is used to perform the residual dose/risk assessment.

A.2 SCENARIO PARAMETERS

The residential scenario assumes an individual lives onsite for 350 days per year for 30 years, beginning at birth. Each day the resident is assumed to spend 16.4 hours indoors and 2.0 hours outdoors (EPA, 1997). Because child and adult ingestion rates, body weights, and exposure durations vary, exposure to the resident via ingestion of soil/sediment is based on a weighted average of the respective child and adult parameters. The scenario exposure parameters for this assessment are summarized in the following table:

Exposure Parameters for Each Medium for Residential Receptor		
Parameter by Media/Pathway	**Units**	**Residential**
Exposure Frequency	days/year	350[a]
Exposure Duration	years	30[a]
Indoor Exposure Frequency	hours/day	16.4[a]
Indoor Fraction	unitless	0.655
Outdoor Exposure Frequency	hours/day	2.0[a]
Outdoor Fraction	unitless	0.0799
Carcinogenic Averaging Time	days	25550
Non-carcinogenic Averaging Time	days	10950
Surface Soil	-	Yes
Subsurface Soil	-	Yes

Exposure Parameters for Each Medium for Residential Receptor (continued)		
Subsurface Soil	-	Yes
Ground Water	-	Yes
Surface Water	-	Yes
External Radiation		
Gamma Shielding Factor	unitless	0.4[d]
Inhalation		
Inhalation Rate	m^3/hour	0.552[a,b]
Exposure Time	hours/day	18.4[a,c]
Ingestion of Plant Foods		
Fruit, Vegetable and Grains Consumption	kg/yr	69[d]
Leafy Vegetable Consumption	kg/yr	14[e]
Depth of Roots	meter	0.9[e]
Ingestion of Meat		
Meat and Poultry Consumption	kg/yr	63[a]
Livestock Fodder Intake for Meat	kg/day	68[e]
Ingestion of Milk		
Milk Consumption	L/yr	92/person[e]
Livestock Fodder Intake for Milk	kg/day	55[e]
Ingestion of Aquatic Food		
Fish Consumption	kg/yr	5.4[a]
Other Seafood Consumption	kg/yr	0
Drinking Water Ingestion		
Ingestion Rate	L/day	2.3[a]
Incidental Ingestion of Soil		
Soil Ingestion Rate		
Adult	mg/day	100[a]
Child	mg/day	200[a]

a EPA 1997, "Exposure Factors Handbook," Volumes I, II, and III, EPA/600/P-95/002Fa-c, EPA, Office of Research and Development, Washington, DC.
b Average of male and female adult values.
c Average time spent at home.
d EPA 2000, "Soil Screening Guidance for Radionuclides: Technical Background Document," EPA/540-R-00-006. EPA, Office of Radiation and Indoor Air/Office of Solid Waste and Emergency Response, Washington, DC. Recommended parameter for EPA resident scenario.
e RESRAD Default Values.

A.3 SOIL CONCENTRATION DETERMINATION

For this assessment, a screening level derived concentration guideline limit (DCGL) of 56 pCi/g of depleted uranium was selected and used as the representative concentration for each residential property. This DCGL was selected based upon the field scanning minimum detectable concentration provided for depleted uranium in Table 6.4 of NUREG-1507. In order to assess the dose/risk from the uranium isotopes and short-lived daughters that constitute depleted uranium, the following isotopic activity ratios were utilized:

- 0.9218 U-238
- 0.0636 U-234
- 0.0149 U-235

For the residential scenario, the residual dose/risk assessments are performed assuming the contamination extends 6 inches (0.15 meter) below the surface and there is no cover on the residual soils. The lack of clean cover over the soils provides the most conservative assessment of the radiation dose/risk to the potential residential receptors. Given this information, the soil parameters used in the assessment are summarized in the following table.

Hydrological Data

RESRAD default values were used for each of the following hydrological parameters.

Site Data	Contaminated Zone	Saturated Zone	Unsaturated Zone
Thickness (m)	0.15	N/A	4
Density (g/cc)	1.5	1.5	1.5
Erosion Rate (m/yr)	0.00001	0.00001	N/A
Total Porosity	0.4	0.4	0.4
Effective Porosity	Not defined	0.2	0.2
Soil b Parameter	5.3	5.3	5.3
Hydraulic Conductivity (m/yr)	10	100	10

Initial Soil Concentration

The concentrations of each of the three radionuclides is shown in the following table.

Name of Radionuclides	Units	Value
U-234	pCi/g	3.562
U-235[1]	pCi/g	0.834
U-238[2]	pCi/g	51.604

[1] RESRAD assumes short-lived daughter Th-231 is in secular equilibrium.
[2] RESRAD assumes short-lived daughters Th-234 and Pa-234m are in secular equilibrium.

A.4 ASSESSMENT METHODOLOGY

RESRAD Version 6.0 is used to estimate potential radiation dose due to exposure to radiological contaminants in soil and sediment. The RESRAD code uses Federal Guidance Reports 11 and 12 to estimate dose and risk. The exposure parameters used in the assessment were selected to provide a conservative, yet reasonable, estimate of potential dose to each receptor. The parameters discussed above were used to describe site conditions. Parameter values were chosen to provide conservative estimates of risk. RESRAD standard default values, average defaults recommended by the *Exposure Factors Handbook* (EPA, 1997), or recommended EPA resident parameters included in the *Soil Screening Guidance for Radionuclides: Technical Background Document* were used. The model assumes that contamination is always spread over a large area and is never covered. Thus, the assumption that these measured concentrations are present at the surface provides a conservative estimate of potential radiation dose to each receptor.

Dose/Risk Assessment Results

The radiological doses and risks to the residential receptor due to the exposure of depleted Uranium at t = 0 and at t = 1000 years is summarized in the following table.

Summary of Radiological Doses and Risks at t = 0 and t = 1000 years		
Time	**Dose (mrem/yr)**	**Risk**
0	3	2 E-05
1000	8	5 E-05

The maximum dose due to residential exposure is 8 mrem/yr and occurs at t = 1000 years. The associated risk at this time is 5 E-05. The risk level determined using a residential scenario indicates that the use of the selected remediation goal would provide a risk within the CERCLA target risk range (10^{-4} to 10^{-6}) specified for protection of human health.

A.5 REFERENCES

EPA, 1997. *Exposure Factors Handbook, Volumes I, II, and III*, EPA/600/P-95/002Fa-c, Office of Research and Development, Washington, D.C., August.

EPA, 2000. *Soil Screening Guidance for Radionuclides: Technical Background Document*, EPA/540-R-00-006, Office of Radiation and Indoor Air/Office of Solid Waste and Emergency Response, Washington, D.C., October.

U.S Nuclear Regulatory Commission. 1998. *NUREG-1507: Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*. Washington, D.C.

APPENDIX B

2" x 2" NAI DETECTOR
SCAN DETECTION OF DEPLETED URANIUM FRAGMENTS

B.1 NAI 2-INCH BY 2-INCH SCINTILLATION DETECTOR SCAN DETECTION OF DEPLETED URANIUM FRAGMENTS

NUREG 1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC, 1998), and NUREG 1575, *Multi-Agency Radiation Survey and Site Investigation Manual, Revision 1* (MARSSIM) (EPA, 2000) provide examples of typical MDCs for various radionuclides using gamma scan detectors. These documents state that the MDCs provided are examples only and other scan MDC values may be equally justifiable depending on the values chosen for the various input parameters and site-specific conditions. The MDC value listed in NUREG 1507 for soil contaminated with depleted uranium is considered justifiable and sufficient. However, the use of this value is not appropriate for the detection of visible, solid DU fragments. Due to the specific activity of a depleted uranium fragment there is little doubt that the typical hotspot modeled in NUREG 1507 (0.25-cm radius) could be detected. The question is how small of a fragmented piece of depleted uranium can be detected with confidence.

The steps for calculating the size of a depleted uranium fragment that can be detected generally follow the approach detailed in NUREG 1507. The steps include:

1. Calculating the minimum detectable count rate (MDCR) by selecting a given level of performance, scan speed, and background level of a 2-inch by 2-inch (or 2" × 2") NaI detector,
2. Selecting a surveyor efficiency, and
3. Relating the surveyor's MDCR ($MDCR_{surveyor}$) to a given exposure rate.
4. Modeling the exposure rate of various size fragments.
5. Comparing the MDCR exposure rate to the modeled exposure rates.

The development of this relationship in item three requires two significant steps. In step one, the relationship between the detector's net counting rate to net exposure rate in counts per minute per micro-Roentgen per hour (cpm/μR/hr) is established. In step two, the relationship between the specific activity of depleted uranium and exposure rate is determined. For particular gamma energies, the relationship of the 2" x 2" NaI detector's counting rate (in counts per minute or cpm) and exposure rate may be determined analytically. Once this relationship is known, the $MDCR_{surveyor}$ (in cpm) of the NaI detector can be related to the minimum detectable net exposure rate. This minimum rate is used to determine the minimum detectable depleted uranium fragment by modeling a specified postulated fragment.

For determining the MDCR, an average background for the 2" x 2" NaI detector of 10,000 cpm was selected. The observable background counts is the number of background counts observed within the observation interval. This is commonly referred to as *b'*. The equation used for calculating *b'* is as follows:

b' = (background count rate) × (observation interval) × (1 min/60 sec) = counts/interval

b' = (10,000 cpm) × (1 sec) × (1 min/60 sec) = 166.67 counts.

The observational interval of 1 second is based on the selected instrument to be used during the GPS assisted gamma walkover. The detector/meter combination will produce a data point or estimated cpm reading every second during operation. This reading will be married to a specific X Y coordinate and recorded in the associated data logger.

The MDCR is defined as the increase above background recognizable during a survey in a given period of time. The variable, *d'*, is the alpha/beta error acceptable for a given survey. Alpha and

beta errors of 95% (true positive rate) and 60% (false positive rate), respectively, were selected to be consistent with NUREG 1507. Selection of a high beta error signifies that the surveyor will stop the scan at very small increases in detection signal "clicks" in order to conduct an intensified scan. This slows down the survey but provides a higher level of confidence in the results of the survey. The value of 1.38 was obtained from Table 6.1 in NUREG 1507 (Table 6.5 in MARSSIM).

$$MDCR = (d') \times (\text{sq. root of } b') \times (\#\text{ of observation/minute}) = \text{cpm}$$

$$MDCR = (1.38) \times (\text{sq. root } 166.67) \times (60 \text{ observations/min}) = 1069 \text{ cpm}$$

The $MDCR_{surveyor}$ or minimum detectable count rate of the surveyor is defined as the increase above background during a survey that will be identified as an increase by the surveyor. Surveyor efficiency was selected to be 50%, consistent with NUREG 1507:

$$MDCR_{surveyor} = (MDCR) / (\text{sq. root of surveyor efficiency})$$

$$MDCR_{surveyor} = (1069) / (\text{sq. root of } 0.5) = 1512 \text{ cpm.}$$

An estimated exposure rate for various sizes of square depleted uranium fragments was obtained by modeling with Microshield Version 5.01. A rectangular volume of depleted uranium with various lengths and a constant width and thickness of 1.0 cm was selected. The modeled exposure rate was used to calculate the expected increase in count rate above background for the 2" x 2" NaI detector. Using the same parameters as above, the same sizes of depleted uranium fragments were modeled with 5 cm (approximately 2 inches) of soil cover material. The density of the soil was estimated at 1.6 g/cm^3. Table B-1 shows the size of the depleted uranium fragment, associated cpm increase for a sodium iodide 2" x 2" modeled for a fragment located on the ground surface, and the associated cpm increase for a 2" x 2" NaI detector modeled for a fragment covered with 5 cm of soil.

Table B-1. Modeled Count Rate versus DU Fragment Size

DU Fragment Size (cm^3)	Net count rate with DU fragment on ground surface (cpm)[1]	Net count rate with DU fragment beneath 5 cm of soil (cpm)[1]
1.0	2100	1100
2.0	4100	2100
3.0	5900	3200
4.0	7700	4200
5.0	9400	5100
6.0	10900	6000
7.0	12200	6900
8.0	13300	7600
9.0	14300	8300
10.0	15200	9000

[1] Net count rate using a 2"x2" NaI detector.

Since the $MDCR_{surveyor}$ = 1512 cpm a one cubic centimeter depleted uranium fragment located on the surface of the survey area is capable of being detected. However, survey experience has shown that random background fluctuation interferes with recognizing a 1500 cpm increase in count rates. An investigation level of 2000 cpm above relevant background is typically established and used as a field screening value. Setting 2000 cpm above background as the investigation level maintains the size of detectable DU fragments on the ground surface to 1.0 cubic centimeters when the detector is located directly above the fragment for one second. Maintaining the investigation level constant at 2000 cpm above relevant background establishes that a 2 cm^3 depleted uranium fragment buried beneath 5 cm of soil can be detected when the detector is located directly above the fragment for one second. As shown in the table, in both

cases, as the size of the fragment increases the modeled count rate increases. The larger the fragment size the easier it becomes to detect.

However, the detection of the above fragments is dependent on the detector being positioned directly above the fragment for the entire 1 second count interval. The typical scan rate employed during gamma walkovers is 0.5 meters per second. This means that the detector will cover approximately 0.5 m^2 or 50 cm^2 in one second. Therefore, during a typical scan survey the detector would only be positioned above the fragment for a fraction of the 1 second count time.

To maintain the required confidence that the fragment would be detected during a normal scan survey the lowest count rate for a specific size depleted uranium fragment obtainable in the 1 second count rate window when normalized to cpm must be greater than2000 cpm. The lowest obtainable count rate within the 1 second count rate window when moving at 50 cm per second would occur 25 cm from the fragment.

An estimated exposure rate 25 cm from various sizes of square depleted uranium fragments was obtained by modeling with Microshield Version 5.01. A rectangular volume of depleted uranium with a various lengths and a constant width and thickness of 1.0 cm was selected. The modeled exposure rate was used to calculate the expected increase in count rate above background for the 2" x 2" NaI detector. Using the same parameters as above, the same sizes of depleted uranium fragments were modeled with 5 cm (2 inches) of soil cover material. The density of the soil was estimated at 1.6 g/cm^3. Table B-2 shows the size of the depleted uranium fragment, associated cpm increase for a 2" x 2" NaI detector modeled for a fragment located on the ground surface, and the associated cpm increase for a 2" x 2" NaI detector modeled for a fragment covered with 5 cm of soil.

Table B-2. Modeled Count Rate versus DU Fragment Size at 25 cm

DU Fragment Size (cm^3)	Net count rate at 25 cm with DU fragment on ground surface (cpm)[1]	Net count rate at 25 cm with DU fragment beneath 5 cm of soil (cpm)[1]
5.0	1717	1113
6.0	2047	1326
7.0	2370	1534
8.0	2684	1736
9.0	2990	1932
10.0	3286	2121

Maintaining the investigation level constant at 2000 cpm above relevant background establishes that a 6.0 cm^3 depleted uranium fragment on the surface of the survey area and that 10.0 cm^3 depleted uranium fragment buried beneath 5 cm of soil can be detected with confidence during a normal scan survey. Once again, the larger the fragment the higher the probability of detection.

In summary, the smallest piece of DU located on the surface of the survey area that can be detected is approximately a 1.0 cubic centimeter fragment. The smallest piece of DU that can be detected with confidence during a normal scan survey using conservative assumptions is a 6.0 cubic centimeter fragment. The smallest piece of DU that is covered with 5 cm of soil that can be detected is approximately a 2.0 cubic centimeter fragment. The smallest piece of DU that is covered with 5 cm of soil that can be detected with confidence during a normal scan survey using conservative assumptions is a 10 cubic centimeter fragment.

B.2 REFERENCES

EPA, 2000. EPA 402-R-97-016, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, Revision 1, August.

Nuclear Regulatory Commission (NRC). 1998. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*. NUREG/CR-1507, Final, NRC, Washington, D.C.