FUSRAP
Maywood Superfund Site

Post-Remedial Action Report
Burial Pit No. 1 (NRC License STC-1333)
100 West Hunter Avenue
Block 124, Lots 39 Through 44
Borough of Maywood, New Jersey

Formerly Utilized Sites Remedial Action Program
Maywood Superfund Site

Prepared by:

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100 West Hunter Avenue
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Prepared for:

US Army Corps of Engineers®

Contract No. DACW41-99-D-9001

August 2011, Revision 0

POST-REMEDIAL ACTION REPORT
BURIAL PIT NO. 1
(NUCLEAR REGULATORY COMMISSION LICENSE STC-1333)
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM

MAYWOOD SUPERFUND SITE
MAYWOOD, NEW JERSEY

SITE-SPECIFIC ENVIRONMENTAL RESTORATION
CONTRACT NO. DACW41-99-D-9001
TASK ORDER 005
WAD 26

Submitted to:

Department of the Army
U.S. Army Engineer District, New York
Corps of Engineers
FUSRAP Project Office
26 Federal Plaza
New York, New York 10278

Department of the Army
U.S. Army Engineer District, Kansas City
Corps of Engineers
700 Federal Building
Kansas City, Missouri 64106

Submitted by:

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Maywood, New Jersey 07607

Revision 0
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Revision 0
August 2011

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RECORD OF REVISIONS

Revision No.	Description of Revision	Date
Draft Revision A	First Shaw/USACE Team Review	May 2011
Revision 0	Issued to Regulators	August 2011

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ABBREVIATIONS AND ACRONYMS

α	alpha, Type I (false positive) error rate
β	beta, Type II (false negative) error rate
σ	sigma, standard deviation
ARAR	applicable, relevant, and appropriate requirement
BCUA	Bergen County Utilities Authority
bgs	below ground surface
BNI	Bechtel National, Inc.
CDQMP	Chemical Data Quality Management Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cm	centimeter
cpm	counts per minute
CQCP	Contractor Quality Control Plan
DCGL	Derived Concentration Guideline Level
DGPS	differential global positioning system
DOE	U.S. Department of Energy
DQO	data quality objective
EMC	elevated measurement comparison
EPA	U.S. Environmental Protection Agency
FMSS	FUSRAP Maywood Superfund Site
FSS	final status survey
FSS Plan	Master Final Status Survey Plan, including Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPS	global positioning system
GWS	gamma walkover survey
LBGR	lower bound – gray region
m^2	square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCW	Maywood Chemical Works
MDC_{scan}	Scan Minimal Detectable Concentrations
MFSSP	Master Final Status Survey Plan
MISS	Maywood Interim Storage Site
MOU	Memorandum of Understanding
mrem/yr	millirem per year
MS/MSD	matrix spike/matrix spike duplicate
NaI	sodium iodide
NJ	New Jersey
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NRC	U.S. Nuclear Regulatory Commission
PARCC	precision, accuracy, representativeness, completeness, and comparability
pCi/g	picoCurie(s) per gram
pCi/L	picoCurie(s) per liter
PRAR	Post-Remedial Action Report

PVC/PET	polyvinyl chloride/polyethylene teraphthalate
QA	quality assurance
QC	quality control
QCSR	Quality Control Summary Report
Ra-226	radium-226
RAO	remedial action objective
RAWP	Remedial Action Work Plan
ROD	Record of Decision
SDG	sample delivery group
Shaw	Shaw Environmental, Inc.
SSHP	Site Safety and Health Plan
SU	survey unit
S&W	Stone & Webster, Inc. (also Stone & Webster)
Th-232	thorium-232
U-238	uranium-238
UFML	USACE FUSRAP Maywood Laboratory
USACE	U.S. Army Corps of Engineers
USDOJ	U.S. Department of Justice
WRS	Wilcoxon Rank Sum
yd^3	cubic yards

EXECUTIVE SUMMARY

Shaw Environmental, Inc. (Shaw) was contracted by the U.S. Army Corps of Engineers (USACE) for the environmental remediation of the Formerly Utilized Sites Remedial Action Program (FUSRAP) Maywood Superfund Site (FMSS). The FMSS is identified on the *National Priorities List* as the "Maywood Chemical Company" with the Comprehensive Environmental Response, Compensation, and Liability Information System identification number NJD980529762. The remedial action was performed under the FUSRAP Maywood Site-Specific Environmental Remediation Contract, DACW41-99-D-9001, and the *Record of Decision for Soils and Buildings at the FUSRAP Maywood Superfund Site* (USACE, 2003). The Record of Decision (ROD) was signed into agreement by USACE in August 2003 and by the U.S. Environmental Protection Agency (EPA) in September 2003.

Shaw has prepared this Post-Remedial Action Report (PRAR) to document the remedial action performed on the property located at 100 West Hunter Avenue in the Borough of Maywood, New Jersey (NJ) (Block 124, Lots 31-33 and 39-48). This PRAR pertains specifically to the U.S. Nuclear Regulatory Commission (NRC)-licensed Burial Pit located within Lots 40 through 44 that is identified as "Burial Pit No. 1" in project-wide planning documents and is hereafter referred to as "Burial Pit No. 1." USACE took possession of Burial Pit No. 1 for the purposes of performing the remedial action in accordance with the 2001 Memorandum of Understanding between USACE and NRC (see Section 1.1 and Appendix A).

This PRAR was prepared in accordance with EPA, Office of Solid Waste Emergency Response Directive 9320.2.09A-P, *Close-Out Procedures for National Priority List Sites* (EPA, 2000a), and includes the remedial action guidelines, a description of the remedial activities, and an evaluation of the post-remedial action measurements.

REMEDIAL ACTION GUIDELINES

The general remedial action objectives (RAOs) established in the ROD (USACE, 2003) are to prevent or mitigate further release of FUSRAP waste to the surrounding environment via the selected remedial alternative of excavation and off-site disposal; to meet the established release criteria; and to comply with applicable, relevant, and appropriate requirements (ARARs). The release criteria established in the ROD were based upon the 100 West Hunter Avenue Property's reasonably anticipated future land use designation of Restricted Use (commercial). Therefore, the Restricted Use (commercial) criteria were used for the purposes of evaluating the post-remedial action data presented in this PRAR. These criteria consist of the following residual activity limits: an average of 15 picocuries per gram (pCi/g) combined radium-226 and thorium-232 above background in subsurface soil with an as-low-as-reasonably-achievable goal of 5 pCi/g; and 100 pCi/g total uranium (50 pCi/g of uranium-238) above background. Attainment of these release criteria ensures compliance with the substantive requirements of the New Jersey Administrative Code (NJAC) 7:28-12.8(a) (NJDEP, 2000) and Title 10 Code of Federal Regulations (CFR) 20.1402 (see Table ES-1).

CONSTRUCTION ACTIVITIES

On-site pre-mobilization activities began in February 2010. Excavation personnel and equipment mobilized to Burial Pit No. 1 on May 17, 2010, and proceeded with soil remediation via the ROD-selected alternative of excavation and off-site disposal (USACE, 2003). Following excavation, a final status survey (FSS) was performed to collect post-remedial action measurements in order to document residual contamination levels. The FSS data were evaluated and, upon verification that the RAOs were satisfied, the excavations were backfilled in accordance with the Remedial Action Work Plan (USACE, 2004a) and restoration was completed in-kind. The total volume of soil removed from Burial Pit No. 1 and ultimately shipped off site to a licensed disposal facility in Utah was 12,460 in situ cubic yards (yd^3).

POST-REMEDIAL ACTION MEASUREMENTS

Following soil removal activities, post-remedial action measurements were collected to quantify the residual concentrations of radiological constituents in soil, and to determine if Burial Pit No. 1 satisfied the Restricted Use (commercial) release criteria. The FSS methodology for collecting post-remedial action measurements was based on the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (EPA, 2000b) approach as outlined in the *Master Final Status Survey Plan, FUSRAP Maywood Superfund Site, Revision 1* (USACE, 2001b), and the Property-specific *Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan) Revision 0* (USACE, 2004b).

The FSS consisted of the following activities:

- Gamma walkover survey over 100% of accessible areas
- Collection and gamma spectrometry analysis of systematic surface and subsurface soil samples
- Collection and gamma spectrometry analysis of biased surface and subsurface soil samples
- Data validation and evaluation

In accordance with the MOU between USACE and NRC, the NRC observed FSS activities at Burial Pit No. 1 on June 15, 2010 and November 10, 2010. NRC was provided with split samples collected from ten systematic sample locations within survey units 10A-29 and 10A-30. The observations and split sample results are presented in NRC reports included in Appendix A.

PERFORMANCE SUMMARY

Table ES-1 compares the RAOs established in the ROD (USACE, 2003) with the work completed and described in this PRAR.

Table ES-1
Performance Results Compared with Remedial Action Objectives

Remedial Action Objectives (RAOs)	Performance Results
Prevent or mitigate further release of FUSRAP waste to the surrounding environment, and eliminate or minimize the potential for human contamination and exposure via the selected ROD (USACE, 2003) alternative of "Excavation and Disposal."	12,460 in situ yd^3 of material were removed from Burial Pit No. 1 and disposed at an off-site licensed disposal facility.
Verify that Burial Pit No. 1 satisfies the Restricted Use (commercial) Release criteria.	MARSSIM FSS Null Hypothesis rejected for all survey units. All regions of Burial Pit No. 1 were accessible and satisfy RAOs for Restricted Use (commercial).
Applicable, relevant, and appropriate requirements (ARARs)	**Details of compliance with ARARs**
Title 10 CFR 20.1402 (25 mrem/yr NRC exposure limit)	Compliance for Burial Pit No. 1 attained through remediation.
NJAC 7:9.6 (point source water discharge limitations)	All potentially impacted water was treated and discharged in compliance with BCUA permits.
Title 40 CFR 262.11 (hazardous waste determination)	No FUSRAP waste was identified as hazardous waste.
NJAC 7:7A Subchapter 15 (wetlands mitigation)	Not applicable: No wetlands within Burial Pit No. 1.
NJAC 7:28-12.8(a)1 (15 mrem/yr exposure limit)	Compliance attained through remediation.
NJAC 7:28-12.8(a)2 (3 pCi/L indoor radon limit)	Compliance attained through remediation.

BCUA denotes Bergen County Utilities Authority.
CFR denotes U.S. Code of Federal Regulations.
NJAC denotes New Jersey Administrative Code.
mrem/yr denotes millirem per year.
pCi/L denotes picoCuries per liter.

BURIAL PIT NO. 1 STATUS

Remediation activities are complete for Burial Pit No. 1. The selected remedy for accessible FUSRAP waste on FMSS properties is complete excavation and off-site disposal. All regions of contamination within Burial Pit No. 1 were accessible, and the analytical data presented in this PRAR demonstrate compliance with the Restricted Use (commercial) release criteria as set forth in the ROD (USACE, 2003), thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and Title 10 CFR 20.1402 are met. Burial Pit No. 1 can be released for Restricted Use (commercial) per the ROD.

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1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) was contracted by the U.S. Army Corps of Engineers (USACE) for the environmental remediation of the Formerly Utilized Sites Remedial Action Program (FUSRAP) Maywood Superfund Site (FMSS). The FMSS is identified on the *National Priorities List* as the "Maywood Chemical Company" with the Comprehensive Environmental Response, Compensation, and Liability Information System identification number NJD980529762. The remedial action was performed under the FUSRAP Maywood Site-Specific Environmental Remediation Contract, DACW41-99-D-9001, and the *Record of Decision for Soils and Buildings at the FUSRAP Maywood Superfund Site* (USACE, 2003). The Record of Decision (ROD) was signed into agreement by USACE in August 2003 and by the U.S. Environmental Protection Agency (EPA) in September 2003. The general remedial action objectives (RAOs) established in the ROD are to prevent or mitigate further release of FUSRAP waste to the surrounding environment; to meet the established release criteria; and to comply with applicable, relevant, and appropriate requirements (ARARs).

Shaw has prepared this Post-Remedial Action Report (PRAR) in accordance with the EPA Office of Solid Waste Emergency Response Directive 9320.2.09A-P, *Close-Out Procedures for National Priority List Sites, EPA 540-R-98-016* (EPA, 2000a). This PRAR was prepared to document the remedial activities associated with a U.S. Nuclear Regulatory Commission (NRC)-licensed Burial Pit located on the property at 100 West Hunter Avenue in the Borough of Maywood, New Jersey (NJ) (Block 124, Lots 31-33 and 39-48). This PRAR pertains specifically to the NRC-licensed Burial Pit located within Lots 40 through 44 that is identified as Burial Pit No. 1 in project-wide planning documents and is hereafter referred to as Burial Pit No. 1. Additional PRARs documenting the remediation of other areas on the Stepan Property will be prepared as remedial objectives are achieved. The release criteria established in the ROD were based upon the 100 West Hunter Avenue Property's reasonably anticipated future land use designation of Restricted Use (commercial) (refer to Section 2.0).

The remedial action at Burial Pit No. 1 was performed in accordance with the Remedial Action Work Plan (RAWP) (USACE, 2004a) and other approved plans including, but not limited to, the following:

- *Soil Load-Out Work Plan* (USACE, 2001a)
- *Master Final Status Survey Plan, FUSRAP Maywood Superfund Site, Revision 1* (MFSSP) (USACE, 2001b)
- *Material Handling, Transport, and Disposal Plan, Revision 1* (USACE, 2001c)
- *Contractor Quality Control Plan, FUSRAP Maywood Superfund Site, Revision 1* (CQCP) (USACE, 2005)
- *Chemical Data Quality Management Plan, Revision 2* (CDQMP) (USACE, 2009a)
- *Site Safety and Health Plan, Revision 3* (SSHP) (USACE, 2011)

In addition, several plans specific to the 100 West Hunter Avenue Property were also prepared for the remedial action including, but not limited to, the following:

- *Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan), Revision 0* (USACE, 2004b)
- *Construction Work Plan Triangle Clusters – Phase 10* (USACE, 2004c)
- *Cluster 10 Site Safety and Health Plan Addendum* (USACE, 2008)

- *Burial Pit No. 3 Dewatering Plan Addendum BP1 Dewatering and Plume Monitoring QA Plan* (USACE, 2010)

1.1 SITE HISTORY

The FMSS consists of 88 designated residential, commercial, municipal, and government-owned properties in the Boroughs of Maywood and Lodi and the Township of Rochelle Park. Maywood, Lodi, and Rochelle Park are in a highly developed area of Bergen County in northeastern New Jersey, approximately 12 miles (20 kilometers) northwest of New York City and 13 miles (21 kilometers) north of Newark, New Jersey (refer to Figure 1-1). Prior to the ROD (USACE, 2003), 64 of the 88 designated properties had previously been remediated as authorized under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). These 64 residential and municipal properties constitute the FMSS Phase 1 properties. Figure 1-2 presents the location of Burial Pit No. 1 as well as many, but not all, of the other FMSS properties that have either been remediated or are scheduled for remediation.

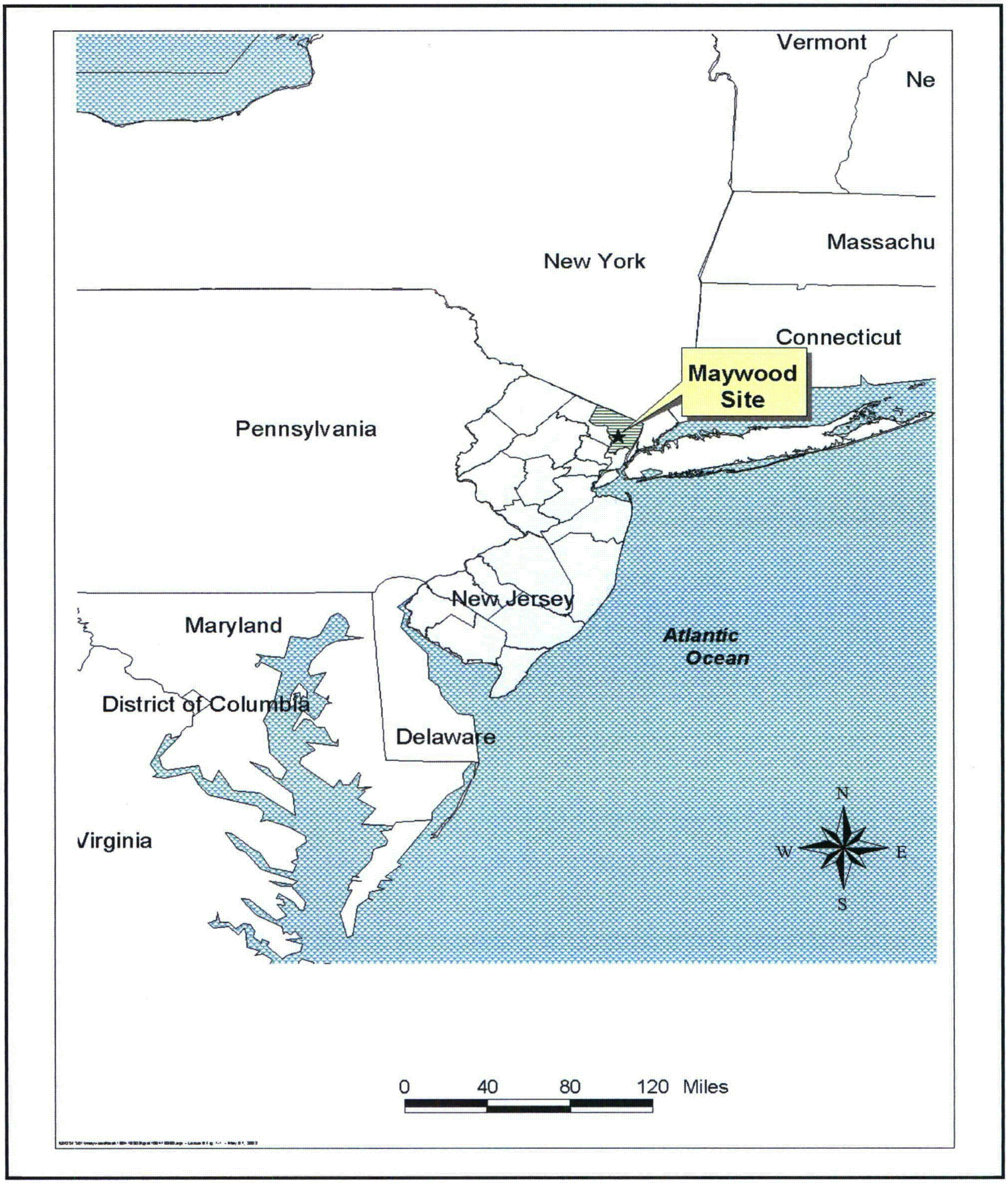


Figure 1-1
Location of FMSS, Bergen County, New Jersey

Figure 1-2
Plan of FMSS Properties

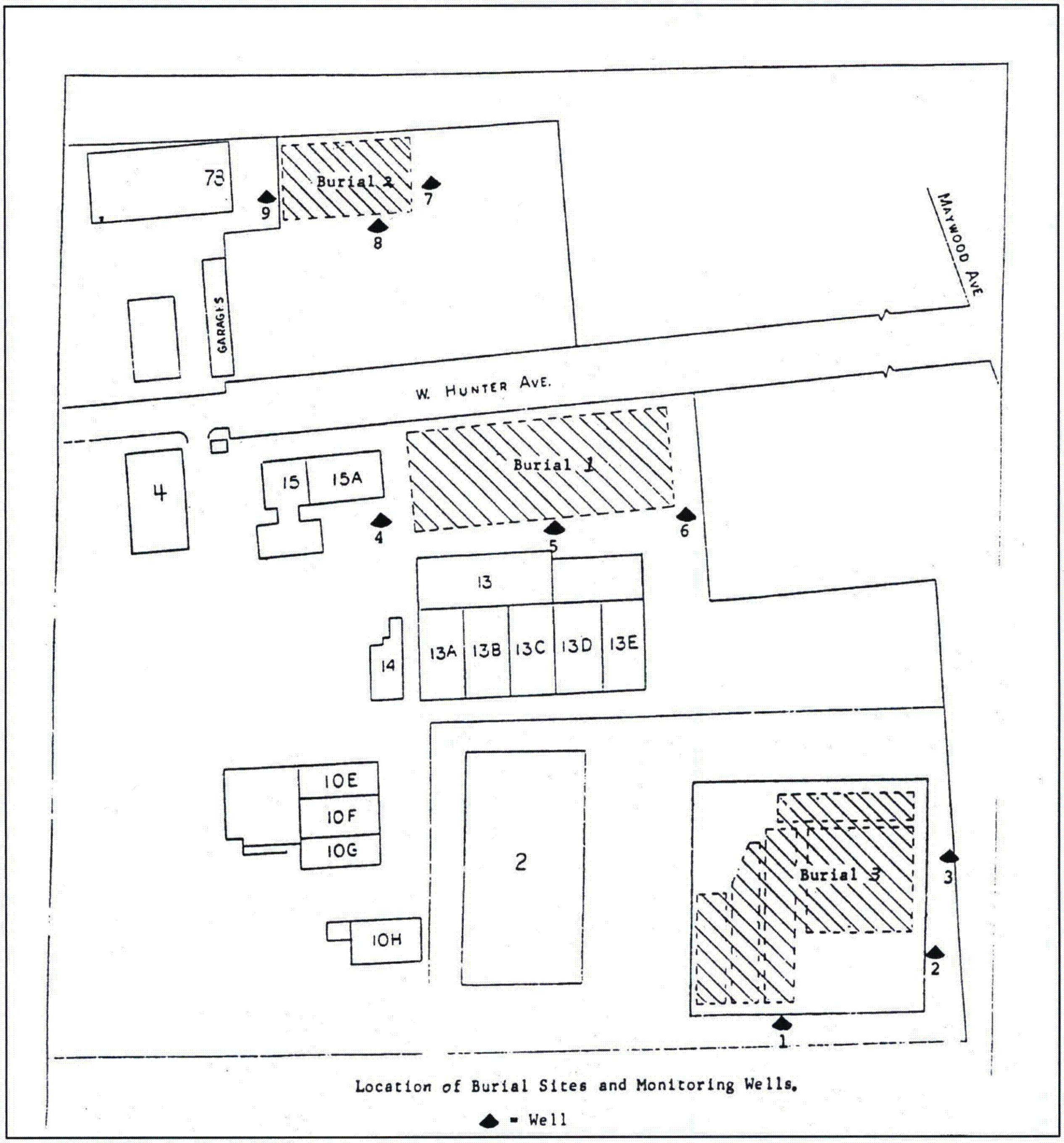
Radiological contamination on FMSS properties resulted from rare earth and thorium processing operations conducted by the Maywood Chemical Works (MCW) between 1916[1] and 1956. These operations resulted in the generation of wastes and residues associated with the processing of thorium and thorium compounds from monazite ores. Thorium processing ceased in 1956. Approximately 3 years later, the Stepan Company purchased the 30-acre MCW Property.

Waste generated from processing operations was generally stored in open piles and retention ponds on the original processing site where the Maywood Interim Storage Site (MISS) and Stepan Company are now located. These wastes were spread to nearby properties through two primary mechanisms: the use of contaminated soil as mulch and fill material; and sediment transport from natural drainage and flooding events associated with the formerly open channel of the Lodi Brook.

In the late 1960s, Stepan Company took corrective measures at some of the former disposal areas located on the original MCW property. These corrective measures included relocation and burial of approximately 19,100 cubic yards (yd^3) of waste materials to three burial pits on property currently owned by Stepan Company. These burial pits were subsequently licensed by NRC to Stepan Company pursuant to Title 10 Code of Federal Regulations (CFR) 40 on April 4, 1978. The possession-only license authorized Stepan Company to possess the material in underground storage. Figure 1-3 is an historical figure circa 1983 taken from the NRC Docket 40-08610 that shows the approximate footprints of the burial pits. The wells indicated on the figure are owned by Stepan and are used for purpose of groundwater monitoring in accordance with the requirements of NRC license STC-1333. Note that on May 20, 2009, NRC issued STC-1333 License Amendment No. 4, thereby excluding Well No. 6 from Stepan's groundwater monitoring program.

In 1983, the FMSS was added to the National Priorities List as the "Maywood Chemical Company." In the same year, the U.S. Department of Energy (DOE) began investigating the FMSS and the surrounding area. The DOE proceeded to clean up 25 residential properties during 1984 and 1985. The contamination removed from these residential properties was stored on property owned by the Stepan Company. The DOE subsequently acquired this property from the Stepan Company and named it the "MISS." The DOE initiated additional cleanup activities in 1995. In 1997, responsibility for the execution and administration of FUSRAP was transferred by Congress from DOE to USACE. By 2000, USACE completed the remainder of the residential cleanup actions that DOE initiated in 1995, thereby completing remediation of the Phase 1 properties. In December 1998, USACE issued a "Scope of Services" for the design and remediation of the remaining 24 commercial and governmental properties that potentially contained deposits of radioactive materials resulting from former activities at the MCW. These properties were designated as Phase 2 properties. In 2003, USACE published the ROD (USACE, 2003) to address the 24 remaining (Phase 2) FMSS Properties.

[1] According to the ROD (USACE 2003), some records indicate that thorium processing from monazite sands may have begun as early as 1895.



Source: U.S. NRC Docket No. 40-08610

Figure 1-3
Location of Burial Sites and Monitoring Wells

Because Burial Pit No. 1 contained NRC-licensed materials, NRC had the statutory responsibility for ensuring protection of the public's health and safety related to Burial Pit No. 1 materials under the Atomic Energy Act of 1954. USACE was allowed to take possession of Burial Pit No. 1 and perform the remedial action pursuant to the 2001 *Memorandum of Understanding Between The U.S. Nuclear Regulatory Commission and The U.S. Army Corps of Engineers for Coordination on Cleanup & Decommissioning of* *the FUSRAP Sites with NRC-Licensed Facilities* (see Appendix A). The Memorandum of Understanding (MOU) was entered into by NRC and USACE for the purposes of minimizing dual regulation and duplication of regulatory requirements at FUSRAP sites with NRC-licensed facilities. The MOU set out the conditions, consistent with the protection of the public health and safety, that permitted NRC to exercise its discretion to place its NRC licenses at FUSRAP sites in abeyance, thereby allowing USACE to remediate the sites under CERCLA.

The relevant Burial Pit No. 1 NRC License, STC-1333, is held by the Stepan Company. In accordance with the *Settlement Agreement – United States and Stepan Company* (U.S. Department of Justice [USDOJ] 2004), USACE has agreed to perform remediation of Burial Pit No. 1 as part of FUSRAP. NRC placed License STC-1333 in abeyance prior to the start of remediation at Burial Pit No. 1. This abeyance was in accordance with the "Confirmatory Order Modifying License No. STC-1333," which was issued to the Stepan Company on October 21, 2008, and documented in the Federal Register (Vol. 73, No. 215) on November 5, 2008 (Appendix A). The NRC license was placed in abeyance when USACE took physical possession of Burial Pit No. 1 by notice to NRC dated January 20, 2010 (Appendix A).

In accordance with the MOU, NRC and USACE have had ongoing communication regarding Burial Pit remediation. NRC has also visited the FMSS on several occasions to perform observations. At Burial Pit No. 1, NRC observed final status survey (FSS) activities on June 15, 2010 and again on November 10, 2010, as documented in NRC Reports 04008610/2010001 and 04008610/2010002 (see Appendix A). The NRC reports also document other site visits and additional contacts between the two agencies.

1.2 PREVIOUS INVESTIGATIONS

The FMSS team performed the final investigation of the Phase 2 properties in 2000 to acquire the remaining data necessary to complete remedial designs. The results of previous DOE investigations conducted at the 100 West Hunter Avenue Property by Bechtel National, Inc. (BNI) (DOE, 1992) and CH2M Hill (DOE, 1994) were compiled and presented along with the final pre-design investigation data collected by Stone and Webster (S&W) in the *Pre-Design Investigation Report: Cluster No. 10, Revision 1* (USACE, 2001d). All survey results were evaluated by USACE and Shaw, and a rationale for contaminant delineation was developed. The areas of the 100 West Hunter Avenue Property designated for cleanup by USACE were outlined in the *Pre-Design Investigation Data Assessment/Evaluation For Cluster No. 10* (USACE, 2000).

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2.0 REMEDIAL ACTION GUIDELINES

Contaminated material in Burial Pit No. 1 was classified as FUSRAP waste under the terms of the Federal Facilities Agreement[1] as described in the ROD (USACE, 2003). FUSRAP waste in Burial Pit No. 1 primarily included soil contaminated with the radionuclides-of-concern related to historic thorium processing by the MCW. USACE and EPA identified the following radionuclides of concern: thorium-232 (Th-232), radium-226 (Ra-226), uranium-238 (U-238), and their respective daughter products. The general RAOs established in the ROD are to prevent or mitigate further release of FUSRAP waste to the surrounding environment via the selected alternative of excavation and off-site disposal; to meet the established release criteria, which are dependent upon the reasonably anticipated future land use of the 100 West Hunter Avenue Property; and to comply with the identified ARARs.

2.1 RELEASE CRITERIA

The ROD (USACE, 2003) identifies Burial Pit No. 1 for Restricted Use (commercial) based on the 100 West Hunter Avenue Property's reasonably anticipated future land use. Therefore, the following criteria were applied during remediation and data evaluation:

- An average of 15 picoCuries per gram (pCi/g) combined Ra-226 and Th-232 above background in subsurface soil with an as-low-as-reasonably-achievable goal of 5 pCi/g.
- An average of 100 pCi/g above background for total uranium, which equates to 50 pCi/g U-238 above background, at all properties addressed in the ROD. These values (100 pCi/g and 50 pCi/g) constitute the Derived Concentration Guideline Level (DCGLs) for total uranium and U-238, respectively.
- Soil and building remediation must meet the 15 millirem per year (mrem/yr) above background dose limit specified in the New Jersey Administrative Code (NJAC) 7:28-12.8(a)1 (New Jersey Department of Environmental Protection [NJDEP], 2000) at all properties addressed in the ROD. Satisfaction of this criterion will also ensure that Burial Pit No. 1, an NRC-licensed portion of the FMSS, meets the 25 mrem/yr above background dose limit specified in Title 10 CFR 20.1402.
- Soil and building remediation must meet the 3 picoCuries per liter (pCi/L) above background indoor radon-222 limit specified in the NJAC 7:28-12.8(a)2 (NJDEP, 2000) at all properties addressed in the ROD.

All of the FMSS properties have the potential to generate storm water from surface run-on and/or groundwater infiltration, depending on the depth of excavation. Therefore, the ROD (USACE, 2003) required that FMSS remediation-derived water meet the following criteria prior to discharge:

- Any FMSS remediation-derived water discharged from a point source to a surface water body or groundwater must comply with the relevant and appropriate promulgated state and federal standards for the FMSS contaminants of concern.
- In the absence of specific discharge limits, point source discharges must satisfy federal maximum contaminant levels for each contaminant of concern.

[1] The Federal Facilities Agreement was executed by DOE and EPA to establish the procedural framework and schedule for the cleanup while fostering cooperation between the two agencies. The agreement was designed to ensure thoroughness and legal compliance during all phases of remedial planning and implementation. The agreement's definition of "FUSRAP waste" is also included in the ROD (USACE, 2003).

The ROD (USACE, 2003) is included as part of the USACE Administrative Record established for the FMSS. The Administrative Record is available for review at the USACE FUSRAP Public Information Center at 75A West Pleasant Avenue, Maywood, New Jersey, or online at http://www.fusrapmaywood.com.

2.2 APPLICATION OF CRITERIA

Post-remedial soil sample results were compared directly to the release criteria presented in Section 2.1. If all post-remedial soil sample results had concentrations that were less than the release criteria (referred to as DCGL), the property was deemed radiologically appropriate for release, and no further remediation is required. However, if any of the post-remedial sample results exceeded the release criteria, the non-parametric Wilcoxon Rank Sum (WRS) test was performed to statistically compare the results to background levels in accordance with guidance from EPA 402-R-97-016-Rev 1: *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (EPA, 2000b).

The *Background Study Investigation Report, Revision 1* (USACE, 2004d) was prepared to establish average background levels of radioactivity in soil near the FMSS. The background levels were established to serve as a reference for evaluating analytical data in achieving the RAOs, and to provide suitable data to perform the WRS nonparametric statistical test established in MARSSIM (EPA, 2000b) and incorporated into the MFSSP (USACE, 2001d). Table 2-1 summarizes the calculated background levels and established restoration criteria for backfill materials as presented in the *Background Study Investigation Report, Revision 1* (USACE, 2004d).

Table 2-1
Summary of Background Criteria for Restoration Material Selection

Analyte	Background Level (pCi/g)	95th Upper Confidence Limit of Background* (pCi/g)
U-238	1.33	2.64
Ra-226 + Th-232	1.64	2.76

Note: *The upper limits of acceptable background, based on an evaluation at the 95% confidence interval, were used to assess backfill conformance (USACE, 2004d).

3.0 CHRONOLOGY OF EVENTS

Table 3-1 provides the order of significant events completed during the characterization and remediation of Burial Pit No. 1.

Table 3-1
Chronology of Events

Date	Event
1992–1999	Investigations of the FMSS were conducted by BNI (DOE, 1992), CH2M Hill (DOE, 1994), and Shaw S&W (USACE, 2001d)
August 1995	*Remedial Design/Remedial Action Implementation Plan for the Maywood Vicinity Properties* issued (DOE, 1995)
May 2001	*Pre-Design Investigation Report: Cluster No. 10, Revision 1* issued (USACE, 2001d)
July 2001	USACE and NRC executed an MOU creating a mechanism for USACE to take possession of Burial Pit No. 1 and perform remediation (Appendix A)
August 2003–September 2003	USACE and EPA signed ROD (USACE, 2003), which was issued as a remedial decision document for soils and building at the FMSS
January 2004	*Construction Work Plan Triangle Clusters – Phase 10* issued (USACE, 2004c)
February 2004	Remedial Action Work Plan (USACE, 2004a) for FUSRAP-contaminated properties to be remediated under the ROD was issued for construction
November 2004	*Settlement Agreement United States – Stepan Company* (USDOJ, 2004) executed between the United States Government and Stepan Company
October 28, 2008	Confirmatory Order Modifying License No. STC-1333 issued (Appendix A)
January 20, 2010	USACE submitted a letter notifying NRC that it had taken physical possession of Burial Pit No. 1, thereby placing License STC-1333 in abeyance for Burial Pit No. 1 (Appendix A)
Remedial Activities	
February 1, 2010	Pre-remedial geophysical surveys were performed.
March 8, 2010	Local utility company relocated utility poles and lines.
March 25, 2010	Installation of soldier piles for shoring system began.
May 6, 2010	Soldier pile installation was completed.
May 17, 2010	Remediation crews and equipment began mobilization.
May 20, 2010	Installation of dewatering wells began.
May 26, 2010	Excavation of FUSRAP waste began (above water table).
June 30, 2010	Installation of dewatering wells was completed.
July 1, 2010	24-hour dewatering and treatment began.
July 6, 2010	Excavation of deep contamination began.
October 16, 2010	FSS activities began.
October 25, 2010	Backfilling began.
February 22, 2011	FSS activities were completed.
April 7, 2011	Backfilling was completed.
September 2011*	Restoration and demobilization are expected to be completed.

* Anticipated date to complete reseeding of lawn area accurate at time of printing. Date subject to change.
FSS denotes final status survey.

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4.0 DESCRIPTION OF REMEDIAL ACTIVITIES

This section describes the remediation and restoration of Burial Pit No. 1. The selected remedial action as specified in the ROD (USACE, 2003) for accessible soil and bulk waste was excavation and off-site disposal. Accessible soil was defined in the ROD as soil that is not located under permanent structures, such as buildings and active roadways. Soil under sidewalks, parking lots, and non-permanent structures was considered accessible, unless its removal would compromise the integrity of a permanent structure, such as a building foundation, roadway, railway, or utility corridor. All FUSRAP-related contamination within Burial Pit No. 1 was considered accessible.

Remediation of Burial Pit No. 1 was performed in accordance with the RAWP (USACE, 2004a), which provided overall guidance, general construction methodology, and execution plans for the cleanup of FUSRAP contamination on properties designated in the ROD (USACE, 2003). Cluster-specific addenda to the RAWP were also prepared for the remediation of Burial Pit No. 1 to establish methodologies and plans for dewatering and groundwater plume monitoring (USACE, 2010). The property-specific remedial plan, the *Construction Work Plan Triangle Clusters – Phase 10* (USACE, 2004c), provided additional details including the following information:

- Documentation of existing site conditions
- Proposed construction methodology, including the layout of construction phases and estimated excavation limits
- Estimated quantity of contaminated soil to be removed
- Estimated quantities of materials needed to execute the remedial design
- Plans for site restoration
- Miscellaneous details for temporary facilities

4.1 PRE-MOBILIZATION

Pre-mobilization refers to the preparatory work performed prior to physical mobilization to the site. As part of pre-mobilization activities, the FMSS team performed the following tasks:

- Supported execution of a Settlement Agreement (USDOJ, 2004) between the U.S. Government and the Stepan Company
- Established possession of Burial Pit No. 1 in accordance with the MOU (see Appendix A), thereby placing NRC License STC-1333 in abeyance for Burial Pit No. 1 so USACE could remediate under CERCLA
- Verified that applicable permits, notifications, and approvals had been obtained from, or submitted to, the appropriate agencies
- Conducted radiological surveys to establish radiological posting requirements and worker protection measures
- Prepared traffic plans for remediation
- Prepared and reviewed the details of the *Construction Work Plan Triangle Clusters – Phase 10* (USACE, 2004c) to lay out limits of excavation, establish survey controls, and document existing site conditions and topography

- Prepared and reviewed details of the *Burial Pit No. 3 Dewatering Plan Addendum BP1 Dewatering and Plume Monitoring QA Plan* (USACE, 2010)
- Contacted New Jersey One-Call a minimum of 72 hours (3 working days) prior to construction activities
- Reviewed details of existing subsurface geophysical surveys

4.2 SITE PREPARATION AND MOBILIZATION

After pre-mobilization activities were completed, equipment and personnel began site preparations for the remedial action. A significant aspect of site preparation involved the installation of an earth-shoring system along West Hunter Avenue consisting of 46 soldier piles and timber lagging (see photos in Appendix B). This system allowed for complete remediation and satisfaction of clean-up criteria.

Another significant component of site preparation involved the installation of 23 dewatering wells around the perimeter of Burial Pit No. 1. These wells were installed to draw the water table down below the anticipated depth of excavation. Groundwater level measurements were recorded daily during remediation. The system also included the installation of a pumping station as well as installation of electrical systems for operation. The displaced water was treated through an on-site water treatment plant that was designed and installed specifically to treat "Burial Pit" water (USACE, 2009b). Treated water was discharged through a pipe that was installed between the treatment plant and a Borough of Maywood sanitary sewer line. Section 4.4 discusses water treatment and discharge in more detail.

Additional tasks performed as part of mobilization and site preparation included the following:

- Established protocols to ensure effective communication between crews at Burial Pit No. 1 and the FMSS field office
- Inspected and performed initial radiological surveys on construction equipment
- Prepared lay down and parking areas for heavy equipment, personal vehicles, and material and equipment storage
- Installed temporary facilities, including temporary electric utilities, portable access control sheds, personnel decontamination facilities, traffic-control barriers and devices, and temporary fencing
- Established traffic and access controls, posted construction signs, and established restricted/contaminated areas
- Established air, industrial hygiene, personnel, and environmental monitoring operations in accordance with the SSHP
- Identified and obtained access to the nearest water source for dust-management activities
- Performed follow-up geophysical surveys to investigate potential data gaps in the original survey, verified subsurface utility locations for clearance, and identified metallic anomalies
- Installed 13 groundwater monitoring wells for plume migration monitoring (these same monitoring wells were installed and used for plume migration monitoring associated with remediation of Burial Pit No. 3)
- Relocated the existing electric service to Stepan (old equipment was taken out of service and replaced with new equipment including: two utility poles, overhead and underground wires, transformer pad, switch gear, and control panel)
- Cleared and grubbed vegetation

- Removed Stepan Company sign, flag pole, and lights
- Performed a vibration evaluation to determine if building monitoring should be implemented during soldier pile installation.
- Performed baseline settlement monitoring of structures adjacent to Burial Pit No. 1
- Nine test pits were excavated to verify the pre-design investigation limits of contamination
- Photographed existing site conditions for the Burial Pit No. 1 Photograph Log (Appendix B) and provided existing conditions report to Stepan Company

4.3 SOIL EXCAVATION

4.3.1 Design

The remedial design for Burial Pit No. 1 was based on the radiological data collected during previous investigations by BNI (DOE, 1992), CH2M Hill (DOE, 1994), and S&W as summarized in the *Pre-Design Investigation Report: Cluster No. 10, Revision 1* (USACE, 2001d). Data from these investigations were used to prepare the *Construction Work Plan Triangle Clusters – Phase 10* (USACE, 2004c). The initial site conditions and the design limits of contamination are presented on Figure 4-1.

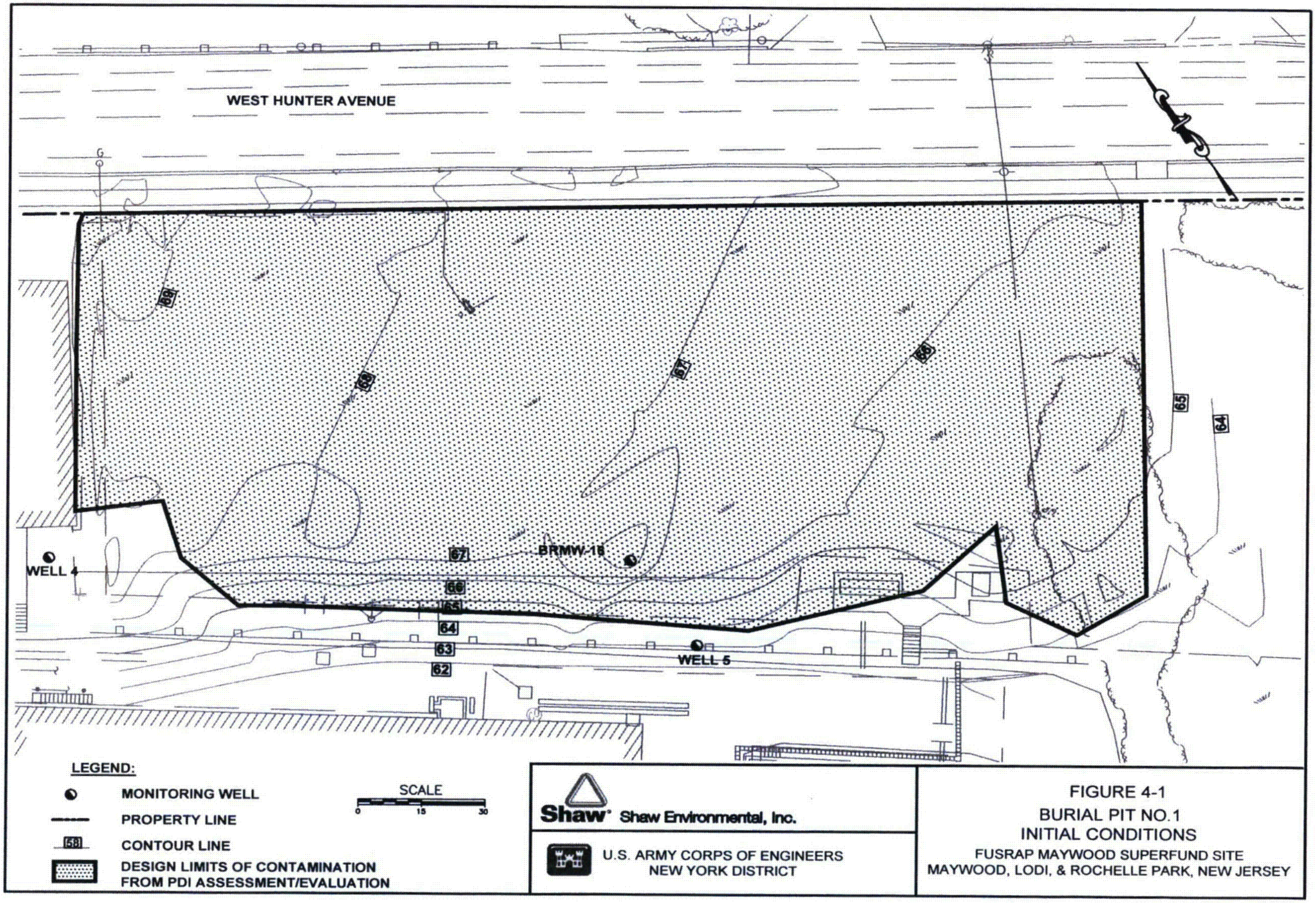


Figure 4-1
Burial Pit No. 1 Initial Conditions

4.3.2 Excavation

Remedial designs for the excavation of contaminated material from Burial Pit No. 1 were detailed in the *Construction Work Plan Triangle Clusters – Phase 10* (USACE, 2004c). In general, excavation activities were executed with the goal of preparing land areas for post-remedial action measurements (also known as FSS, see Section 5.0); therefore, the remaining discussion of excavation activities will reference FSS survey units (SUs). The remediation of Burial Pit No. 1 was comprised of two SUs as detailed in Section 5.0. The volume of contaminated soil removed from Burial Pit No. 1 was 12,460 in situ yd^3. This volume was calculated by the excavation "as-built" survey included as Figure 4-2. Excavation as-built surveys are the method used by the project to calculate the volume of contaminated soil removed from an excavation. Volume is recorded as in situ yd^3, which refers to the volume of soil as it existed in-place within the excavation (i.e., no bulking factor is applied).

4.3.3 Groundwater Monitoring Wells

One Stepan Company remedial investigation well was located within the remedial footprint of the Burial Pit No. 1 excavation. This well, identified as BRMW16, was protected during remediation, and its casing was decontaminated as necessary to meet release criteria. Upon completion of remedial activities, Well BRMW16 was operational. Two groundwater monitoring wells owned by Stepan Company were located adjacent to the remedial footprint of Burial Pit No. 1. These wells, identified as Well 4 and Well 5, were installed by Stepan for the purpose of monitoring groundwater down gradient of Burial Pit No. 1 as required by NRC License STC-1333. Access to these wells by Stepan consultants for quarterly monitoring sampling events was accommodated as practical during remediation. Upon completion of remedial activities, the wells were operational.

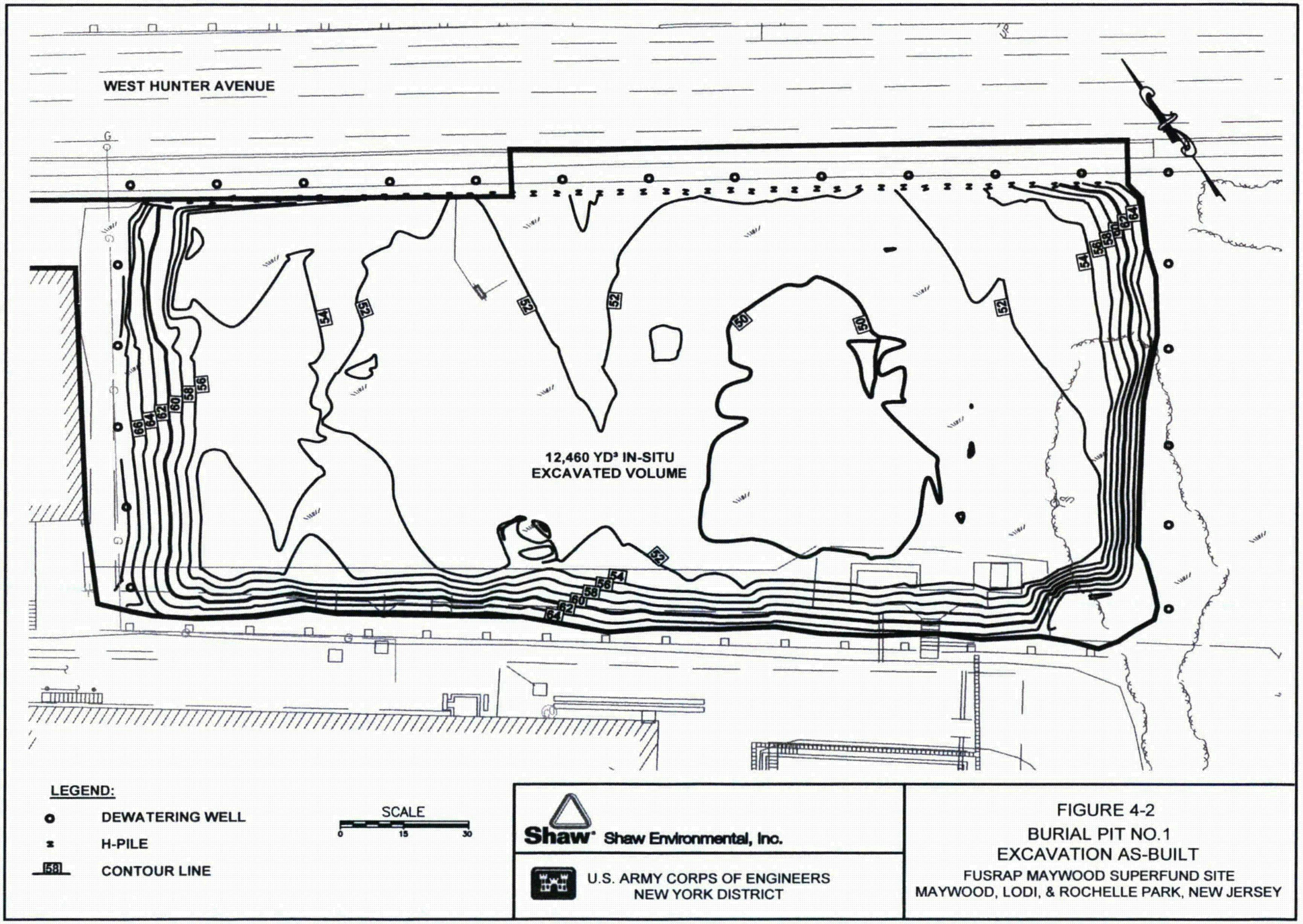


Figure 4-2
Burial Pit No. 1 Excavation As-Built

4.4 MATERIAL HANDLING AND TRANSPORT

4.4.1 Soil

Excavated soil with contamination exceeding release criteria was transported to the MISS by covered dump trucks. Transportation occurred mainly via a dedicated internal haul route; when trucks needed to use West Hunter Avenue instead of the internal haul route, they were lined with 6-millimeter polyethylene sheeting and covered. Radiological surveys were conducted on all vehicles transporting contaminated soil between Burial Pit No. 1 and the MISS to ensure that radiological levels were in accordance with U.S. Department of Transportation requirements, and to verify that the trucks were free of loose contamination that could potentially contaminate the environment. The survey reports are regularly transmitted to USACE and are also maintained at the on-site FMSS Project field office.

In total, 12,460 in situ yd^3 of contaminated soil was transported to the MISS. The material was temporarily stored on the MISS before being transported off site via rail to an approved licensed disposal facility in accordance with the requirements of the *Material Handling, Transport, and Disposal Plan, Revision 1* (USACE, 2001c). Material shipped off site for disposal was treated as 11(e)(2) by-product material in accordance with the ROD (USACE, 2003). As described in the ROD, 11(e)(2) by-product material refers to the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

4.4.2 Wastewater

Precipitation that collected in the excavations during remedial activities was considered radiologically-impacted, and was handled in accordance with the Water Management Plan (USACE, 2001e). In addition, all groundwater displaced by the dewatering well system was considered radiologically-impacted and was treated on site. A total of approximately 1,706,900 gallons of potentially-impacted wastewater was displaced through the dewatering system or pumped from the Burial Pit No. 1 excavation. Wastewater was processed through an on-site treatment plant. Treatment consisted of transferring the wastewater to holding tanks, where it was allowed to settle, and treating it with coagulant if necessary. Wastewater was then filtered to remove particulates, processed through granular-activated carbon to remove organic compounds, and then processed through ion-exchange columns to remove residual radioactivity. Treated wastewater was then sampled and analyzed for contaminants of concern in accordance with the BCUA Treated Groundwater Discharge Permit requirements (Permit No. 1050). Treated wastewater was discharged into a Borough of Maywood sanitary sewer in accordance with an agreement between Shaw and Borough of Maywood (Shaw, 2009). Analytical results were submitted to BCUA through monthly monitoring reports, and data packages are included in project records currently maintained on the FMSS.

4.5 BACKFILL TESTING AND COMPACTION

The open excavation of Burial Pit No. 1 was backfilled using approximately 24,400 tons of common fill and structural fill (roughly equal to 17,400 yd^3). Landscaping materials included topsoil. All landscaping and backfill material were tested and shown to be free of chemical and radiological contamination prior to use. Backfill material from off-site sources used in Burial Pit No. 1 was sampled for radiological contamination at a frequency of one sample per 1,000 yd^3, and for chemical contamination at a frequency of one sample per 5,000 yd^3. The chemical results were compared to the NJ Residential Direct Contact Soil Cleanup Criteria and the NJ Impact to Groundwater Soil Cleanup Criteria as specified in the RAWP. The radiological results were compared to the FMSS site-specific radiological background activity levels (USACE, 2004d) (refer to Table 2-1). Backfill soil samples were also tested for geotechnical characteristics to ensure compliance with the requirements of the RAWP (USACE, 2004a). Backfill placed within the excavation was compacted, and in-place field density testing was performed to confirm that acceptable parameters were satisfied as required by the RAWP.[1]

All backfill material met the physical, chemical, and radiological specifications of the RAWP (USACE, 2004a). All backfill data demonstrated compliance with Table 2-1. The chemical, radiological, and geotechnical results for the approved backfill material are provided in the following appendices:

Appendix C

- Backfill Conformance Reports
  - Geotechnical test results (compared to acceptance criteria)
  - Radiological test results (compared to acceptance criteria)
  - Chemical test results (compared to acceptance criteria)

Appendix D

- Data Packages for Backfill Samples
  - Chemical data packages for backfill samples
  - Radiological data packages for backfill samples

Appendix E

- Material Placement Test Results
  - Backfill compaction test results
  - Concrete test results

Appendix F

- Data Validation Reports
  - Data validation packages for chemical samples
  - Data validation packages for radiological samples

4.6 RESTORATION

The restoration plan is included as Figure 4-3. The Burial Pit No. 1 excavation has been backfilled using structural fill and common fill. Structural fill was used in the area of the West Hunter Avenue sidewalk and was also initially placed within the excavation to construct an access ramp to facilitate backfilling activities (see photographs in Appendix B). Table 4-1 lists the quantities of materials used. All backfill material was tested for compliance with RAWP specifications as detailed in Section 4.5. Additional restoration items included the following:

- Restoration of the lawn area by spreading topsoil, distributing grass seed, and placing mulch.
- Installation of a 10-foot high chain-link fence along the southwest boundary complete with six-strand barbed wire and privacy slats.

[1] USACE requested that compaction of common fill reach 90% for Burial Pit No. 1 (RAWP requirement is 85%). Material testing results provided in Appendix E indicate that this compaction was achieved for all common fill placed.

- Installation of a mulched landscaped area along the southwest boundary, including planting of 5 Thundercloud plum trees, 16 Shiner Blue spruce trees, 10 Snow Fountain Cherry trees, and 45 Azalea bushes.
- Installation of a mulched landscaped area adjacent to Stepan Building No. 15 along the northwest boundary, including planting of 12 Azalea bushes and 4 Dense Yew bushes.
- Installation of a mulched landscaped area near the center of the lawn area that included re-installing the Stepan sign, along with installing a new flag pole and new lights. The underground electrical conduit for the lights was installed from Stepan Building No. 15. Within this landscaped area, two Dwarf Alberta spruce trees and six Azalea bushes were planted.
- Installation of a concrete sidewalk along West Hunter Avenue.
- Placement of topsoil and seed between the installed sidewalk and the West Hunter Avenue curb. Eight October Glory red maple trees were also planted in the area.
- Installation of new electric service including two new utility poles, new overhead and underground electric lines, a new electrical transformer, and new switch gear, and a new control panel.

Table 4-1 summarizes the types and quantities of material placed at Burial Pit No. 1.

Table 4-1
Summary of Restoration Quantities

Material	Quantity
Backfill (common)	20,656 tons
Backfill (structural)	4,394 tons
Topsoil	520 yd^3
Snow Fountain Cherry trees	10
Shiner Blue spruce trees	16
Dwarf Alberta pine trees	2
Thundercloud plum trees	5
October Glory red maple trees	8
Dense Yews	4
Azaleas (red, white, and purple)	63
Mulched Area	7,500 square feet
Seeded Lawn Area	21,800 square feet
¾ -inch stone	25 tons
Concrete	10 yd^3
10-foot-high chain-link fence with six-strand barbed wire and privacy slats	320 linear feet

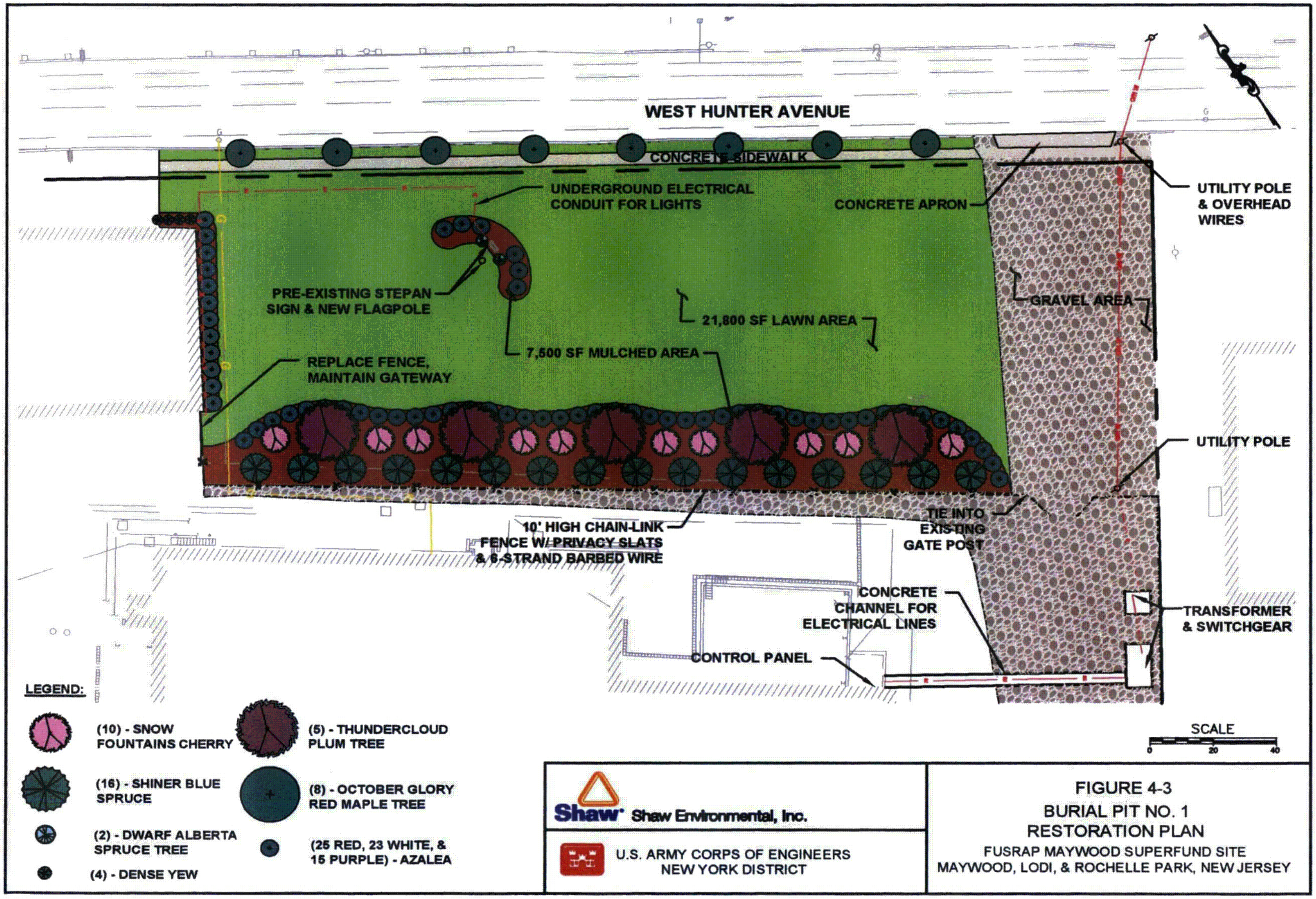


Figure 4-3
Burial Pit No. 1 Restoration Plan

5.0 POST-REMEDIAL ACTION MEASUREMENTS

Post-remedial action measurements, also referred to as FSS, were collected to assess residual radioactivity once remediation was completed. FSS was used to verify that RAOs were achieved and to determine if Burial Pit No. 1 could be released for Restricted Use (commercial). All FSS activities at Burial Pit No. 1 were conducted using a MARSSIM-based approach established in the MFSSP (USACE, 2001b) and specified for the 100 West Hunter Avenue Property in the *MFSSP Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan). Revision 0* (USACE, 2004b), hereafter collectively referred to as the "FSS Plan." FSS at Burial Pit No. 1 consisted of the following primary activities:

- Gamma walkover survey (GWS) over 100% of accessible areas
- Collection and gamma spectroscopy analysis of systematic surface and subsurface soil samples
- Collection and gamma spectroscopy analysis of biased surface and subsurface soil samples
- Data validation and evaluation

After field FSS data were collected and analyzed, the Project Health Physicist evaluated the residual radioactivity status of Burial Pit No. 1. GWS data were evaluated, and bias samples were collected from areas identified by GWS as having potentially elevated radioactivity. Analytical results of bias samples were compared directly to the DCGL (see Section 2.0). Systematic soil sampling data were evaluated using the nonparametric statistical methods established in the MARSSIM (EPA, 2000b) and the FSS Plan.

The primary goal of the FSS was to establish whether the Null Hypothesis, which states "the median concentration in the SU exceeds the median concentration in the reference area by more than the DCGL," was accepted or rejected for a particular SU (USACE, 2001b). The Null Hypothesis is an assumption that the SU exceeds the release criteria, and there are two methods for rejecting it:

1. If all systematic sample results are less than the DCGL, the Null Hypothesis is automatically rejected.
2. If any systematic sample result exceeds the DCGL by more than the lowest background reference area measurement result, the nonparametric WRS test is required to be performed. The WRS is used in situations where the contaminant is present in the background and establishes with sufficient statistical probability that the median concentration in the SU does not exceed the DCGL. The WRS test outcome must exceed the critical value in order to reject the Null Hypothesis and release the SU.

Background and reference area measurements used to support MARSSIM SU evaluations are presented in the *Background Study Investigation Report, Revision 1* (USACE, 2004d). Note that the WRS test was not required to satisfy the RAOs for Burial Pit No. 1.

5.1 SURFACE AND SUBSURFACE SOIL SAMPLING METHODS

FSS surface soil sampling was the primary method used to verify attainment of the RAOs at Burial Pit No. 1. All samples were collected, shipped, analyzed, and validated as specified in the FSS Plan and the CDQMP (USACE, 2009a). A list of the Standard Operating Procedures from the CDQMP used for sampling are included as part of the FSS Quality Control Report in Appendix G.

Surface samples are defined as samples collected from the top 6 inches of soil relative to the final excavation grade of an SU. Therefore, if a sample location falls within an excavation, the sample collected from the bottom of the excavation is identified as a surface sample with a depth of 0.0 to 0.5 feet bgs. Sidewalls of excavations were also sampled, as required, using surface sampling techniques; however, sidewall samples were technically considered subsurface samples, and the depths of the samples were recorded as relative to the original grade.

Subsurface sampling was performed in accordance with the FSS Plan. Prior to subsurface sampling, geophysical surveys were performed and remedial plans were reviewed to locate and identify utilities. A track-mounted Model 6610DT Geoprobe® rig (hereafter referred to as the direct-push soil probe) was used to collect continuous soil cores. A single rod (i.e., Macro-Core®) system was used to collect the subsurface samples. Soil was collected in 4-foot soil cores within polyvinyl chloride/polyethylene teraphthalate (PVC/PET) liners. All sampling equipment (rig, direct-push soil probe casing, and tools) was decontaminated by manual washing prior to use and following each borehole installation.

After the direct-push soil probe cores were collected, down-hole gamma logging was performed using a Ludlum Model 44-62 0.5-inch (1.3 centimeter [cm]) diameter by 1-inch (2.5 cm) thick sodium iodide (NaI) gamma detector connected via a cable to a Ludlum Model 2221 scaler-ratemeter. Timed 1-minute gross gamma measurements were recorded at 0.5-foot (0.15-meter) depth increments in the cased soil probe holes. The casing used for the down-hole gamma logging was constructed of PVC or steel. PVC casings were preferable since they attenuated gamma rays less, but steel casings were used at locations where PVC lacked the strength to penetrate the column to depth. After collection of down-hole gamma logging data, each direct-push soil probe hole was backfilled for the full length using bentonite. Down-hole gamma logging data, including sample location identifiers, depths (feet bgs), gross count rate readings, and type of casing used, were recorded.

The down-hole gamma readings were used to locate sampling depths from the soil core(s). One sample was collected from the interval corresponding to the highest down-hole gamma reading. In addition, samples were also typically collected from the surface interval and from the deepest interval.

5.2 SYSTEMATIC SAMPLE COLLECTION

A systematic sample is a sample collected from a location determined by a uniformly spaced triangular sampling grid established from a random starting point. The minimum number of systematic sample locations required for each SU was dependent upon the number of samples needed to perform the WRS test, and was determined using the MARSSIM-based approach described in the MFSSP (USACE, 2001b). The triangular systematic sampling grid spacing is established for each SU based on the area of the SU and the minimum number of samples required. The use of a random starting location provides an unbiased method for generating sample locations. The triangular systematic grid for the two Burial Pit No. 1 SUs and the as-built NJ State plane coordinates for each systematic sample location are presented in Appendix H (sample coordinates are also presented in Appendix I).

5.3 GAMMA WALKOVER SURVEY

The purpose of the GWS was to identify areas of elevated radioactivity for potential sampling that may not have been captured by the randomly located triangular systematic sampling grid. The GWS procedure consisted of walking straight parallel lines approximately 1 meter (3.28 feet) apart, while moving a 3-inch by 3-inch (7.62-cm by 7.62-cm) NaI gamma scintillation detector coupled to a Ludlum Model 2221 scaler-ratemeter in a serpentine motion at a maximum of 2 to 3 inches above the ground surface. Remediated excavation slopes and sidewalls were also scanned during the GWS.

Data in counts per minute (cpm) were logged automatically from the scaler-ratemeter into the differential global positioning system (DGPS) unit once per second. All GWS measurements were recorded as "gross" with no subtraction of ambient background radiation. A Trimble Pro XRS™ DGPS with TSC-1 Asset Surveyor™ was used to record gamma measurements and corresponding global positioning system (GPS) location data. The data were then downloaded from the DGPS unit into a personal computer file and into a geospatial software program to plot the results. Completed GWS maps were documented and submitted to USACE as part of the Final Status Survey Report prepared for each SU. The original FSS Reports are maintained on site at the FMSS field office. The GWS maps for Burial Pit No. 1 are included in Section 5.6. A secondary evaluation was performed on the GWS data to examine measurements that exceeded a Z-score of three (i.e., readings greater than three standard deviations [sigma] above the mean). The "+3 sigma" GWS maps were used to help identify bias sampling locations, and are provided in Appendix J.

Scan Minimal Detectable Concentrations (MDC_{scan}) values were established for the instruments used to perform GWS as detailed in the MFSSP (USACE, 2001b). Based on the a priori MDC_{scan} evaluation, no additional soil samples were required in order to identify potential small areas of elevated activity per MARSSIM (EPA, 2000b). The a priori MDC_{scan} evaluation is supported by a post-walkover evaluation using the maximum GWS measurement, as presented in Appendix G. However, the GWS did identify a small area of elevated activity that was subjected to additional sampling and an elevated measurement comparison (EMC) evaluation; the EMC evaluation and discussion are included in Section 5.6.2.

5.4 BIASED SOIL SAMPLE COLLECTION

As required in the FSS Plan, a minimum of one bias sample was collected in each SU from the location corresponding to the maximum GWS measurement. Additional bias samples were collected, as necessary, to address GWS measurements exceeding a Z-score of three and also at the discretion of the FSS field team. GWS measurements that exceed a Z-score of three are presented on the "+3 sigma" GWS maps included in Appendix J. The as-built NJ State plane coordinates for each FSS bias sample location are presented in Appendix I.

5.5 SAMPLE ANALYSIS AND DATA VALIDATION

All surface and subsurface soil samples (systematic, bias, and associated quality control) were prepared and analyzed by dry, equilibration-corrected gamma spectroscopy. The correction factor applied was established in the *Radon Ingrowth Correction Factor* Interoffice Memorandum (USACE, 2001f). Samples were analyzed by the USACE FUSRAP Maywood Laboratory (UFML), an on-site NJ-certified radiochemistry laboratory (State of NJ Lab Number 02022). All soil sampling data included in this PRAR are presented as gross with no subtraction for regional background soil concentrations unless noted.

Data validation was performed on FSS analytical results in accordance with the CDQMP (USACE, 2009a). The quality of radiological data were evaluated using the *Radionuclide Data Quality Evaluation Guidance* (USACE, 2009c), as presented in the CDQMP.

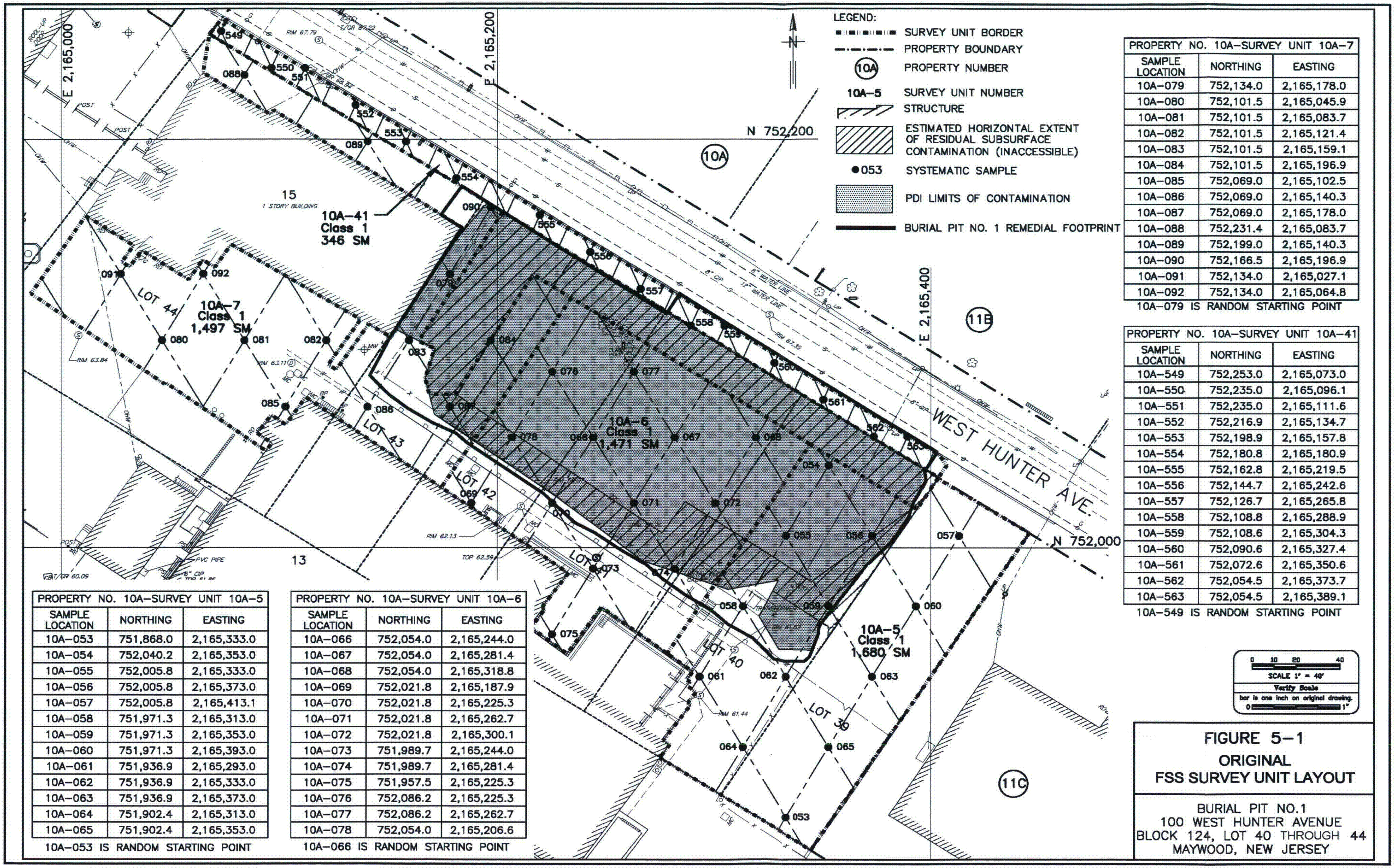
5.6 SURVEY UNIT DATA COLLECTION AND RESULTS

The initial FSS design presented in the FSS Plan for this area of the 100 West Hunter Avenue Property was not based on the size nor shape of Burial Pit No. 1. As a result, portions of four originally designed Class 1 SUs were contained within the remedial footprint as shown on Figure 5-1. Each of these originally designed SUs contained 13 systematic sample locations and the largest SU by area was 1,680 m^2. Actual remediation in this area was targeted to remediate Burial Pit No. 1 in its entirety resulting in two Class 1 SUs being implemented. These two SUs remained true to the design parameters although their SU identifiers and final SU limits were different. As shown on Figure 5-2, SU 10A-29 contained 15 systematic sample locations and was 1,395 m^2 in area; and SU 10A-30 contained 14 systematic sample locations and was 1,226 m^2 in area.

Figure 5-1 also indicates large areas of inaccessible contamination within the remedial footprint of Burial Pit No. 1. These inaccessible areas were originally designed in deference to excavation safety considerations. However, engineering systems and stability control measures allowed for complete remediation and both SUs satisfied Restricted Use (commercial) release criteria with no inaccessible contamination left behind.

FSS design modifications and a summary of collected data for each SU are described in more detail in Sections 5.6.1 and 5.6.2. Figure 5-2 presents the final as-built layout for the Burial Pit No. 1 SUs and indicates the locations of systematic and bias samples collected in support of FSS. The final as-built drawings for each individual SU are included in Appendix H.

In accordance with the MOU between USACE and NRC, the NRC observed FSS activities within Burial Pit No. 1 on June 15, 2010 and November 10, 2010. NRC was provided with split samples collected from ten systematic sample locations within SUs 10A-29 and 10A-30. The observations and split sample results are presented in NRC reports included in Appendix A.



PROPERTY NO. 10A–SURVEY UNIT 10A–5		
SAMPLE LOCATION	NORTHING	EASTING
10A–053	751,868.0	2,165,333.0
10A–054	752,040.2	2,165,353.0
10A–055	752,005.8	2,165,333.0
10A–056	752,005.8	2,165,373.0
10A–057	752,005.8	2,165,413.1
10A–058	751,971.3	2,165,313.0
10A–059	751,971.3	2,165,353.0
10A–060	751,971.3	2,165,393.0
10A–061	751,936.9	2,165,293.0
10A–062	751,936.9	2,165,333.0
10A–063	751,936.9	2,165,373.0
10A–064	751,902.4	2,165,313.0
10A–065	751,902.4	2,165,353.0

10A–053 IS RANDOM STARTING POINT

PROPERTY NO. 10A–SURVEY UNIT 10A–6		
SAMPLE LOCATION	NORTHING	EASTING
10A–066	752,054.0	2,165,244.0
10A–067	752,054.0	2,165,281.4
10A–068	752,054.0	2,165,318.8
10A–069	752,021.8	2,165,187.9
10A–070	752,021.8	2,165,225.3
10A–071	752,021.8	2,165,262.7
10A–072	752,021.8	2,165,300.1
10A–073	751,989.7	2,165,244.0
10A–074	751,989.7	2,165,281.4
10A–075	751,957.5	2,165,225.3
10A–076	752,086.2	2,165,225.3
10A–077	752,086.2	2,165,262.7
10A–078	752,054.0	2,165,206.6

10A–066 IS RANDOM STARTING POINT

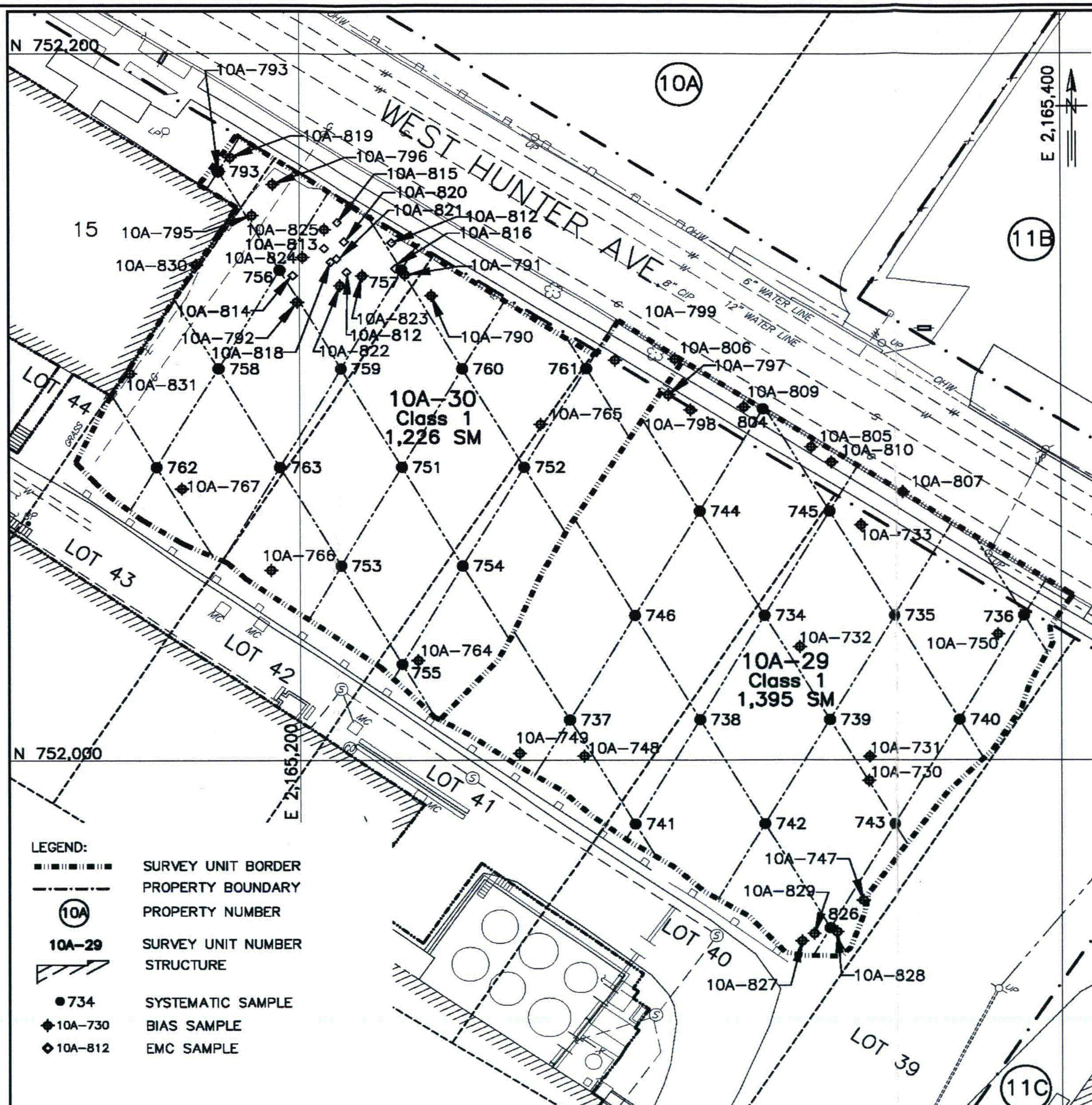
PROPERTY NO. 10A–SURVEY UNIT 10A–7		
SAMPLE LOCATION	NORTHING	EASTING
10A–079	752,134.0	2,165,178.0
10A–080	752,101.5	2,165,045.9
10A–081	752,101.5	2,165,083.7
10A–082	752,101.5	2,165,121.4
10A–083	752,101.5	2,165,159.1
10A–084	752,101.5	2,165,196.9
10A–085	752,069.0	2,165,102.5
10A–086	752,069.0	2,165,140.3
10A–087	752,069.0	2,165,178.0
10A–088	752,231.4	2,165,083.7
10A–089	752,199.0	2,165,140.3
10A–090	752,166.5	2,165,196.9
10A–091	752,134.0	2,165,027.1
10A–092	752,134.0	2,165,064.8

10A–079 IS RANDOM STARTING POINT

PROPERTY NO. 10A–SURVEY UNIT 10A–41		
SAMPLE LOCATION	NORTHING	EASTING
10A–549	752,253.0	2,165,073.0
10A–550	752,235.0	2,165,096.1
10A–551	752,235.0	2,165,111.6
10A–552	752,216.9	2,165,134.7
10A–553	752,198.9	2,165,157.8
10A–554	752,180.8	2,165,180.9
10A–555	752,162.8	2,165,219.5
10A–556	752,144.7	2,165,242.6
10A–557	752,126.7	2,165,265.8
10A–558	752,108.8	2,165,288.9
10A–559	752,108.6	2,165,304.3
10A–560	752,090.6	2,165,327.4
10A–561	752,072.6	2,165,350.6
10A–562	752,054.5	2,165,373.7
10A–563	752,054.5	2,165,389.1

10A–549 IS RANDOM STARTING POINT

Figure 5-1
Original FSS Survey Unit Layout



SURVEY UNIT 10A-29 SYSTEMATIC SAMPLES		
SAMPLE LOCATION	NORTHING	EASTING
10A-734	752,041.0	2,165,322.0
10A-735	752,041.0	2,165,356.1
10A-736	752,041.0	2,165,390.2
10A-737	752,011.5	2,165,270.8
10A-738	752,011.5	2,165,304.9
10A-739	752,011.5	2,165,339.1
10A-740	752,011.5	2,165,373.2
10A-741	751,981.9	2,165,287.9
10A-742	751,981.9	2,165,322.0
10A-743	751,981.9	2,165,356.1
10A-744	752,070.5	2,165,304.9
10A-745	752,070.5	2,165,339.1
10A-746	752,041.0	2,165,287.9
10A-804	752,099.5	2,165,321.7
10A-826	751,952.4	2,165,339.1

SURVEY UNIT 10A-29 BIAS SAMPLES		
SAMPLE LOCATION	NORTHING	EASTING
10A-730	751,994.2	2,165,349.2
10A-731	752,001.0	2,165,349.4
10A-732	752,032.1	2,165,331.2
10A-733	752,066.6	2,165,347.3
10A-747	751,960.2	2,165,347.7
10A-748	752,001.2	2,165,274.5
10A-749	752,002.0	2,165,257.8
10A-750	752,035.7	2,165,383.4
10A-797	752,103.5	2,165,296.8
10A-798	752,099.2	2,165,302.6
10A-805	752,088.7	2,165,334.3
10A-807	752,075.9	2,165,358.4
10A-809	752,100.0	2,165,316.7
10A-810	752,084.4	2,165,339.6
10A-827	751,948.7	2,165,331.6
10A-828	751,951.3	2,165,340.8
10A-829	751,950.8	2,165,334.8

SURVEY UNIT 10A-30 EMC SAMPLES		
SAMPLE LOCATION	NORTHING	EASTING
10A-812	752,146.5	2,165,224.4
10A-813	752,138.2	2,165,212.6
10A-814	752,145.0	2,165,206.4
10A-815	752,137.2	2,165,198.2
10A-816	752,152.3	2,165,210.9
10A-817	752,139.2	2,165,225.4
10A-818	752,141.1	2,165,208.1
10A-820	752,146.8	2,165,211.9
10A-821	752,142.0	2,165,209.8

SURVEY UNIT 10A-30 SYSTEMATIC SAMPLES		
SAMPLE LOCATION	NORTHING	EASTING
10A-751	752,083.0	2,165,227.0
10A-752	752,083.0	2,165,259.2
10A-753	752,055.1	2,165,210.9
10A-754	752,055.1	2,165,243.1
10A-755	752,027.2	2,165,227.0
10A-756	752,138.8	2,165,194.8
10A-757	752,138.8	2,165,227.0
10A-758	752,110.9	2,165,178.8
10A-759	752,110.9	2,165,210.9
10A-760	752,110.9	2,165,243.1
10A-761	752,110.9	2,165,275.2
10A-762	752,083.0	2,165,162.7
10A-763	752,083.0	2,165,194.8
10A-793	752,166.7	2,165,178.8

SURVEY UNIT 10A-30 BIAS SAMPLES		
SAMPLE LOCATION	NORTHING	EASTING
10A-764	752,028.3	2,165,231.2
10A-765	752,095.1	2,165,263.5
10A-766	752,053.9	2,165,192.5
10A-767	752,076.9	2,165,169.4
10A-790	752,131.5	2,165,234.9
10A-791	752,137.4	2,165,227.9
10A-792	752,129.7	2,165,199.3
10A-793	752,166.7	2,165,178.8
10A-795	752,154.2	2,165,187.5
10A-796	752,163.0	2,165,193.0
10A-799	752,113.3	2,165,282.8
10A-806	752,113.6	2,165,298.5
10A-819	752,170.6	2,165,181.8
10A-822	752,134.4	2,165,210.7
10A-823	752,137.1	2,165,216.7
10A-824	752,142.4	2,165,200.7
10A-825	752,150.3	2,165,206.4
10A-830	752,140.2	2,165,173.1
10A-831	752,109.5	2,165,155.7

SCALE 1" = 30'
Verify Scale
bar is one inch on original drawing.

FIGURE 5-2
AS-BUILT
FSS SURVEY UNIT LAYOUT

BURIAL PIT NO.1
100 WEST HUNTER AVENUE
BLOCK 124, LOT 40 THROUGH 44
MAYWOOD, NEW JERSEY

Figure 5-2
As-Built FSS Survey Unit Layout

5.6.1 Survey Unit 10A-29

5.6.1.1 Survey Unit Design and Systematic Sampling

The post-remedial design of Class 1 SU 10A-29 was based on the original SU designed for this area in the FSS Plan (see Figure 5-1). The minimum required number of systematic samples established in the FSS Plan was 13. The final as-built area of SU 10A-29 was 1,395 square meters (m^2), and the SU contained 15 systematic sample locations as illustrated on Figure 5-2.

Systematic samples within SU 10A-29 were collected using surface sampling techniques. Table 5-1 presents the results of the systematic samples analyzed by the UFML. All sample results were below their respective Restricted Use (commercial) DCGLs when regional background activity is taken into account. Sample 10a-57549, collected from location 10a-734, had a combined Ra-226 + Th-232 activity of 15.20 pCi/g; subtracting the smallest background reference area measurement (0.5 pCi/g combined Ra-226 +Th-232 [USACE, 2004d]) yielded a value less than the DCGL (i.e., 14.7 pCi/g is less than 15 pCi/g). Therefore, the WRS test was not required to evaluate the systematic sample results. Systematic sample location coordinates are included in Appendix I.

5.6.1.2 Gamma Walkover Survey and Bias Sampling

A 100% GWS was performed in SU 10A-29 in accordance with the requirements of the MFSSP (USACE, 2001b). Shielded gamma count rates ranged from 6,199 cpm to 43,493 cpm, averaging 14,786 cpm with a standard deviation of 4,294 cpm. The maximum gamma count rate (43,493 cpm) was observed at bias sample location 10a-733. Results of GWS were used to identify areas for further evaluation via collection and analysis of bias samples. GWS results and bias sample locations are presented on Figure 5-3.

Nineteen (19) bias samples were collected from the 17 biased locations identified during GWS evaluations. Samples from 15 of the bias locations were collected using surface sampling techniques. Two locations (10A-809 and 10A-810) were sampled using subsurface techniques, and two bias samples from each location were collected and included in the FSS dataset. Table 5-2 presents the results of the bias samples; all sample results were below their respective Restricted Use (commercial) DCGLs. The "+3 sigma" GWS maps, used to help identify bias sample locations, are presented in Appendix J. Bias sample coordinates are presented in Appendix I.

5.6.1.3 Final Status Survey Data Evaluation

All U-238 systematic sample results were below the U-238 Restricted Use (commercial) DCGL. The highest Ra-226 and Th-232 combined systematic sample result slightly exceeded the Ra-226 and Th-232 combined Restricted Use (commercial) DCGL with an activity of 15.2 pCi/g (refer to Table 5-1). However, since this result for Ra-226 and Th-232 combined (15.2 pCi/g) exceeded its DCGL by less than the smallest background reference area measurement for Ra-226 and Th-232 combined (0.5 pCi/g [USACE, 2004d]), the WRS test was not required per MARSSIM (EPA, 2000b).

Based on the maximum count rate of 43,493 cpm (shielded), no additional samples beyond the 19 collected bias samples were required in order to address potential small areas of elevated activity per MARSSIM (EPA, 2000b). Therefore, the area identified as SU 10A-29 can be released for Restricted Use (commercial) per the ROD (USACE, 2003).

All FSS analytical data pertaining to SU 10A-29 met all data quality objective (DQO) requirements as specified by the MFSSP (USACE, 2001b) and the CDQMP (USACE, 2009a). No FSS analytical data were rejected by the UFML, or by third-party validation. Refer to Section 6.0 for detailed quality assurance (QA)/quality control (QC) information.

As provided in Appendix K, the following sample delivery groups (SDGs) contain the analytical results and associated laboratory QC for SU 10A-29: 10G-0560, 10G-0563, 10G-0564, 10G-0565, 10G-0567, 10G-0568, 11G-0004, 11G-0051, 11G-0058, 11G-0060, 11G-0063, and 11G-0108. The associated data validation reports for each data package are included in Appendix F.

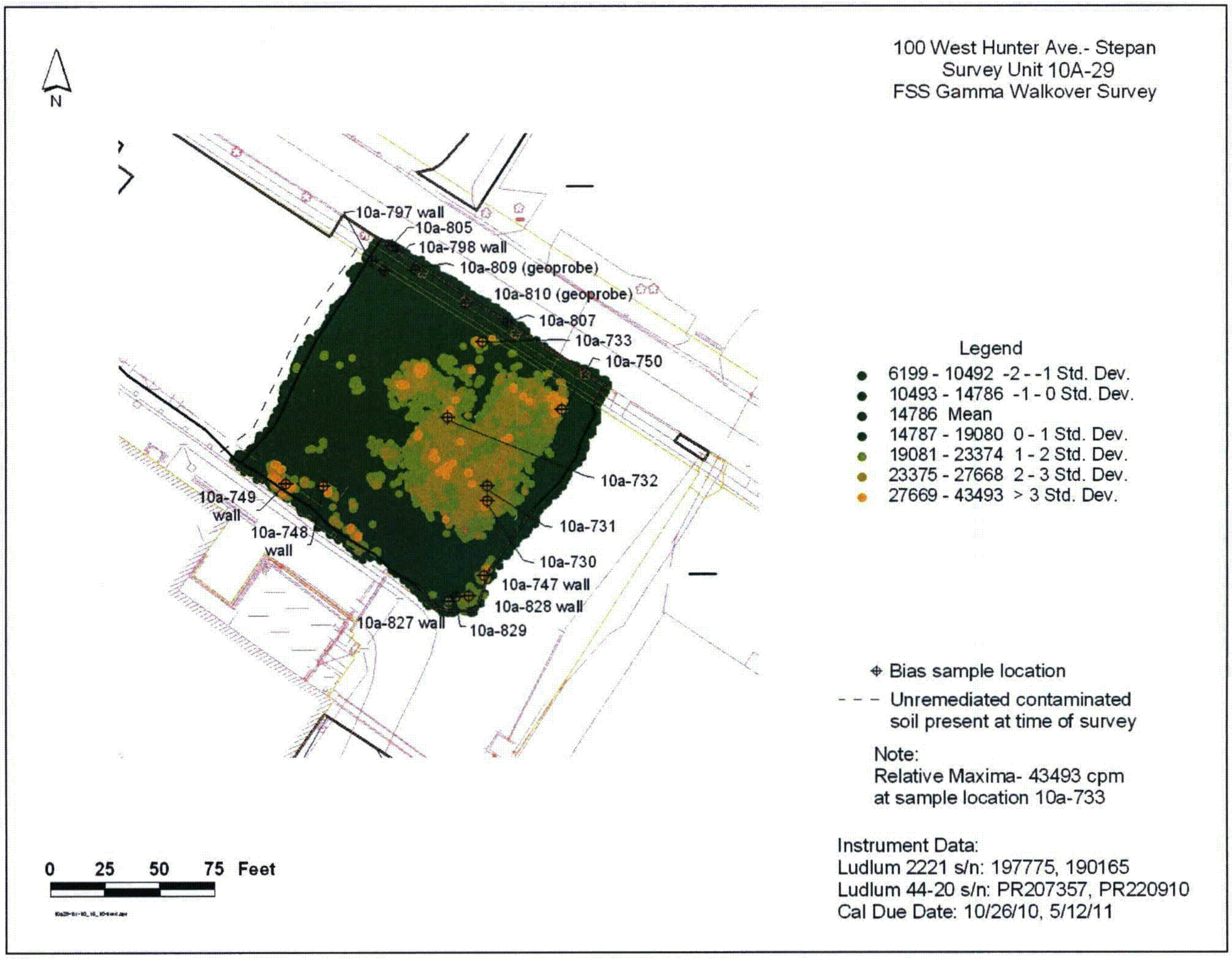


Figure 5-3
Gamma Walkover Survey Results of SU 10A-29

Table 5-1
Systematic Soil Sample Results – Survey Unit 10A-29

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)	
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)
10A-734	0.0 - 0.5	10a-057549	3.26	0.21	0.04		11.94	0.93	0.06		1.62	1.20	0.54		15.20	0.95
10A-735	0.0 - 0.5	10a-057534	2.12	0.15	0.03		4.36	0.38	0.05		1.26	0.66	0.27		6.48	0.40
10A-736	0.0 - 0.5	10a-057528	1.05	0.08	0.01		0.95	0.13	0.03		1.00	0.33	0.14		2.00	0.15
10A-737	0.0 - 0.5	10a-057536	1.71	0.12	0.03		3.57	0.32	0.04		1.09	0.65	0.24		5.28	0.34
10A-738	0.0 - 0.5	10a-057538	1.58	0.11	0.02		2.88	0.26	0.03		0.76	0.52	0.25		4.45	0.28
10A-739	0.0 - 0.5	10a-057533	2.80	0.18	0.04		5.64	0.50	0.06		1.07	0.62	0.29		8.44	0.53
10A-740	0.0 - 0.5	10a-057532	1.23	0.09	0.02		1.14	0.15	0.03		0.99	0.33	0.15		2.37	0.17
10A-741	0.0 - 0.5	10a-057531	0.85	0.07	0.02		0.96	0.14	0.03		0.62	0.29	0.14		1.81	0.16
10A-742	0.0 - 0.5	10a-057535	1.61	0.11	0.02		1.68	0.18	0.03		0.55	0.66	0.23	J(1)	3.29	0.22
10A-743	0.0 - 0.5	10a-057529	1.09	0.09	0.02		1.06	0.16	0.04		0.68	0.47	0.21		2.15	0.18
10A-744	0.0 - 0.5	10a-057542	1.00	0.08	0.01		0.89	0.12	0.02		0.60	0.38	0.17		1.88	0.14
10A-745	0.0 - 0.5	10a-057541	1.33	0.10	0.02		1.18	0.17	0.04		0.27	0.19	0.18		2.51	0.19
10A-746	0.0 - 0.5	10a-057539	2.05	0.16	0.04		5.74	0.52	0.06		0.83	0.66	0.32		7.79	0.54
10A-804	0.0 - 0.5	10a-057752	1.01	0.07	0.01		1.09	0.13	0.02		0.56	0.55	0.18	J(2)	2.10	0.15
10A-826	0.0 - 0.5	10a-057841	0.77	0.07	0.02		1.01	0.13	0.03		0.98	0.29	0.13		1.77	0.14

Notes: σ denotes sigma, standard deviation.
ft bgs denotes feet below ground surface.
MDC denotes minimal detectable concentration.
1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.

Table 5-2
Bias Soil Sample Results – Survey Unit 10A-29

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)		
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	Net Result[3]
10A-730	0.0 - 0.5	10a-057522	2.14	0.16	0.04		11.82	0.92	0.06		3.80	0.91	0.40		13.96	0.94	12.32
10A-731	0.0 - 0.5	10a-057543	3.60	0.23	0.04		9.91	0.80	0.07		1.70	0.76	0.35		13.50	0.83	11.86
10A-732	0.0 - 0.5	10a-054544	2.04	0.14	0.03		5.12	0.42	0.03		0.82	0.57	0.26		7.17	0.44	5.53
10A-733[a]	0.0 - 0.5	10a-057521	2.93	0.21	0.05		9.47	0.80	0.09		1.53	0.95	0.40		12.41	0.83	10.77
10A-747	0.0 - 0.5	10a-057524	1.84	0.16	0.04		9.52	0.78	0.07		1.40	0.75	0.36		11.36	0.80	9.72
10A-748	0.0 - 0.5	10a-057546	2.72	0.18	0.03		9.72	0.75	0.04		0.72	0.88	0.44	J(1)	12.44	0.77	10.80
10A-749	0.0 - 0.5	10a-057527	2.01	0.16	0.04		9.69	0.79	0.08		1.35	0.70	0.36		11.70	0.81	10.06
10A-750	0.0 - 0.5	10a-057547	2.42	0.16	0.03		8.61	0.69	0.05		1.75	1.23	0.44		11.03	0.70	9.39
10A-797$_{w}$	6.5 – 7.0	10a-057696	1.55	0.13	0.03		3.38	0.35	0.06		0.91	0.50	0.24		4.93	0.37	3.29
10A-798$_{w}$	6.5 – 7.0	10a-057697	1.51	0.11	0.02		1.79	0.21	0.04		1.61	0.55	0.24		3.30	0.23	1.66
10A-805	0.0 - 0.5	10a-057744	1.12	0.08	0.02		2.14	0.21	0.03		0.68	0.71	0.23	J(1)	3.26	0.22	1.62
10A-807	0.0 – 0.5	10a-057753	1.35	0.09	0.02		1.68	0.18	0.02		1.21	0.40	0.19		3.03	0.20	1.39
10A-809	6.75-7.25	10a-057755	2.51	0.21	0.05		2.20	0.38	0.09		2.64	0.77	0.35		4.70	0.43	3.06
(geoprobe)	12.5-13.0	10a-057756	1.76	0.18	0.05		1.69	0.31	0.08		1.31	0.63	0.31		3.46	0.36	1.82
10A-810	8.75-9.25	10a-057757	0.92	0.11	0.03		0.86	0.21	0.06		0.96	0.55	0.23	J(3,4)	1.78	0.23	0.14
(geoprobe)	15.5-16.0	10a-057758	1.17	0.13	0.04		1.04	0.29	0.09		1.33	0.68	0.29		2.21	0.31	0.57
10A-827$_{w}$	2.5-3.0	10a-057843	1.70	0.12	0.03		5.47	0.45	0.04		0.82	0.89	0.36	J(1)	7.18	0.47	5.54
10A-828$_{w}$	1.0-1.5	10a-057844	2.20	0.16	0.03		4.50	0.41	0.05		1.22	0.63	0.30		6.70	0.44	5.06
10A-829	0.0 - 0.5	10a-057845	1.00	0.09	0.02		1.13	0.18	0.04		0.53	0.42	0.17		2.13	0.20	0.49

Notes: σ denotes sigma, standard deviation.
ft bgs denotes feet below ground surface.
MDC denotes minimal detectable concentration.
"w" denotes sample collected from sidewall of excavation.
a. Bias sample location identified at the maximum GWS measurement (i.e., relative maximum).

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.
3. Results after subtraction of regional background (1.64 pCi/g for the sum of Ra-226 and Th-232 [USACE, 2004d]).

5.6.2 Survey Unit 10A-30

5.6.2.1 Survey Unit Design and Systematic Sampling

The post-remedial design of Class 1 SU 10A-30 was based on the original SU designed for this area in the FSS Plan (see Figure 5-1). The minimum required number of systematic samples established in the FSS Plan was 13. The final as-built area of SU 10A-30 was 1,226 m^2, and the SU contained 14 systematic sample locations as illustrated on Figure 5-2.

Systematic samples within SU 10A-30 were collected using surface sampling techniques with the exception of Sample 10a-057726, which was collected from location 10A-793 using subsurface sampling techniques (i.e., Geoprobe® sampling). Table 5-3 presents the results of the systematic samples analyzed by the UFML; all sample results were below their respective Restricted Use (commercial) DCGLs. Systematic sample location coordinates are included in Appendix I.

5.6.2.2 Gamma Walkover Survey and Bias Sampling

A 100% GWS was performed in SU 10A-30 in accordance with the requirements of the FSS Plan. GWS identified a small area of elevated activity that was subjected to further investigation using an EMC evaluation in accordance with MARSSIM (EPA, 2000b); this evaluation is discussed in detail in Section 5.6.2.3. Figure 5-4 shows results of the GWS for SU 10A-30 including the EMC area; Figure 5-5 shows GWS results for SU 10A-30 excluding the EMC area; and Figure 5-6 shows the GWS results for the EMC area only. The following discussions within this section (5.6.2.2) are based on the results for SU 10A-30 excluding the EMC area (i.e., based on Figure 5-5). The EMC area is excluded because its inclusion skews the GWS data such that variations between areas of the SU are hidden (this is evident when comparing Figures 5-4 and 5-5; in Figure 5-4 the entire SU appears homogenous, but in Figure 5-5 the variation in the data set is apparent). This approach is conservative as it resulted in more bias samples being identified and collected. However, the EMC evaluation considers the SU in its entirety (see Section 5.6.2.3).

Shielded gamma count rates (excluding the EMC area) ranged from 4,150 cpm to 62,189 cpm, averaging 13,438 cpm with a standard deviation of 3,032 cpm. The maximum gamma count rate (62,189 cpm) was observed at EMC-bounding sample location 10A-823 (see Figure 5-5).

Based on GWS evaluations (excluding the EMC area), 19 bias sample locations were identified within SU 10A-30. Bias samples were collected using surface sampling techniques, except for Sample 10a-057739 collected from location 10A-793 that was collected using subsurface techniques. (Note that two samples were collected at 10A-793 using subsurface techniques. The surface sample was included as a systematic sample [see Section 5.6.2.1], and the sample corresponding to the highest down-hole gamma reading was included as a bias.) Table 5-4 presents the results of the bias samples; all sample results were below their respective Restricted Use (commercial) DCGLs. The "+3 sigma" GWS maps, which were used to help identify bias sample locations, are presented in Appendix J. Bias sample coordinates are presented in Appendix I.

5.6.2.3 Final Status Survey Data Evaluation

All systematic sample results were below their respective Restricted Use (commercial) DCGLs.

All bias sample results (excluding those subsequently identified as EMC samples) were below their respective Restricted Use (commercial) DCGLs (refer to Table 5-4). However, an area of elevated activity was identified during GWS, and subsequent sampling confirmed residual activity in excess of the Restricted Use (commercial) DCGL for Ra-226 and Th-232 combined (all U-238 results were below the Restricted Use [commercial] DCGL); therefore, an EMC evaluation was performed for Ra-226 and Th-232 combined prior to rejecting the Null Hypothesis and establishing that the SU meets release criteria.

Figure 5-6 shows the GWS results and EMC sample locations within the EMC area. Several of the sample locations (10A-791, 10A-792, 10A-795, 10A-796, 10A-822, 10A-823, 10A-824, and 10A-825) shown on Figure 5-6 were bias samples (refer to Section 5.6.2.2 and Table 5-4) used to determine appropriate boundaries of the EMC area and were not used for the EMC evaluation.

Sample locations 10A-812, 10A-813, 10A-814, 10A-815, 10A-816, 10A-817, 10A-818, 10A-820, and 10A-821 constitute the sample set used to represent the EMC area; their results are presented in Table 5-5.

The EMC was performed using the unity rule formula as presented in MARSSIM (EPA, 2000b):

(1)

Where:

DCGL = Derived Concentration Guideline Level (Restricted Use [commercial])—15 pCi/g

The DCGL was established in the FSS Plan and is equivalent to the ROD (USACE, 2003) Restricted Use (commercial) cleanup criteria for Ra-226 and Th-232 combined above background of **15 pCi/g**.

δ = Average Ra-226 and Th-232 Combined Concentration in the Survey Unit—2.61 pCi/g

The average concentration in SU 10A-30 (4.25 pCi/g including background) was calculated from the Ra-226 and Th-232 combined concentrations of the 14 systematic samples presented in Table 5-3. Since the DCGL is presented as the allowable increment above background, the appropriate background value (1.64 pCi/g [USACE 2004d]) was subtracted resulting in an average concentration in the SU of **2.61 pCi/g**.

Note that two samples were collected from location 10A-793; the sample with the higher activity (10A-057726, 4.31 pCi/g) was conservatively considered the systematic sample and was used for this calculation (The other sample from this location is presented as a bias sample, and its results are presented in Table 5-4).

EMC_{ave} = Average Concentration in the Elevated (EMC) Area—(18.36 pCi/g)

The average concentration in the EMC area (20.0 pCi/g including background) was calculated from the concentrations of the nine (9) EMC samples presented in Table 5-5. Since the DCGL is presented as the allowable increment above background, the appropriate background value (1.64 pCi/g [USACE 2004d]) was subtracted resulting in an average concentration in the EMC area of **18.36 pCi/g.** Samples included in the calculation were collected on the bias of local elevated GWS results, and therefore represent a conservative average of the EMC area's activity.

AF_{EMC} = Area factor for the EMC area (2.3)

The FSS Plan, in accordance with MARSSIM (EPA, 2000b), establishes area factor values. Area factors were derived from dose-based considerations such that the dose from a small area of elevated activity can be assessed based on the DCGL. The Th-232 area factor (2.3) corresponding to a 30 m^2 area was conservatively selected for the EMC.

Equation (1) states that the dose-based criterion will be satisfied if the activity from the entire SU plus the activity from the EMC area is less than the normalized DCGL. Entering the variables into the equation results in the following:

— ——— (2)

(3)

Since 0.63 is less than one (1), SU 10A-30 satisfies release criteria.

In conclusion, since all isotopic systematic and regular bias sample activities were below their respective DCGLs and the small area of elevated activity was within tolerance as determined by the EMC evaluation, the Null Hypothesis is rejected. Therefore, the area identified as SU 10A-30 can be released for Restricted Use (commercial) per the ROD (USACE, 2003).

All FSS analytical data pertaining to SU 10A-30 met all DQO requirements as specified by the MFSSP (USACE, 2001b) and the CDQMP (USACE, 2009a). No FSS analytical data were rejected by the UFML, or by third-party validation. Refer to Section 6.0 for detailed QA/QC information.

As provided in Appendix K, the following SDGs contain the analytical results and associated laboratory QC for SU 10A-30: 10G-0616, 10G-0619, 10G-0622, 10G-0673, 10G-0692, 11G-0026, 11G-0043, 11G-0046, 11G-0071, 11G-0076, 11G-0080, 11G-0090, 11G-0093, 11G-0103, and 11G-0134. The associated data validation reports for each data package are included in Appendix F.

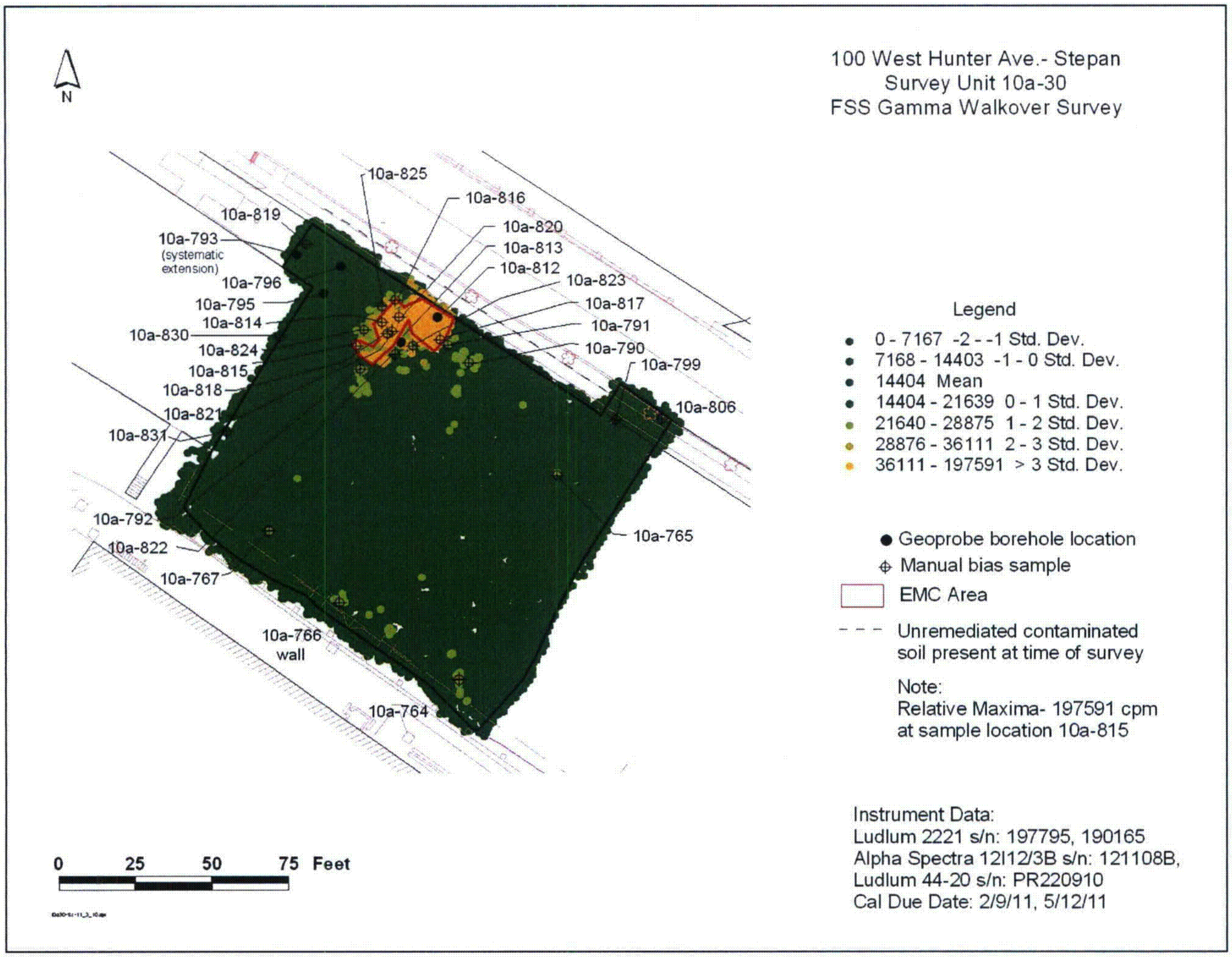


Figure 5-4
Gamma Walkover Survey Results of SU 10A-30

Figure 5-5
Gamma Walkover Survey Results of SU 10A-30 (excluding EMC area)

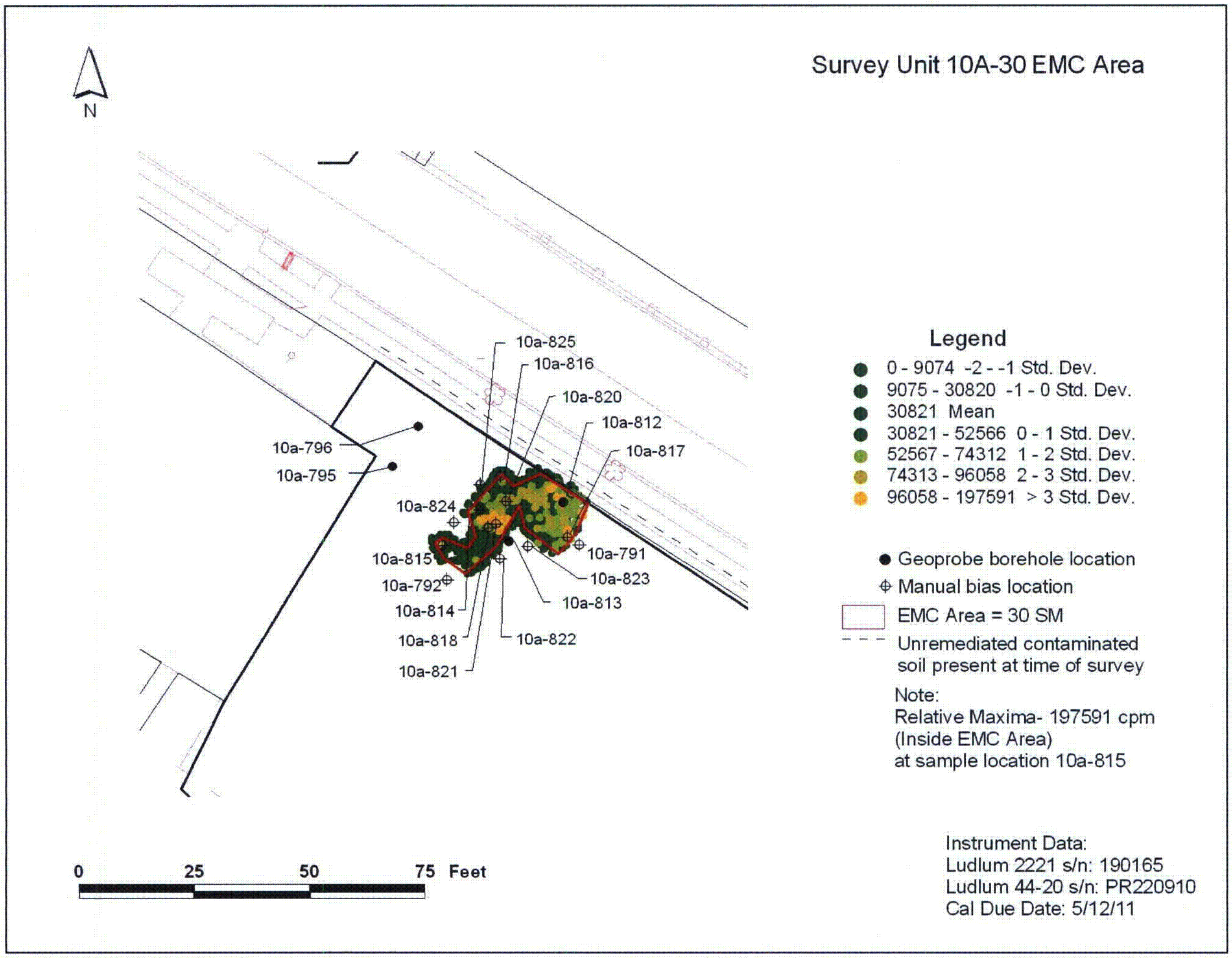


Figure 5-6
Gamma Walkover Survey Results of SU 10A-30 (EMC Area)

Table 5-3
Systematic Soil Sample Results – Survey Unit 10A-30

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)	
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)
10A-751	0.0 - 0.5	10a-057576	0.96	0.08	0.02		0.77	0.13	0.03		0.39	0.30	0.15		1.73	0.01
10A-752	0.0 - 0.5	10a-057582	2.89	0.19	0.03		5.71	0.48	0.05		1.30	0.70	0.31		8.60	0.09
10A-753	0.0 - 0.5	10a-057575	1.31	0.10	0.02		1.86	0.20	0.03		0.50	0.49	0.24	J(2)	3.17	0.02
10A-754	0.0 - 0.5	10a-057578	1.84	0.13	0.03		2.92	0.29	0.04		0.79	0.48	0.22		4.76	0.04
10A-755	0.0 - 0.5	10a-057581	1.02	0.08	0.02		1.23	0.15	0.02		0.84	0.38	0.17		2.24	0.01
10A-756	0.0 - 0.5	10a-057763	0.93	0.07	0.02		0.93	0.12	0.02		0.12	0.45	0.19	U(6)	1.86	0.01
10A-757	0.0 - 0.5	10a-057654	2.27	0.17	0.04		7.67	0.63	0.05		2.73	0.81	0.37		9.94	0.11
10A-758	0.0 - 0.5	10a-057572	1.05	0.09	0.02		1.03	0.13	0.03		0.87	0.29	0.14		2.08	0.01
10A-759	0.0 - 0.5	10a-057577	1.85	0.13	0.03		3.98	0.35	0.04		0.89	0.60	0.23		5.83	0.05
10A-760	0.0 - 0.5	10a-057580	1.94	0.14	0.03		2.49	0.26	0.04		1.02	0.46	0.21		4.43	0.04
10A-761	0.0 - 0.5	10a-057583	1.34	0.09	0.02		1.49	0.16	0.03		0.86	0.85	0.21	J(2)	2.83	0.02
10A-762	0.0 - 0.5	10a-057573	1.13	0.08	0.02		1.12	0.15	0.02		0.97	0.39	0.18		2.25	0.01
10A-763	0.0 - 0.5	10a-057574	1.96	0.14	0.03		3.50	0.34	0.05		1.01	0.53	0.24		5.46	0.05
10A-793 (geoprobe)	0.0 - 0.5	10a-057726	1.63	0.16	0.04		2.68	0.40	0.09		1.19	0.71	0.35		4.31	0.06

Notes: σ denotes sigma, standard deviation.
ft bgs denotes feet below ground surface.
MDC denotes minimal detectable concentration.

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.

Table 5-4
Bias Soil Sample Results – Survey Unit 10A-30

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)		
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	Net Result[3]
10A-764	0.0 – 0.5	10a-057585	2.21	0.15	0.03		5.03	0.43	0.05		1.30	0.61	0.29		7.24	0.07	5.60
10A-765	0.0 – 0.5	10a-057591	1.54	0.11	0.02		1.96	0.25	0.05		0.77	0.43	0.21		3.50	0.03	1.86
10A-766$_{w}$	8.0 – 8.5	10a-057586	2.81	0.19	0.04		5.61	0.51	0.06		0.57	0.60	0.30	J(1)	8.41	0.10	6.77
10A-767	0.0 – 0.5	10a-057592	1.99	0.14	0.03		3.47	0.32	0.04		2.10	0.50	0.22		5.46	0.04	3.82
10A-790	0.0 – 0.5	10a-057655	1.02	0.09	0.03		6.28	0.51	0.04		1.47	1.20	0.38		7.31	0.05	5.67
10A-791	0.0 – 0.5	10a-057656	1.47	0.13	0.03		5.43	0.48	0.06		1.06	0.57	0.28		6.89	0.06	5.25
10A-792	2.5 – 3.0	10a-057658	1.95	0.14	0.03		3.09	0.30	0.05		2.21	0.53	0.23		5.03	0.04	3.39
10A-793 (geoprobe)	14.75–15.25	10a-057739	1.12	0.09	0.02	J(5)	1.18	0.16	0.03	J(5)	0.77	0.45	0.21	J(5)	2.30	0.01	0.66
10A-795 (geoprobe)	0 - 0.5	10a-057722	1.18	0.14	0.04		1.06	0.27	0.08		1.51	0.56	0.27		2.24	0.04	0.60
	12.5 - 13.0	10a-057723	1.72	0.15	0.04		0.85	0.18	0.07		1.84	0.57	0.26		2.57	0.03	0.93
	17.25-17.75	10a-057738	1.14	0.09	0.02		1.02	0.16	0.04		0.97	0.32	0.14		2.16	0.01	0.52
10A-796 (geoprobe)	0 - 0.5	10a-057725	1.46	0.15	0.04		3.19	0.42	0.09		0.17	0.35	0.40	U(6)	4.65	0.06	3.01
	12.0 - 12.5	10a-057740	1.29	0.10	0.02		1.32	0.16	0.03		0.51	0.65	0.22	J(1)	2.61	0.02	0.97
10A-799	6.0 – 6.5	10a-057698	1.06	0.08	0.02		1.35	0.15	0.03		1.19	0.34	0.15		2.41	0.01	0.77
10A-806	0.0 – 0.5	10a-057743	1.11	0.09	0.02		1.19	0.15	0.03		1.07	0.37	0.17		2.30	0.01	0.66
10A-819	0.0 – 0.5	10a-057876	1.03	0.08	0.02		1.36	0.18	0.04		1.16	0.40	0.18		2.38	0.01	0.74
10A-822	16.0 - 16.5	10a-057836	0.62	0.06	0.02		1.35	0.15	0.03		0.59	0.50	0.15		1.97	0.01	0.33
10A-823[a]	16.0 - 16.5	10a-057837	0.65	0.05	0.01		1.21	0.14	0.02		0.29	0.33	0.16	J(1,4)	1.86	0.01	0.22
10A-824$_{w}$	9.5 - 10.0	10a-057838	1.09	0.09	0.02		1.01	0.15	0.04		0.99	0.34	0.15		2.10	0.01	0.46
10A-825$_{w}$	9.5 - 10.0	10a-057839	1.19	0.09	0.02		1.51	0.17	0.03		0.61	0.70	0.22	J(1)	2.70	0.01	1.06
10A-830	0.0 – 0.5	10a-057874	2.10	0.15	0.03		3.79	0.35	0.04		1.60	0.63	0.26		5.89	0.05	4.25
10A-831	0.0 – 0.5	10a-057875	1.20	0.10	0.02		1.54	0.22	0.04		0.30	0.47	0.20	J(1)	2.74	0.02	1.10

Notes: σ denotes sigma, standard deviation.
ft bgs denotes feet below ground surface.
MDC denotes minimal detectable concentration.
"w" denotes sample collected from sidewall of excavation.
a. Bias sample location identified at the maximum GWS measurement (i.e., relative maximum).

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.
3. Results after subtraction of regional background (1.64 pCi/g for the sum of Ra-226 and Th-232 [USACE, 2004d]).

Table 5-5
EMC Soil Sample Results – Survey Unit 10A-30

Sample Location	Depth (ft bgs)	Sample ID	Ra-226 (pCi/g)				Th-232 (pCi/g)				U-238 (pCi/g)				Ra-226+Th-232 (pCi/g)		
			Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	MDC (2σ)	Data Qualifier[2]	Result[1]	Uncertainty (2σ)	Net Result[3]
10A-812	0.0 – 0.5	10a-057765	1.05	0.08	0.02		0.82	0.12	0.03		0.95	0.30	0.15	J(1)	1.87	0.01	0.23
10A-813	0.0 – 0.5	10a-057768	1.02	0.09	0.03		2.87	0.29	0.04		1.19	0.54	0.26		3.89	0.03	2.25
10A-814$_w$	11.5 - 12.0	10a-057790	1.40	0.15	0.05		24.69	1.83	0.08		4.05	1.35	0.54		26.09	0.26	24.45
10A-815$_w$[a]	10.5 - 11.0	10a-057791	0.88	0.20	0.09		74.00	5.39	0.19		6.81	2.05	0.96		74.87	1.06	73.23
10A-816$_w$	10.0 - 10.5	10a-057792	1.44	0.11	0.03		3.20	0.32	0.05		1.23	0.51	0.24		4.64	0.04	3.00
10A-817	0.0 – 0.5	10a-057834	0.93	0.12	0.04		17.42	1.32	0.07		4.64	1.25	0.51		18.35	0.16	16.71
10A-818	0.0 – 0.5	10a-057794	0.34	0.08	0.03		4.41	0.40	0.05		0.66	0.45	0.22		4.74	0.03	3.10
10A-820	0.0 – 0.5	10a-057833	1.03	0.11	0.04		10.89	0.87	0.07		1.53	0.78	0.36		11.92	0.10	10.28
10A-821	0.0 – 0.5	10a-057835	1.30	0.15	0.06		31.94	2.36	0.08		1.45	1.73	0.86	J(1)	33.24	0.35	31.60

Notes: σ denotes sigma, standard deviation.
ft bgs denotes feet below ground surface.
MDC denotes minimal detectable concentration.
"w" denotes sample collected from sidewall of excavation.
a. Bias sample location identified at the maximum GWS measurement (i.e., relative maximum).

1. Sample results are presented as gross with no value for regional background subtracted.
2. Refer to Table 6-3 in Section 6.3 for explanations of data qualifier codes.
3. Results after subtraction of regional background (1.64 pCi/g for the sum of Ra-226 and Th-232 [USACE, 2004d]).

5.7 FINAL STATUS SURVEY SUMMARY AND CONCLUSIONS

5.7.1 Sample Summary

FSS activities at Burial Pit No. 1 were divided into two Class 1 SUs as illustrated on Figure 5-2. Table 5-6 summarizes the FSS sampling activities within Burial Pit No. 1.

Table 5-6
FSS Sampling Summary

Survey Unit Info			Systematic		Bias		Elevated Measurement Comparison	
Survey Unit	Area (m^2)	Class	No. of Locations	No. of Regular Samples	No. of Locations	No. of Regular Samples	No. of Locations	No. of Samples
10A-29	1,395	1	15	15	17	19	0	0
10A-30	1,226	1	14	14	19	22	9	9
Sample Totals			**29**	**29**	**36**	**41**	**9**	**9**

QC samples were taken along with regular samples at the minimum frequencies prescribed by the CDQMP (USACE, 2009a). In total, 79 systematic, bias, and EMC samples were collected along with 6 field duplicate samples and 2 USACE QA split samples (i.e., samples sent off site for independent analysis at a USACE contract laboratory). The property-wide collection frequency requirement for field duplicate samples and QA split samples is 10% and 5%, respectively. The six field duplicate samples represent a frequency of 7.6%, and the two QA split samples represent a frequency of 2.5%. Although these frequencies are less than the property-wide prescriptions, there is no deviation from the CDQMP because Burial Pit No. 1 is only a small part of the entire 100 West Hunter Avenue Property, and property-wide sampling statistics indicate the required frequencies were satisfied. Also note that 10 additional split samples were collected and transferred to NRC for analysis (refer to NRC reports in Appendix A). These NRC split samples were not collected as part of the USACE QA Program, but are included in this PRAR for completeness. Table 5-7 summarizes the QC and QA samples that were taken in support of FSS activities within Burial Pit No. 1.

Table 5-7
QC and QA Sample Summary

Sample Type	Total Number of Samples
Regular Samples	70
EMC Samples	9
Field Duplicate Samples	6
USACE QA Split Samples	2
NRC Split Samples	10
Samples > Release Criteria	4*

* All four samples were located within the 30 m^2 area of SU 10A-30 that was subjected to an EMC evaluation (see Section 5.6.2.3 for details).

5.7.2 Post-Verification of FSS Sample Frequency

A retrospective sample frequency evaluation was performed using the calculated median and standard deviation associated with the collected systematic sample data. The goal of this evaluation was to determine whether sufficient confidence exists to reject the Null Hypothesis in consideration of Type I/II error rates.

The relative shift was calculated according to Equation 1:

$$\Delta / \sigma = (DCGL - LBGR) / \sigma \qquad \text{(Equation 1)}$$

Where:

Δ =	The shift, equal to the DCGL – LBGR
σ =	The standard deviation of the data set
DCGL =	Derived Concentration Guideline Level. Equal to 15.0 pCi/g Ra226 + Th-232, and 49.0 pCi/g U-238 for Restricted Use (commercial) properties
LBGR =	Lower Bound - Gray Region. Equal to the median of the data set
Δ / σ =	The relative shift

The required number of sample locations derived from Equation 2 was used to calculate the total number of data points required for the WRS test (reference area + survey unit):

$$N = (Z_{1-\alpha} + Z_{1-\beta})^2 / 3(P_r - 0.5)^2 \qquad \text{(Equation 2)}$$

Where:

N =	Total number of data points for WRS test
$Z_{1-\alpha}$ =	Percentile represented by the selected value of α (0.05)
$Z_{1-\beta}$ =	Percentile represented by the selected value of β (0.05)
P_r =	Probability that a random measurement from the SU exceeds a random measurement from the reference area by less than the DCGL (Value based on the relative shift as calculated above and determined from MARSSIM Table 5.1 [EPA, 2000b])

The number of sample locations required within a given SU is half the number required for the WRS test (N/2). The α and β error rates (i.e., Type I/II) used in the above equation were both set at 0.05 for the remediation of the FMSS in accordance with the MFSSP (USACE, 2001b). The calculated retrospective relative shift indicated that sufficient samples were collected to reject the Null Hypothesis in consideration of the accepted Type I/II error rates. Tables 5-8 and 5-9 summarize sample frequency evaluation statistics for the Burial Pit No. 1 SUs.

Table 5-8
Retrospective Sample Frequency Evaluation (Ra-226+Th-232)

Survey Unit	LBGR (Median)	Standard Deviation	Relative Shift	P_r Value	Required No. of Locations (N/2)	Actual No. of Locations
10A-29	2.51	3.73	3.35	0.983039	8	15
10A-30	3.74	2.53	4.44	1.000000	8	14

Table 5-9
Retrospective Sample Frequency Evaluation (U-238)

Survey Unit	LBGR (Median)	Standard Deviation	Relative Shift	P_r Value	Required No. of Locations (N/2)	Actual No. of Locations
10A-29	0.83	0.34	143.09	1.000000	8	15
10A-30	0.88	0.59	80.91	1.000000	8	14

5.7.3 Burial Pit No. 1 Status

Remedial excavation and backfilling activities are complete for Burial Pit No. 1. The selected remedy for accessible FUSRAP waste on FMSS properties is complete excavation and off-site disposal. All regions of contamination within Burial Pit No. 1 were accessible, and the analytical data presented in this PRAR demonstrates compliance with the Restricted Use (commercial) release criteria as set forth in the ROD (USACE, 2003), thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and Title 10 CFR 20.1402 are met. Burial Pit No. 1 can be released for Restricted Use (commercial) per the ROD.

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6.0 PERFORMANCE STANDARDS/QUALITY ASSURANCE AND QUALITY CONTROL

6.1 PERFORMANCE STANDARDS

Table 6-1 compares the RAOs stated in the ROD (USACE, 2003) with the work completed and described in this PRAR.

Table 6-1
Performance Results Compared with Remedial Action Objectives

Remedial Action Objectives (RAOs)	Performance Results
Prevent or mitigate further release of FUSRAP waste to the surrounding environment, and eliminate or minimize the potential for human contamination and exposure via the selected ROD (USACE, 2003) alternative of "Excavation and Disposal."	12,460 in situ yd^3 of material were removed from Burial Pit No. 1 and disposed off site at a licensed disposal facility.
Verify that Burial Pit No. 1 satisfies the Restricted Use (commercial) Release criteria.	MARSSIM FSS Null Hypothesis rejected for all survey units. All regions of Burial Pit No. 1 were accessible and satisfy ROD RAOs for Restricted Use (commercial).
Applicable, relevant, and appropriate requirements (ARARs)	**Details of compliance with ARARs**
Title 10 CFR 20.1402 (25 mrem/yr NRC exposure limit)	Compliance for Burial Pit No. 1 attained through remediation.
NJAC 7:9.6 (point source water discharge limitations)	All potentially impacted water was treated and discharged in compliance with BCUA permits.
Title 40 CFR 262.11 (hazardous waste determination)	No FUSRAP waste was identified as hazardous waste.
NJAC 7:7A Subchapter 15 (wetlands mitigation)	Not applicable: No wetlands within Burial Pit No. 1.
NJAC 7:28-12.8(a)1 (15 mrem/yr exposure limit)	Compliance attained through remediation.
NJAC 7:28-12.8(a)2 (3 pCi/L indoor radon limit)	Compliance attained through remediation.

6.2 QUALITY ASSURANCE AND QUALITY CONTROL

The QA/QC program enables the evaluation of analytical results to determine whether they are accurate and adequate, and to ensure satisfactory execution of the remedial action. The QA/QC program is further detailed in the approved CDQMP (USACE, 2009a). QA/QC information related to FSS and backfill activities at Burial Pit No. 1 is presented in this report as follows:

Appendix D—Backfill Data Packages

- Data Packages for Radiological Backfill Samples
- Data Packages for Chemical Backfill Samples

Appendix F—Data Validation Reports

- Data Validation Reports for Radiological Backfill Samples
- Data Validation Reports for Chemical Backfill Samples

- Data Validation Reports for Final Status Survey Samples

Appendix G—Final Status Survey Quality Control Report

- FSS radiation survey instrument QC
- GPS QC
- Field replicate QC
- Lab replicate QC
- Equipment blank/rinsate results
- Retrospective sample frequency evaluations for each MARSSIM SU

Appendix K—Data Packages for FSS Samples

Appendix L—Quality Control Summary Report (QCSR)

- Sample/data collection QC
- Data analysis and validation QC
- Analytical and QA/QC problems encountered

6.2.1 PARCC Parameters

PARCC refers to the QA/QC parameters of precision, accuracy, representativeness, completeness, and comparability (PARCC). The adequacy of the QA/QC program is determined by how well the PARCC parameters met the objectives of the CDQMP (USACE, 2009a). Table 6-2 summarizes how well the PARCC parameters for Burial Pit No. 1 data compare to the DQOs of the CDQMP.

Table 6-2
PARCC Parameters Compared to Data Quality Objectives

PARCC Parameter	Evaluated Criteria	Section Reference	Pass/Fail DQO
Precision	Laboratory Replicate Samples	6.2.1.1	Pass
Precision	Field Duplicate Samples	6.2.1.1	Pass
Accuracy	Laboratory Control Samples	6.2.1.2	Pass
Accuracy	Matrix Spikes	6.2.1.2	Pass
Representativeness	Sample Collection and Preparation Methodology	6.2.1.3	Pass
Representativeness	Field Duplicate Samples	6.2.1.3	Pass
Completeness - Chemical	Percent of Usable Data	6.2.1.4	Pass
Completeness - Radiological	Percent of Usable Data	6.2.1.4	Pass
Comparability	Laboratory Performance Evaluation Samples	6.2.1.5	Pass
Comparability	USACE QA Split Samples	6.2.1.5	Pass

6.2.1.1 Precision

Precision is defined as the variability in a set of results obtained from a group of related samples, and indicates the level of quality in sample preparation and analytical methodology. Laboratories measure precision by preparing and analyzing laboratory replicate samples and evaluating the results of the samples. Laboratory replicates are performed at a minimum frequency of 10% within a given analytical batch. For FSS samples, 43 associated laboratory replicates were analyzed by the UFML (14 of which were performed on Burial Pit No. 1 FSS samples). The results of the laboratory replicates associated with FSS are tabulated in Appendix G. Laboratory replicate results are also provided within the laboratory data packages located in Appendix C (backfill) and Appendix K (FSS). Additional information on laboratory replicate QC is included in Appendix L (QCSR).

Field duplicates are primarily indicative of the precision associated with sample collection methodology, but also provide an indication of sample preparation and analysis precision. The FSS field duplicate samples were collected from locations directly adjacent to the regular sample locations at a minimum property-wide frequency of 10%. Six FSS field duplicate samples were collected from Burial Pit No. 1 along with 79 regular samples for a collection frequency of 7.6%. Although this frequency is less than the 10% property-wide requirement, there is no deviation from the CDQMP (USACE, 2009a) because Burial Pit No. 1 is only a small part of the entire 100 West Hunter Avenue Property, and property-wide sampling statistics indicate the required 10% minimum frequency is satisfied. All FSS field duplicate results were within absolute difference control limits as specified in the CDQMP. No field duplicates were submitted for any of the backfill chemical sample data packages. For these data packages, precision was measured from the matrix spike/matrix spike duplicate (MS/MSD) results (organic compounds), or from the laboratory replicate results (inorganic compounds). Based on the results of field duplicate and laboratory replicate samples, the CDQMP DQO for precision was satisfied. MS/MSD precision and laboratory replicate precision are discussed in Appendix L. Field duplicate pair results for FSS samples are tabulated in Appendix G.

6.2.1.2 Accuracy

Accuracy is defined as the closeness of a measurement to its true value, and is indicative of the quality of the analytical method (sample preparation and instrument performance). Instrument performance accuracy is indicated by laboratory control sample results and is verified daily with instrument source checks. Sample preparation accuracy is checked by preparing MS samples and comparing the results to known values. Data packages included in Appendix C (backfill) and Appendix K (FSS) contain the analytical data, and Appendix L (QCSR) provides detailed information regarding method and batch QC. These appendices indicate excellent accuracy for Burial Pit No. 1 data, thereby satisfying the CDQMP DQOs.

6.2.1.3 Representativeness

Representativeness is dependent upon the number and locations of collected samples, as well as on the method of sample preparation. Whether a given sample or group of samples are representative of a given area (e.g., an SU) depends upon the distribution of contamination, the type of contaminants, and the range of contaminant concentrations or activities. Using the MARSSIM-based approach of the MFSSP (USACE, 2001b) statistically ensured that samples collected and analyzed were representative of the residual contamination for a given SU. Representativeness can also be evaluated for each individual sample: the more homogeneous the collected sample, the greater likelihood that a representative sample aliquot will be taken from the sample container by the laboratory technician for analysis. Maywood FSS samples were dried and ground. The grinding process homogenizes the sample, and a fairly large percentage of the sample—typically 40% or more—is used for analysis. The precision and accuracy parameters also provided an indication of representativeness of the sample aliquot that was taken by the laboratory technician because these parameters depend, to an extent, on method preparation. Field duplicates were also used as a measure of representativeness as well as precision (see Section 6.2.1.1). Because 100% of the field duplicate samples collected from Burial Pit No. 1 passed duplicate QC criteria, the collected samples strongly represented the SU activity. In conclusion, the CDQMP DQO for sample representativeness was satisfied because the preparation method yielded representative aliquots, the MARSSIM-based sampling approach provided an acceptable statistical representation of an SU, the associated precision and accuracy parameters were within USACE QC limits, and the field duplicates were 100% acceptable.

6.2.1.4 Completeness

The completeness of the data is measured by the amount of usable (i.e., not rejected) data. The project data completeness requirement of 95% as presented in the CDQMP (USACE, 2009a) was met for radiological analyses as no data were rejected (100% completeness). Chemical analyses, when broken down by the categories of elemental analysis, semivolatile organic compounds, volatile organic compounds, and polychlorinated biphenyl organic compounds, also satisfies the 95% completeness requirement; therefore, the CDQMP DQO for completeness was satisfied. Appendix L contains specific information relating to completeness of data associated with Burial Pit No. 1.

6.2.1.5 Comparability

Comparability refers to the ability of a laboratory to reproduce results that agree with results from another laboratory. Comparability is measured through the preparation and analysis of performance evaluation samples and USACE QA split samples. The UFML is NJ-certified (State of NJ Lab Number 02022) and must pass annual performance evaluation sample analyses for all radio-analytical procedures in order to maintain certification. Performance evaluation sample results are discussed in Appendix L and the results indicate that the CDQMP DQO is satisfied.

USACE QA split sample collection was required at a minimum frequency of 5% across an entire property. Two USACE QA split samples were collected from Burial Pit No. 1 that represented 2.5% of the 79 regular samples collected. Although this percentage is less than the 5% property-wide requirement, there is no deviation from the CDQMP (USACE, 2009a) because Burial Pit No. 1 is only a small part of the entire 100 West Hunter Avenue Property, and property-wide sampling statistics indicate the required 5% minimum frequency was satisfied. USACE QA split samples were sent to an independent USACE-approved laboratory for gamma spectroscopy analysis. The results from the independent laboratory were then compared to results of the selected contract laboratory (i.e., the UFML). The two split samples met the QA split acceptance criteria (within a factor of four), thereby satisfying the CDQMP DQO (USACE, 2009a). Results of USACE QA split sample data evaluations are contained in the QCSR, which is provided as Appendix L.

Note that an additional 10 split samples were collected and transferred to NRC for analysis by their contract laboratory. These samples were not collected as part of the USACE QA Program and as such were not formally evaluated against USACE acceptance criteria; however, results from all 10 split samples would satisfy USACE acceptance criteria. Results of the NRC split samples are provided in the NRC Report dated March 25, 2011 (Appendix A). A comparison of the data from the two laboratories revealed data for U-238 and Th-232 to be in general agreement. Consistently higher results for Ra-226 analysis by the UFML were observed and attributed in part to a conservative correction factor applied by the UFML.

6.2.2 Sample Collection Quality Control

6.2.2.1 Equipment Blanks

Equipment blanks were collected to determine whether or not the sample collection methodology introduced contamination into the collected sample. Equipment blanks consisted of smear samples collected from decontaminated stainless steel bowls and trowels used to collect surface samples. Equipment blanks were collected daily during soil sampling activities prior to using the equipment. The equipment blank results are summarized in Appendix G (FSS QC Report), and results of the smear samples were reported on radiological survey forms included in Appendix M. Equipment blank results were all nondetect. For chemical rinsate blank results associated with backfill samples, the effect of trace level metals contamination and low-level contamination from common laboratory contaminants for organic parameters is discussed in Appendix L. Overall, the results of equipment blanks indicate that no cross-contamination affected the data quality of collected samples.

6.2.2.2 FSS Retrospective Sample Frequency Evaluation

A series of retrospective sampling frequency evaluations was performed using systematic sample results to verify that a sufficient number of samples had been collected from each SU to meet or exceed the DQOs established in the FSS Plan (i.e., Type I/II error rates). The evaluations, which are summarized in Section 5.7, concluded that a sufficient number of systematic samples had been collected in each SU to reject the Null Hypothesis and to satisfy FSS DQOs. Relevant data and calculation summary worksheets for the retrospective sample frequency evaluations are presented in Appendix G.

6.3 DATA VALIDATION

One hundred percent of the analytical data collected in support of FSS and backfilling activities at Burial Pit No. 1 was validated by an independent third-party data validator. These data included FSS soil samples and backfill source material samples. The validation subcontractor used the QC data analyzed by the laboratory to evaluate and qualify the analytical results. Data validation reports were prepared for 100% of the laboratory data packages submitted for validation. Because validation qualifiers supersede laboratory qualifiers and are ultimately used as the final qualifier for validated samples, all validation qualifiers were incorporated in the FMSS analytical database. The analytical data for samples collected from Burial Pit No. 1 were validated by Kestrel Environmental Technologies, Inc. based in Freeport, Maine.

The data validation reports are included in Appendix F. The data validation codes were assigned by the independent third-party data validator and used to qualify the radiological backfill and FSS data presented in this PRAR. The codes are provided in Table 6-3. The laboratory data packages for the backfill source materials and FSS soil samples are included in Appendices D and K, respectively.

Table 6-3
Radiological Data Validation Codes

Number	Explanation
(1)	Accept the result as estimated (J). The reported result is less than the 2 sigma uncertainty and greater than the minimal detectable concentration.
(2)	Accept the result as estimated (J). Using professional judgment, significant analytical uncertainty is indicated.
(3)	Accept the result as estimated (J). The reported result is within the analytical window for the daily blank result.
(4)	Accept the result as estimated (J). The reported result is within the analytical window for the method blank result.
(5)	Accept all results as estimated (J). The sample matrix density is less than 70%.
(6)	Accept the result as non-detect (U). A normal, non-detected (< critical value) result.

7.0 OPERATION AND MAINTENANCE

Remedial excavation and backfilling activities have been completed for Burial Pit No. 1. For FUSRAP waste at the FMSS properties considered to be accessible, the selected remedy in the ROD (USACE, 2003) was complete excavation and off-site disposal. All FUSRAP waste in Burial Pit No. 1 was accessible and the analytical data presented in this report demonstrates compliance with the Restricted Use (commercial) release criteria as set forth in the ROD, thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and Title 10 CFR 20.1402 are met. Ongoing USACE operations and maintenance are not expected.

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8.0 COMMUNITY RELATIONS

An Administrative Record file for the remedial action was established within 60 days of the start of on-site activities. In August 2002, USACE and EPA released the *Proposed Plan for Soils and Buildings at the FUSRAP Maywood Superfund Site* (USACE, 2002) for public comment. The plan was made available to the public at the FUSRAP Maywood Public Information Center, 75A West Pleasant Ave, Maywood, New Jersey, and online at www.fusrapmaywood.com. Availability of the Proposed Plan and a public comment period were advertised in local media. The public comment period was held between August 14, 2002 and November 11, 2002. In addition, a public availability session was held on August 28, 2002 at the Borough of Maywood Public Library. Several oral and written comments were received during the public comment period and are addressed in Section III of the ROD (USACE, 2003).

Extensive coordination with Stepan Company management was conducted throughout the remediation process. These interactions included numerous meetings and site walkovers at the Property, and extensive review of remedial designs, existing conditions and restoration plans, and other specifications. Coordination issues included the remediation schedule and phasing, site security, maintenance of business operations, utility protection, temporary parking and traffic management, information requests from property employees, and property restoration. A real estate right-of-entry agreement was not required with Stepan Company because property access was granted by the 2004 Settlement Agreement (USDOJ, 2004) between the U.S. Government and Stepan Company. Site visits were also conducted with local building department officials to ensure compliance with applicable construction codes during the work. As detailed in Section 1.0 and elsewhere, coordination between USACE and NRC also occurred in accordance with the MOU between the two agencies.

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