FUSRAP
Maywood Superfund Site

Post-Remedial Action Report

Burial Pit No. 2
(Nuclear Regulatory Commission License STC-1333)
100 West Hunter Avenue
Block 124, Lot 47
Borough of Maywood, New Jersey

Formerly Utilized Sites Remedial Action Program
Maywood Superfund Site

Prepared by:

Shaw Environmental, Inc.
100 West Hunter Avenue
Maywood, New Jersey 07607

Prepared for:

US Army Corps of Engineers

Contract No. DACW41-99-D-9001

July 2011, Revision 0

POST-REMEDIAL ACTION REPORT
BURIAL PIT NO. 2
(NUCLEAR REGULATORY COMMISSION LICENSE STC-1333)
100 WEST HUNTER AVENUE
BLOCK 124, LOT 47
BOROUGH OF MAYWOOD, NEW JERSEY

FUSRAP 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:

Shaw Environmental, Inc.
100 West Hunter Avenue
Maywood, New Jersey 07607

July 2011
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Issued to: _____ Date: _____

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RECORD OF REVISIONS

Revision No.	Description of Revision	Date
Draft Revision A	First Shaw/USACE Team Review	April 2010
Draft Revision B	Second Shaw/USACE Team Review	November 2010
Revision 0	Issued to Regulators	July 2011

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Note: These appendices are provided electronically on the compact disc enclosed at the back of this report.

ABBREVIATIONS AND ACRONYMS

σ	sigma, standard deviation
11(e)(2)	section of the Atomic Energy Act defining radioactive byproduct material
ALARA	as-low-as-reasonably-achievable
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
CFR	U.S. Code of Federal Regulations
cm	centimeter
COC	Contaminant of Concern
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
EPA	U.S. Environmental Protection Agency
FMSS	FUSRAP Maywood Superfund Site
FSS	final status survey
FSS Plan	Master Final Status Survey Plan, including the Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)
ft bgs	feet below ground surface
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPS	Global Positioning System
GWS	gamma walkover survey
LBGR	lower bound – gray region
LCS	laboratory control sample
m^2	square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCW	Maywood Chemical Works
MDC	minimum detectable concentration
MDC_{scan}	Scan Minimal Detectable Concentrations
MFSSP	Master Final Status Survey Plan
MISS	Maywood Interim Storage Site
MOU	Memorandum of Understanding
MS/MSD	matrix spike/matrix spike duplicate
NAD	normalized absolute difference
NaI	sodium iodide
NJ	New Jersey
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NRC	U.S. Nuclear Regulatory Commission
NYSW	New York Susquehanna & Western Railroad (also NYSW Railway Corporation)
ORNL	Oak Ridge National Laboratories

PARCC	precision, accuracy, representativeness, completeness, and comparability
pCi/g	picoCurie(s) per gram
pCi/L	picoCurie(s) per litre
PDI	Pre-Design Investigation
PRAR	Post-Remedial Action Report
QA	quality assurance
QC	quality control
QCSR	Quality Control Summary Report
Ra-226	Radium-226
RAO	remedial action objective
RAWP	Remedial Action Work Plan
Rn-222	Radon-222
ROD	Record of Decision
RPD	relative percent difference
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

ES 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 the 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 between July 2009 and June 2011 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 Lot 47, which is identified as "Burial Pit No. 2" in project-wide planning documents and is hereafter referred to as "Burial Pit No. 2." The USACE took possession of Burial Pit No. 2 for the purposes of performing the remedial action in accordance with the 2001 Memorandum of Understanding (MOU) between the USACE and the NRC (see **Section 1.1** and **Appendix A**).

This PRAR was prepared 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 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). However, an evaluation of the collected post-remedial action data indicated that Burial Pit No. 2 satisfied the Unrestricted Use (residential) criteria. The Unrestricted Use (residential) criteria are more conservative and represent the as-low-as-reasonably-achievable (ALARA) goal of the Restricted Use (commercial) criteria (Refer to **Section 2.0**). Therefore, the Unrestricted Use (residential) 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 for both surface and subsurface soil: 5 picocuries per gram (pCi/g) of Radium-226 and Thorium-232 combined above background, and 100 pCi/g total uranium (50 pCi/g Uranium-238) above background. Attainment of these release criteria ensures that the substantive requirements of the New Jersey Administrative Code (NJAC) 7:28-12.8(a) and the U.S. Code of Federal Regulations (CFR) 10 CFR 20.1402 are not exceeded (see **Table ES-1**).

CONSTRUCTION ACTIVITIES

FMSS personnel and equipment mobilized to Burial Pit No. 2 on July 29, 2009 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 2004b). Restoration activities and demobilization were completed on June 1, 2011. The total volume of soil removed from Burial Pit No. 2 and ultimately shipped off site to a licensed disposal facility in Utah was 4,504 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. 2 satisfied the Unrestricted Use (residential) 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* (USACE 2001d), and the Property-specific *Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)* (USACE 2004d).

The FSS consisted of the following:

- A gamma walkover survey (GWS) over 100 percent of accessible areas
- The collection and gamma spectrometry analysis of systematic surface soil samples
- The collection and gamma spectrometry analysis of biased surface and subsurface soil samples
- Data validation and evaluation

In accordance with the MOU between USACE and the NRC, the NRC observed FSS activities within Burial Pit No. 2 on December 8, 2009. The NRC was provided with split samples collected from five systematic locations within survey unit 10A-16. The observations and split sample results are presented in an NRC report included in Appendix A. USACE sample results as reported to the NRC are also provided in Appendix A.

PERFORMANCE SUMMARY

Table ES-1 compares the RAOs established in the ROD (USACE 2003) with the work completed.

Table ES-1
Performance Results Compared with Remedial Action Objectives

Remedial Action Objectives	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."	4,504 in situ yd^3 of material were removed from Burial Pit No. 2 and disposed off site at a licensed disposal facility. All contamination was accessible and no FUSRAP-related waste in excess of the Unrestricted Use (residential) clean-up criteria remains within Burial Pit No. 2's footprint (survey unit 10A-16).
Verify that Burial Pit No. 2 satisfies the Restricted Use (commercial) release criteria.	MARSSIM FSS Null Hypothesis "rejected" for the survey unit. All regions of Burial Pit No. 2 were accessible and meet the ROD RAOs for Unrestricted Use (residential) (the ALARA goal of the Restricted Use [commercial] criteria).

Table ES-1
Performance Results Compared with Remedial Action Objectives (continued)

Remedial Action Objectives	Performance Results
Comply with ARARs:	The remedial action complied with all applicable ARARs as detailed:
10 CFR 20.1402 (25 mrem/yr NRC exposure limit)	Compliance for Burial Pit No. 2 attained through remediation.
NJAC 7:9.6 (point source water discharge limitations)	All potentially impacted water was transported to the MISS, treated, and discharged in compliance with BCUA permits.
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. 2 area.
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.

CFR = U.S. Code of Federal Regulations
MISS = Maywood Interim Storage Site
NJAC = New Jersey Administrative Code
BCUA = Bergen County Utilities Authority

BURIAL PIT NO. 2 STATUS

Remedial and restorative activities are complete for Burial Pit No. 2. 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. 2 were accessible and all FUSRAP contamination was removed. The analytical data presented in this PRAR demonstrate compliance with the Unrestricted Use (residential) release criteria as set forth in the ROD (USACE 2003), thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and 10 CFR 20.1402 are not exceeded. No FUSRAP-related contamination above criteria remains within the historical footprint of Burial Pit No. 2, and Burial Pit No. 2 can be released for Unrestricted Use (residential) 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 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 the 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 action performed between July 2009 and June 2011 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 Lot 47, which is identified as "Burial Pit No. 2." 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). However, an evaluation of the collected post-remedial action data indicated that Burial Pit No. 2 satisfied the Unrestricted Use (residential) criteria. The Unrestricted Use (residential) criteria are more conservative and represent the as-low-as-reasonably-achievable (ALARA) goal of the Restricted Use (commercial) criteria (refer to **Section 2.0**).

The remedial action at Burial Pit No. 2 was performed in accordance with the *Remedial Action Work Plan* (RAWP) (USACE 2004b) and other approved plans including, but not limited to: the *Soil Load-Out Work Plan* (USACE 2001a), the *Master Final Status Survey Plan* (MFSSP) (USACE 2001d), the *Site Safety and Health Plan* (SSHP) (USACE 2011), the *Contractor Quality Control Plan* (CQCP) (USACE 2005), the *Chemical Data Quality Management Plan* (CDQMP) (USACE 2009b), and the *Material Handling, Transport, and Disposal Plan* (USACE 2001e). In additional, several Property-specific plans were also prepared for the remedial action including, but not limited to the *MFSSP Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)* (USACE 2004d)[1], the *Construction Work Plan Triangle Clusters – Phase 9* (USACE 2004a) and the *Cluster 10 Site Safety and Health Plan Addendum* (USACE 2008).

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 (**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 (CERCLA). **Figure 1-2** presents the location of Burial Pit

[1] Note that the MFSSP Addendum C-10A mistakenly identifies this area as Burial Pit No. 1.

No. 2 as well as many, but not all, of the other FMSS properties that have either been remediated or are scheduled for remediation.

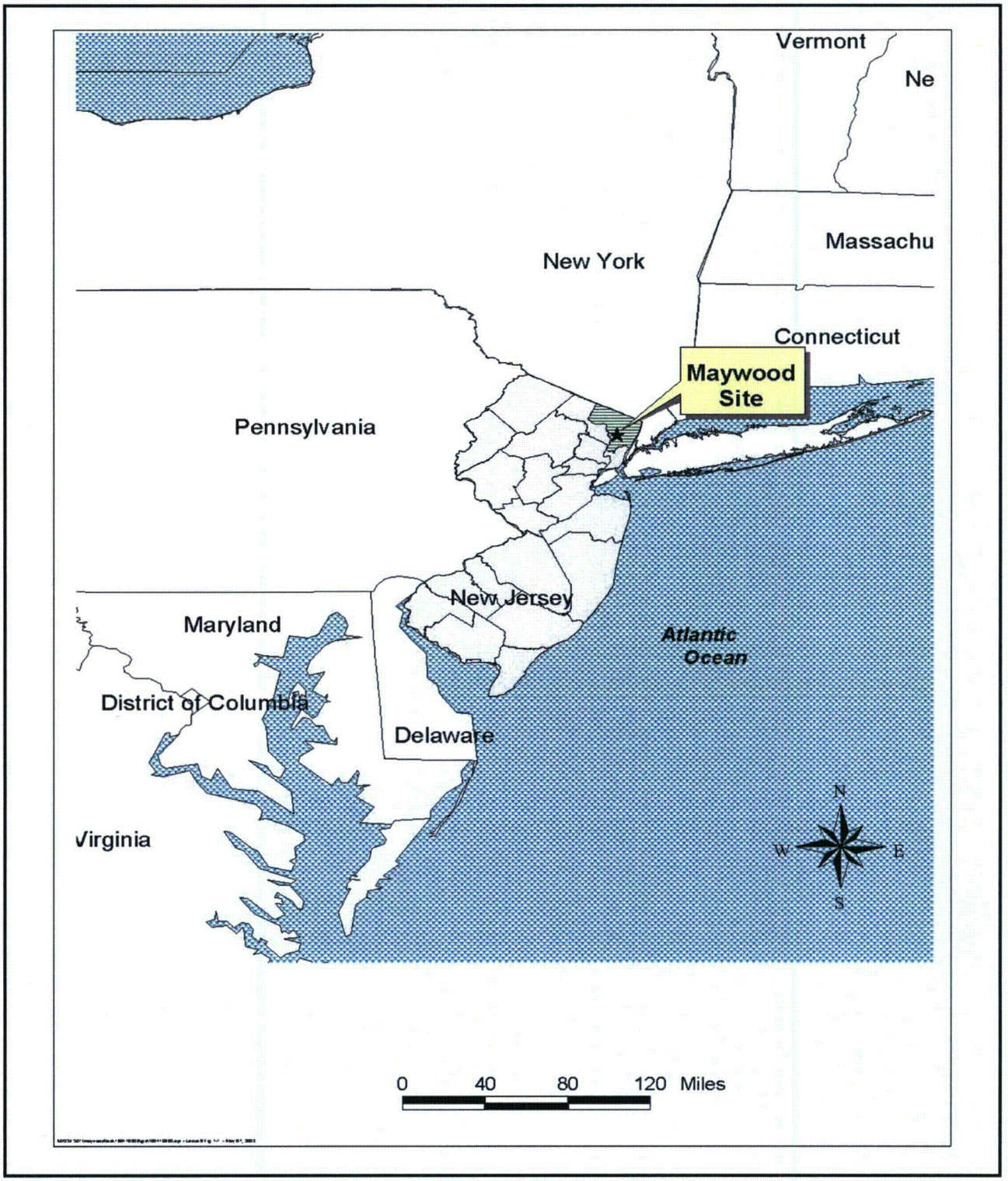


Figure 1-1
Location of FMSS, Bergen County, New Jersey

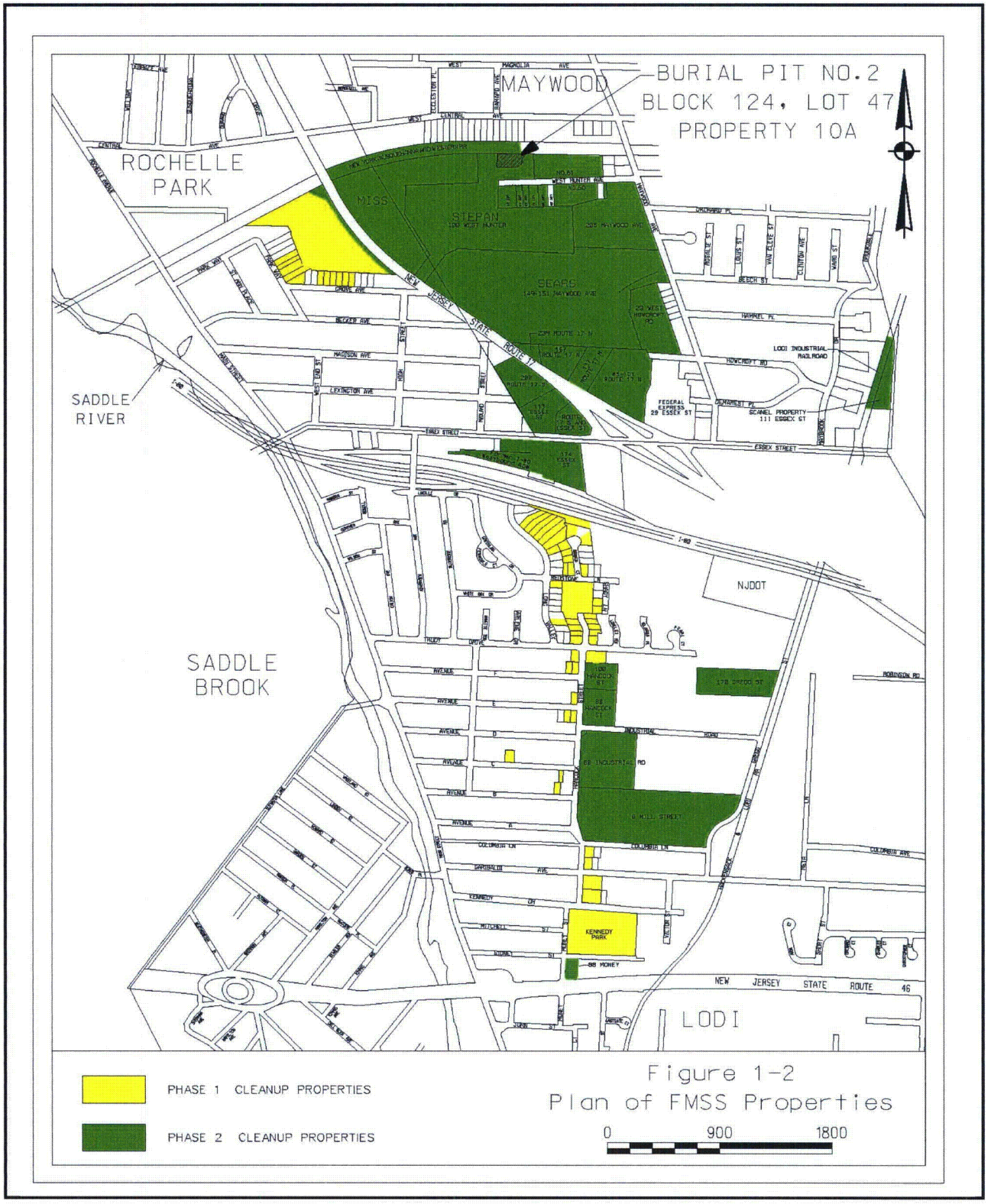


Figure 1-2
Plan of FMSS Properties

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, and approximately 3 years later, the 30-acre MCW Property was purchased by the Stepan Company.

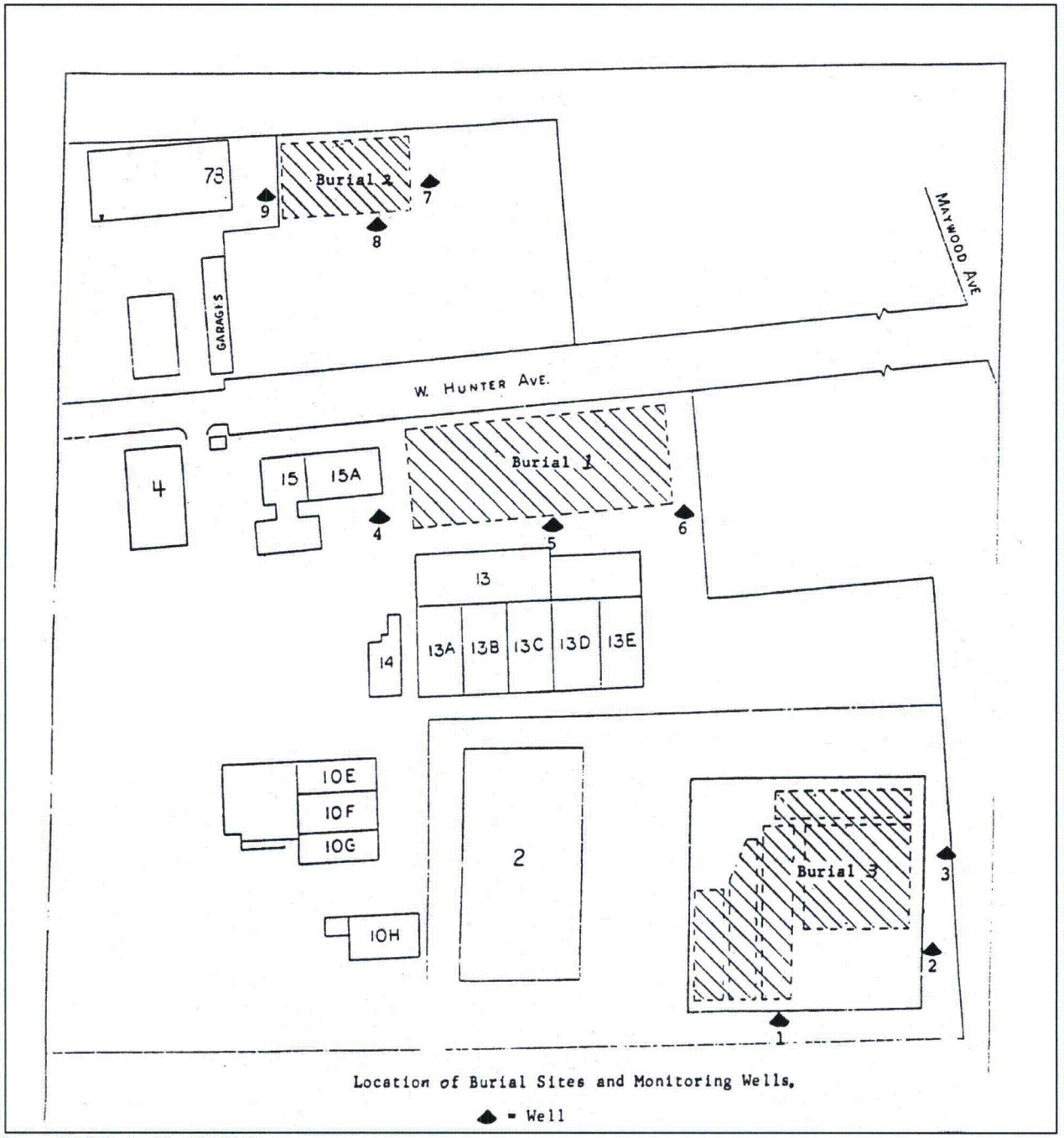
Waste generated from the manufacturing process was generally stored in open piles and retention ponds on the original processing site where the Maywood Interim Storage Site (MISS) and Stepan Company are now located. These wastes were spread to nearby properties through two primary mechanisms: the use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

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 yd^3 of excavated waste materials. Between 1966 and 1968 these waste materials were relocated to three burial pits on the current Stepan Company Property. These burial pits were subsequently licensed by the NRC to Stepan Company pursuant to 10 CFR 40 on April 4, 1978. The "possession-only" license authorized Stepan to possess the material in underground storage. **Figure 1-3** is a historical figure circa 1983 taken from the NRC Docket 40-08610 that shows the approximate footprints of the burial pits. Three monitoring wells identified as Well 7, Well 8, and Well 9 were installed by Stepan for the purpose of monitoring groundwater downgradient of Burial Pit No. 2 as required by NRC License STC-1333. Under this NRC license, Stepan is required to perform quarterly sampling and to report analytical results to the NRC. Access to these wells by Stepan consultants for quarterly monitoring sampling events was accommodated as practical during remediation.

The FMSS was added to the *National Priorities List* as the "Maywood Chemical Company" in 1983, and that same year the U.S. Department of Energy (DOE) began investigating the FMSS and the surrounding area. The DOE proceeded to cleanup 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. Additional cleanup activities were initiated by the DOE in 1995. In 1997, responsibility for the execution and administration of FUSRAP was transferred from the DOE to the USACE, and by 2000 the USACE completed the remainder of the residential cleanup actions initiated by the DOE in 1995. In December 1998, the 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 II properties, and in 2003, the USACE published the ROD (USACE 2003) to address the 24 remaining (Phase II) FMSS Properties.

This PRAR addresses the remediation of Burial Pit No. 2 located on the Phase II Property at 100 West Hunter Avenue in the Borough of Maywood. Burial Pit No. 2 is located in the northern corner of Block 124, Lot 47 (see **Figures 1-2** and **1-3**). The surface above Burial Pit No. 2 was primarily being used as an asphalt-paved parking lot by the Stepan Company. Block 124, Lot 47 is bounded to the northeast by the New York, Susquehanna & Western Railway (NYSW) (FMSS Property 12A), to the southeast by Block 124, Lot 48 (100 West Hunter Avenue), to the southwest by Maywood Avenue, and to the northwest by Block 124, Lot 46 (100 West Hunter Avenue).

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



Source: NRC Docket No. 40-08610

Figure 1-3
Location of Burial Sites and Monitoring Wells

Because Burial Pit No. 2 contained NRC-licensed materials, the NRC had the statutory responsibility for ensuring protection of the public's health and safety related to Burial Pit No. 2 under the Atomic Energy Act of 1954. The USACE was allowed to take possession of Burial Pit No. 2 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, and between, the NRC and the 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 public health and safety, that permitted the NRC to exercise its discretion to place its NRC licenses at FUSRAP sites in abeyance so that USACE could remediate the sites under CERCLA.

The NRC License relevant to the remedial action at Burial Pit No. 2, 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), the USACE has agreed to perform remediation of Burial Pit No. 2 as part of FUSRAP. License STC-1333 was placed in abeyance by the NRC prior to the start of remediation within Burial Pit No. 2 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 USACE took physical possession of Burial Pit No. 2 by a notice to the NRC dated August 6, 2009 (**Appendix A**) thereby placing the NRC license in abeyance.

In accordance with the MOU's spirit of cooperation, the NRC and USACE have had ongoing communication regarding Burial Pit remediation and the NRC has also visited the FMSS on several occasions to perform observations. As it relates to Burial Pit No. 2, the NRC observed final status survey (FSS) activities on December 8, 2009 as documented in the NRC report dated April 20, 2010 (see **Appendix A**). The NRC report also documents other site visits and additional contacts between the two agencies.

1.2 PREVIOUS INVESTIGATIONS

The FMSS team performed the final investigation of the Phase II 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), CH2M Hill (DOE 1994), and Stone & Webster (S&W) were compiled and presented with the final pre-design investigation data in the *Pre-Design Investigation Report: Cluster No. 10* (USACE 2001b). Additionally, the results of a 1988 Property-specific radiological survey, conducted by Oak Ridge National Laboratory (ORNL) for the DOE, were evaluated 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).

2.0 REMEDIAL ACTION GUIDELINES

The contaminated material in Burial Pit No. 2 was classified as "FUSRAP waste" under the terms of the Federal Facilities Agreement[1] as explained in the ROD (USACE 2003). FUSRAP waste in Burial Pit No. 2 primarily included soil contaminated with the radionuclides of concern related to the past thorium processing by the former MCW. The radionuclides-of-concern were approved by the USACE and the EPA and were identified as Thorium 232 (Th-232), Radium 226 (Ra-226), Uranium 238 (U-238), and their 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 Property; and to comply with the identified ARARs.

2.1 RELEASE CRITERIA

The ROD (USACE 2003) designates Burial Pit No. 2 as Restricted Use (commercial) based upon the 100 West Hunter Avenue Property's reasonably anticipated future land use. The Restricted Use (commercial) criterion for Ra-226 and Th-232 limits residual concentrations in subsurface soil as follows: an average of 15 picoCuries per gram (pCi/g) of Ra-226 and Th-232 combined above background for subsurface soils with an ALARA goal of 5 pCi/g.

An evaluation of the collected post-remedial action data indicated that Burial Pit No. 2 satisfied the Unrestricted Use (residential) criteria. With the exception of the criterion listed above for Ra-226 and Th-232 combined, the Unrestricted Use (residential) criteria are identical to the Restricted Use (commercial) criteria. The Unrestricted Use (residential) criterion for Ra-226 and Th-232 combined is more conservative and represents the ALARA goal of the Restricted Use (commercial) criteria. Therefore, the Unrestricted Use (residential) release criteria were applied for data evaluation purposes as follows:

- An average of 5 pCi/g of Ra-226 and Th-232 combined above background for surface and subsurface soil. This value constitutes the Derived Concentration Guideline Level (DCGL) for the sum of Ra-226 and Th-232.
- 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 DCGLs for total uranium and U-238, respectively.
- Soil and building remediation will meet the 15 millirem per year 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. 2, an NRC-licensed portion of the FMSS, meets the 25 millirem per year above background dose limit specified in the Code of Federal Regulations (CFR) 10 CFR 20.1402.
- Soil and building remediation will meet the 3 picoCuries per liter (pCi/L) above background radon 222 (Rn-222) limit specified in the NJAC 7:28-12.8(a)2 (NJDEP, 2000) at all properties addressed in the ROD.

[1] The Federal Facilities Agreement was initially entered into between DOE and EPA and set 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 2003a).

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 contamination and the anticipated depth of excavation. Therefore, the ROD (USACE 2003) requires 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 will comply with the relevant and appropriate promulgated state and federal standards for the FMSS Contaminants of Concern (COCs)
- In the absence of specific discharge limits, point source discharges will satisfy federal maximum contaminant levels for each COC

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

2.2 APPLICATION OF CRITERIA

Post-remedial soil sample results are compared directly to the release criteria presented in **Section 2.1**. If all post-remedial soil sample results have concentrations that are less than the release criteria (referred to as DCGL), the property is deemed radiologically appropriate for release and no further remediation is required. However, if any of the post-remedial sample results exceed the release criteria, the non-parametric Wilcoxon Rank Sum (WRS) test is 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* (USACE 2004c) was prepared in May 2004 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, which is 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*.

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 percent confidence interval, are used to assess backfill conformance (USACE 2004c).

3.0 CHRONOLOGY OF EVENTS

Table 3-1 provides the order of significant events completed during the remediation of Burial Pit No. 2.

Table 3-1
Chronology of Events

Date	Event
1992 – 1999	Investigations of the Property were conducted by BNI (DOE 1992), CH2M Hill (DOE 1994), and Shaw S&W.
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, Rev. 1* issued (USACE 2001b).
July 2001	MOU reached between USACE and the NRC creating a mechanism for USACE to take possession of Burial Pit No. 2 and perform remediation (**Appendix A**).
August 2003 – September 2003	ROD (USACE 2003) is signed by the USACE and the EPA, and is issued as a remedial decision document for the FMSS.
January 2004	*Construction Work Plan Triangle Clusters – Phase 9* issued (USACE 2004a).
February 2004	*Remedial Action Work Plan* (USACE 2004b) for FUSRAP-contaminated properties to be remediated under the ROD is issued for construction.
November 2004	*Settlement Agreement* (USDOJ 2004) executed between the United States and Stepan Company granting USACE access to 100 West Hunter Property and responsibility for remediation of Burial Pit No. 2.
October 28, 2008	*Confirmatory Order Modifying License No. STC-1333* issued (**Appendix A**).
August 6, 2009	USACE letter to the NRC placing License STC-1333 in abeyance for Burial Pit No. 2 issued (**Appendix A**).
Remedial Activities	
July 29, 2009	Mobilization to Burial Pit No. 2, site preparation activities begin.
August 10, 2009	Geophysical survey initiated.
August 12, 2009	Preparatory inspection performed.
August 31, 2009	Excavation begins.
October 22, 2009	FSS activities begin.
December 11, 2009	Backfilling operations begin.
June 1, 2011	Restoration completed and demobilization from site.

FSS = Final Status Survey

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4.0 DESCRIPTION OF REMEDIAL ACTIVITIES

This section describes the remediation and restoration of Burial Pit No. 2. The selected remedial action as specified in the ROD (USACE 2003) for accessible soil and bulk waste is excavation and off-site disposal. Accessible soil is 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 is 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. 2 was considered to be accessible.

Remediation of Burial Pit No. 2 was performed in accordance with the RAWP (USACE 2004b) which provides overall guidance, general construction methodology, and execution plans for the cleanup of FUSRAP contamination on properties designated in the ROD (USACE 2003). The property specific remedial plan, the *Construction Work Plan Triangle Clusters – Phase 9* (USACE 2004a), provided the following:

- 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 PREMOBILIZATION

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

- Supported execution of a Settlement Agreement (USDOJ 2004) between the U.S. Government and the Stepan Company
- Established possession of Burial Pit No. 2 in accordance with the MOU (see **Appendix A**), thereby placing NRC license STC-1333 in abeyance for Burial Pit No. 2 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 9* (USACE 2004a) to lay out limits of excavation, establish survey controls, and document existing site conditions and topography
- 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 MOBILIZATION AND SITE PREPARATION

After pre-mobilization activities were completed, equipment and personnel were mobilized to Burial Pit No. 2 on July 29, 2009 to prepare the site for the remedial action. General tasks performed by the FMSS team as part of mobilization and site preparation included the following:

- Established communication protocols to ensure effective communication between Burial Pit No. 2 and the FMSS Field Office
- Inspected and performed radiological surveys on construction equipment prior to deployment
- Prepared lay down and parking areas for heavy equipment, personal vehicles, and storage of materials and supplies
- Installed temporary facilities, including temporary electric utilities, portable access control sheds, personnel decontamination facilities, traffic control barriers and devices, and temporary fencing
- Established traffic controls, posted construction signs, and established restricted/contaminated areas
- Established air, industrial hygiene, personnel, and environmental monitoring operations in accordance with the SSHP
- Cleared and grubbed vegetation in and around the surveyed excavation limits
- Identified and obtained access to the nearest water source for dust management activities
- Performed a follow up geophysical survey to investigate potential data gaps in the original survey, verify subsurface utility locations for clearance, and identify metallic anomalies
- Relocated utilities and removed a light pole
- Photographed existing site conditions for the Burial Pit No. 2 Photograph Log (**Appendix B**) and provided existing conditions report to Stepan

4.3 SOIL EXCAVATION

4.3.1 Design

The remedial design for Burial Pit No. 2 was based on the radiological data collected during previous investigations by ORNL, BNI, and S&W, as well as data collected during pre-design investigation (PDI) as summarized in the *Pre-Design Investigation Report: Cluster No. 10* (USACE 2001b). Data from these investigations were used to prepare the *Construction Work Plan Triangle Clusters – Phase 9* (USACE 2004a). The initial site conditions and the designed limits of contamination are presented on **Figure 4-1**.

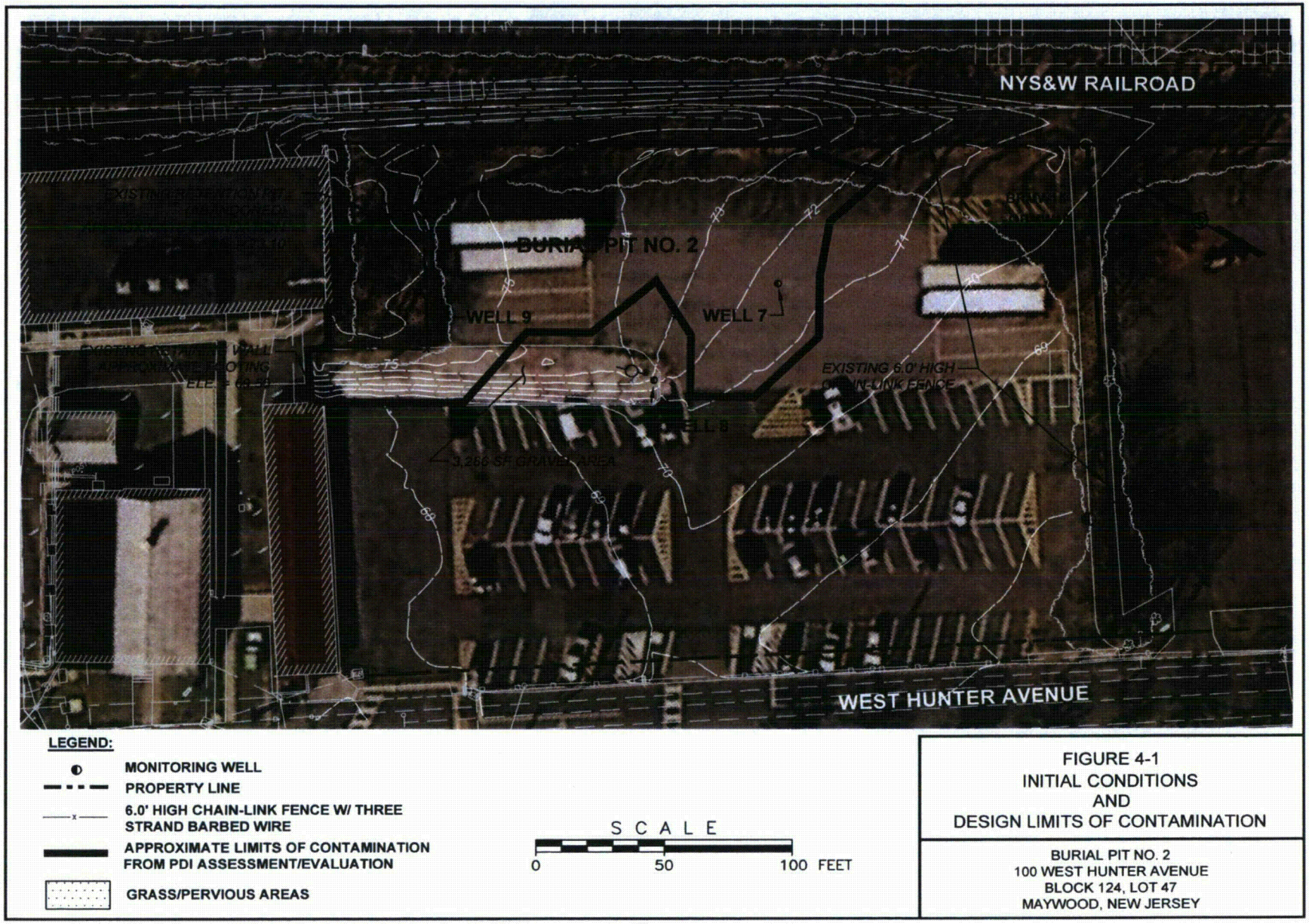

Figure 4-1
Initial Conditions and Design Limits of Contamination

4.3.2 Excavation

Remedial designs for the excavation of contaminated material from Burial Pit No. 2 were detailed in the *Construction Work Plan Triangle Clusters – Phase 9* (USACE 2004a). 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. 2 was contained within a single SU (SU 10A-16) on the 100 West Hunter Avenue Property. The volume of contaminated soil removed from Burial Pit No. 2 was 4,504 in situ cubic yards (yd^3). This volume was calculated by the excavation "as-built" survey included as **Figure 4-2**. Excavation as-built surveys are the method employed 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 Monitoring Wells

Three groundwater monitoring wells owned by Stepan Company were located within the remedial footprint of the excavation. These wells, identified as Well 7, Well 8, and Well 9 (see **Figure 4-1**), were protected during remediation and their casings were decontaminated as necessary to meet release criteria. Upon completion of remedial activities the three wells were operational.

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 lined with 6-millimeter polyethylene sheeting. Radiological surveys were conducted on vehicles transporting contaminated soil along public roadways between Burial Pit No. 2 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 presently maintained at the on-site FMSS Project Field Office.

In total, 4,504 in situ yd^3 of contaminated soil were 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* (USACE 2001e). Material shipped off-site for disposal was treated as 11(e)(2) by-product material in accordance with the ROD (USACE 2003). As used here 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

Groundwater and precipitation that collected in the excavations during remedial activities were handled as "impacted" in accordance with the *Water Management Plan* (USACE 2001c). Approximately 132,750 gallons of potentially impacted wastewater were pumped from the Burial Pit No. 2 excavation and transported to the MISS. Wastewater received at the MISS was processed through an on-site treatment plant. Treatment consisted of transferring the wastewater to holding tanks, where it was held to allow for settling and was treated 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 COCs in accordance with the *BCUA Treated Groundwater Discharge Permit* requirements. Treated wastewater was discharged to a sanitary sewer manhole on the MISS.

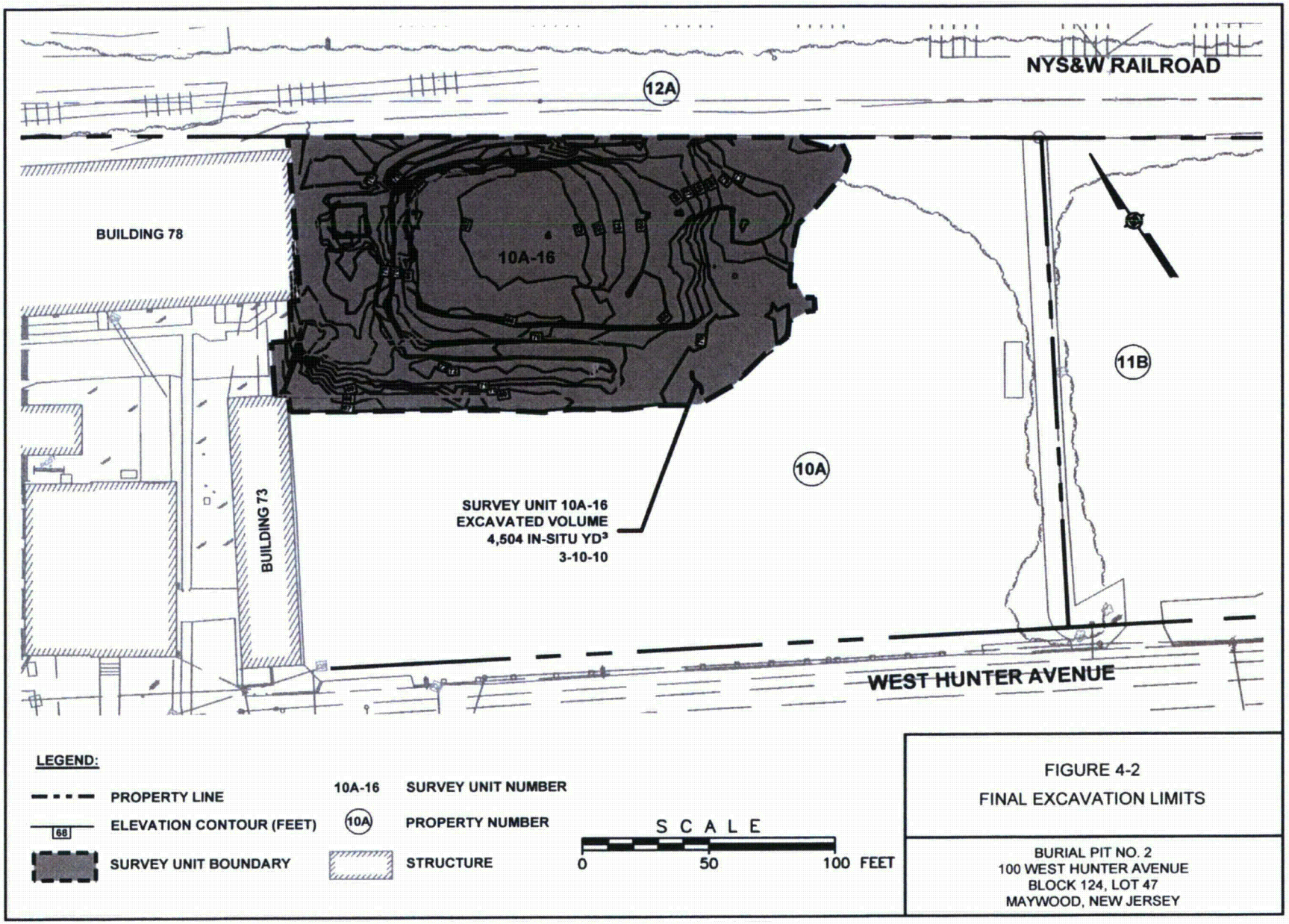

Figure 4-2
Final Excavation Limits

4.5 BACKFILL TESTING AND COMPACTION

The open excavation of Burial Pit No. 2 was backfilled using 8,442 tons of common fill and structural fill. Landscaping materials including 210 tons of stone and 204 tons of topsoil were also placed in the Burial Pit No. 2 area. All landscaping and backfill material was tested to ensure that it was free of chemical and radiological contamination. The backfill material used in Burial Pit No. 2 came from off-site sources and was therefore 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. Backfill soil samples were also tested for geotechnical characteristics to ensure that the requirements outlined in the RAWP were achieved (USACE 2004b). The chemical results were compared to the New Jersey Residential Direct Contact Soil Cleanup Criteria and the New Jersey 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 2004c) (**Table 2-1**). Backfill placed within the excavation was compacted, and in-place field density testing was performed to confirm that acceptable parameters were satisfied as required in the RAWP.

All backfill material met the physical, chemical, and radiological specifications listed in the RAWP (USACE 2004b), and 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
- Chemical data comparison tables

Appendix D

- Chemical data packages for backfill samples
- Radiological data packages for backfill samples

Appendix E

- Backfill compaction test results
- Asphalt density test results

Appendix F

- Chemical data validation packages for backfill samples
- Radiological data validation packages for backfill samples

4.6 RESTORATION

The restoration plan for Burial Pit No. 2 is shown on **Figure 4-3**. The Burial Pit No. 2 excavation was backfilled using structural fill and common fill. Structural fill was used in areas intended for parking lot(s), roadways, and walkways. Common fill was used in areas destined for decorative landscaping. All backfill material was tested for compliance with RAWP (USACE 2004b) specifications as detailed in **Section 4.5**.

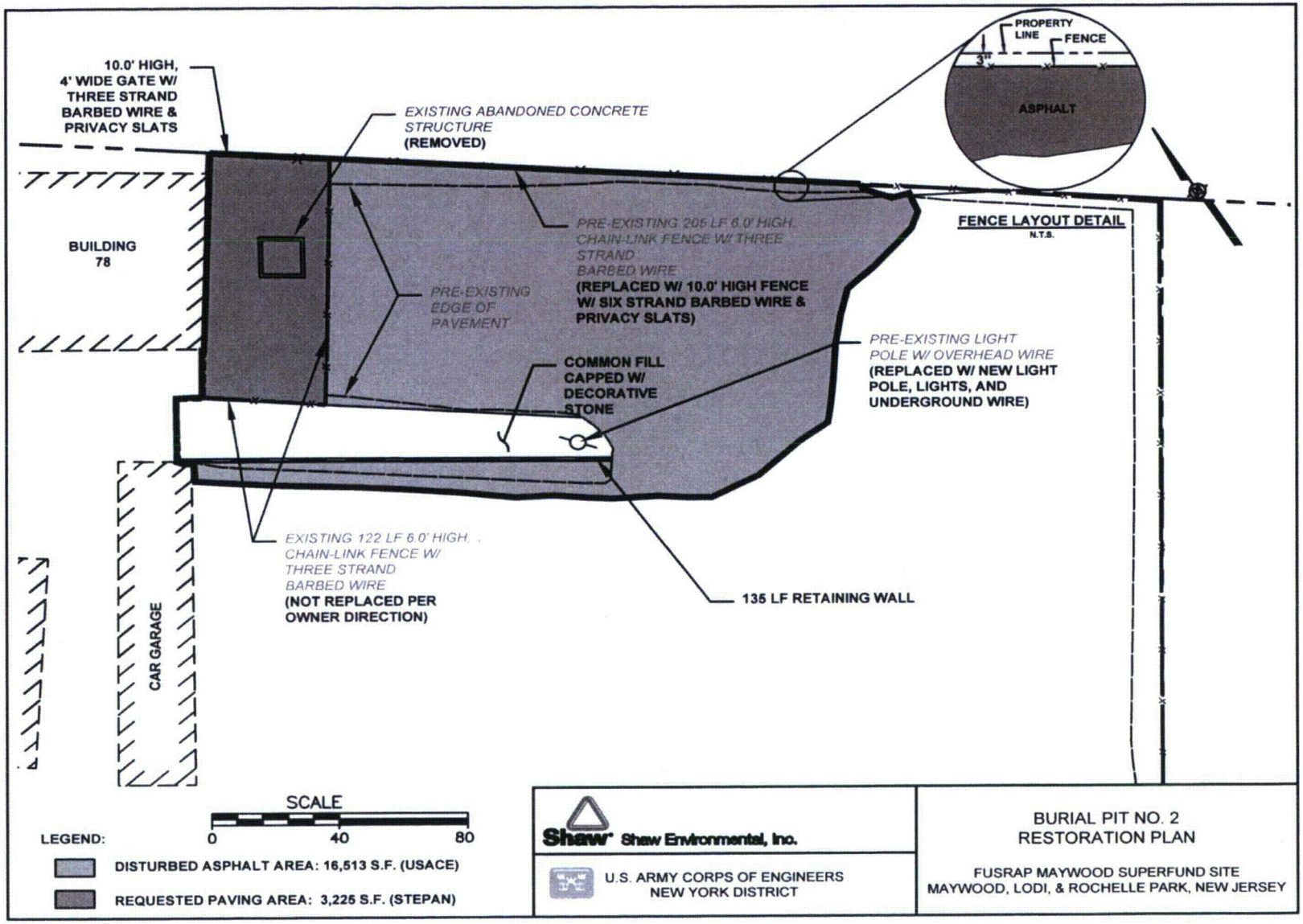

Figure 4-3
Burial Pit No. 2 Restoration Plan

Additional details of restoration include the following:

- Installation of a 10-foot-high chain-link fence along the northern perimeter of Burial Pit No. 2 with six strands of barbed wire and privacy slats. A 4-foot-wide gate was installed at the northern corner with three strands of barbed wire and privacy slats. The 10-foot-high fence continued past the gate to overlap Building 78 slightly; this section also contained three strands of barbed wire and privacy slats.
- Installation of a retaining wall along the southwestern Burial Pit No. 2 perimeter.
- Placement of structural fill and decorative stone behind the retaining wall.
- Removal of an existing (abandoned) concrete retention pit (work performed by Stepan).
- Installation of a light pole with underground electrical wires.
- Installation of asphalt pavement using a 2 ½- inch layer of "I-2" base course topped with a 1 ½- inch layer of "1-5" surface course, including striping.

Table 4-1 summarizes the types and quantities of material placed at the Burial Put.

Table 4-1
Summary of Restoration Quantities

Material	Quantity
Backfill (common)	435 tons[1]
Backfill (structural)	8,007 tons
Light fixture with lights and pole	1
"I-2" base course asphalt mix	210 tons[2]
"I-5" surface course asphalt mix	130 tons[2]
10-foot-high chain-link fence with 6 strands of barbed wire and privacy slats	205 linear feet
10-foot-high chain-link fence with 3 strands of barbed wire and privacy slats (gate)	4 linear feet
10-foot-high chain-link fence with 3 strands of barbed wire and privacy slats	10 linear feet
Landscape retaining wall	135 linear feet
3/4-inch stone	132 tons
3/8-inch stone	26 tons
Decorative stone	52 tons
Topsoil	204 tons

1. Due to concurrent backfilling operations, the recorded quantity of common fill placed in Construction Phase 9 did not differentiate common fill placed in SU 10A-16 from common fill placed in nearby SUs. The quantity reported in Table 4-1 is estimated from survey drawings. Because common fill was not differentiated, test results (Section 4.5) are provided for all common fill placed in Construction Phase 9 during the period of backfilling operations within SU 10A-16.
2. Quantities estimated based on restoration plan and RAWP (USACE 2004b) specifications for asphalt paving.

5.0 POST-REMEDIAL ACTION MEASUREMENTS

Post-remedial action measurements, also referred to as FSS, were performed to assess residual radioactivity once remediation was completed. FSS was used to verify that RAOs were achieved and to determine if Burial Pit No. 2 could be released for Unrestricted Use (residential) without institutional controls. All FSS activities at Burial Pit No. 2 were conducted using a MARSSIM-based approach established in the MFSSP (USACE 2001d) and specified for the 100 West Hunter Avenue Property in the *MFSSP Addendum C-10A Final Status Survey Plan 100 West Hunter Avenue (Stepan)* (USACE 2004d), hereafter referred to together as the "FSS Plan." FSS at Burial Pit No. 2 consisted of the following primary activities:

- A gamma walkover survey (GWS) over 100 percent of accessible areas
- The collection and gamma spectroscopy analysis of systematic surface soil samples
- The 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. 2. 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 non-parametric 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 2001d). The DCGL for Burial Pit No. 2 was originally based on the Restricted Use (commercial) criteria but was changed to the more conservative Unrestricted Use (residential) criteria as detailed in **Section 2.1**. The Null Hypothesis is an assumption that the SU exceeds the release criteria, and there are two methods for rejecting it:

- If all systematic sample results are less than the DCGL, the Null Hypothesis is automatically rejected.
- If any systematic sample result exceeds the DCGL by more than the lowest background reference area measurement result, the non-parametric WRS test is required to be performed. The WRS is used in situations where the contaminant is present in 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* (USACE 2004c). Note that performing the WRS test was not required to satisfy the RAOs for Burial Pit No. 2.

5.1 SURFACE SOIL SAMPLING METHOD

Surface soil sampling for the FSS was the primary method used at Burial Pit No. 2 to verify attainment of the RAOs. All samples were collected, shipped, analyzed, and validated as specified in the FSS Plan and

the CDQMP (USACE 2009b). A list of the Standard Operation Procedures from the CDQMP used for sampling are included as part of the "Quality Control of FSS Results" 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 below ground surface (bgs). Sidewalls of excavations were also sampled, as required, using surface sampling techniques; however, sidewall samples were technically considered subsurface samples and the depth of the sample was recorded as relative to the original grade. All samples collected from Burial Pit No. 2 were sampled using surface sampling techniques in accordance with the FSS Plan.

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 is determined using the MARSSIM-based approach described in the MFSSP (USACE 2001d). The triangular systematic sampling grid spacing is established for each SU based on the area of the survey unit and 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 single Burial Pit No. 2 SU and the "as-built" NJ State Plane Coordinates for each systematic sample location are presented in **Appendix H**.

5.3 GAMMA WALKOVER SURVEY

The purpose of the GWS was to identify areas of elevated radioactivity for potential sampling which 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- centimeter [cm] by 7.62-cm) Sodium Iodide (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 the geospatial software program to plot the results. Completed GWS maps were documented and submitted to the USACE as part of the *Final Status Survey Report* submitted for each SU. The original FSS Reports are maintained on site at the FMSS Field Office. The GWS map for Burial Pit No. 2 is included in **Section 5.6**. The "+3 sigma" GWS map, which was used to help identify bias sampling locations, is provided in **Appendix I**.

Scan Minimal Detectable Concentrations (MDC_{scan}) values were established for the instruments used to perform GWS as detailed in the MFSSP (USACE 2001d). Based on the *a priori* MDC_{scan} evaluation, no additional soil samples were required in order to address 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**.

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 (i.e., readings greater than three standard deviations above the mean) and 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 I**. The "as-built" NJ State Plane Coordinates for each FSS bias sample location are presented in **Appendix J**.

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 2009b). Radiological data were evaluated using the *Radiological Data Quality Evaluation Guidance* (USACE 2009a), as presented in the CDQMP.

5.6 SURVEY UNIT DATA COLLECTION AND RESULTS

Based on the size of Burial Pit No. 2, the planned stages of excavation, and the requirements of the FSS Plan, one SU was originally specified and classified. Classification was based on the extent of the potential contamination located within the boundaries of each SU. Class 1 SUs are considered to have radiological contamination in soil that exceeds the release criteria; Class 2 area soil is expected to meet or be lower than the release criteria. The single SU for Burial Pit No. 2 remediation was a Class 1 SU; the original design layout of the proposed SU is presented on **Figure 5-1**.

SU layouts were modified during this remedial action in response to sampling/surveying activities and to address excavation growth in response to contamination beyond design limits. FSS design modifications and a summary of collected data for the SU are described in more detail in **Section 5.6.1**. **Figure 5-2** presents the as-built layout for the single Burial Pit No. 2 SU, and indicates the locations of systematic and bias samples collected in support of FSS.

In accordance with the MOU between USACE and the NRC, the NRC observed FSS activities within Burial Pit No. 2 on December 8, 2009. The NRC was provided with split samples collected from five systematic locations within survey unit 10A-16. The observations and split sample results are presented in an NRC report included in Appendix A. USACE sample results as reported to the NRC are also provided in Appendix A. Note that although sample locations correspond to FSS sample locations, four of the five sample splits are unique samples with different identification numbers.

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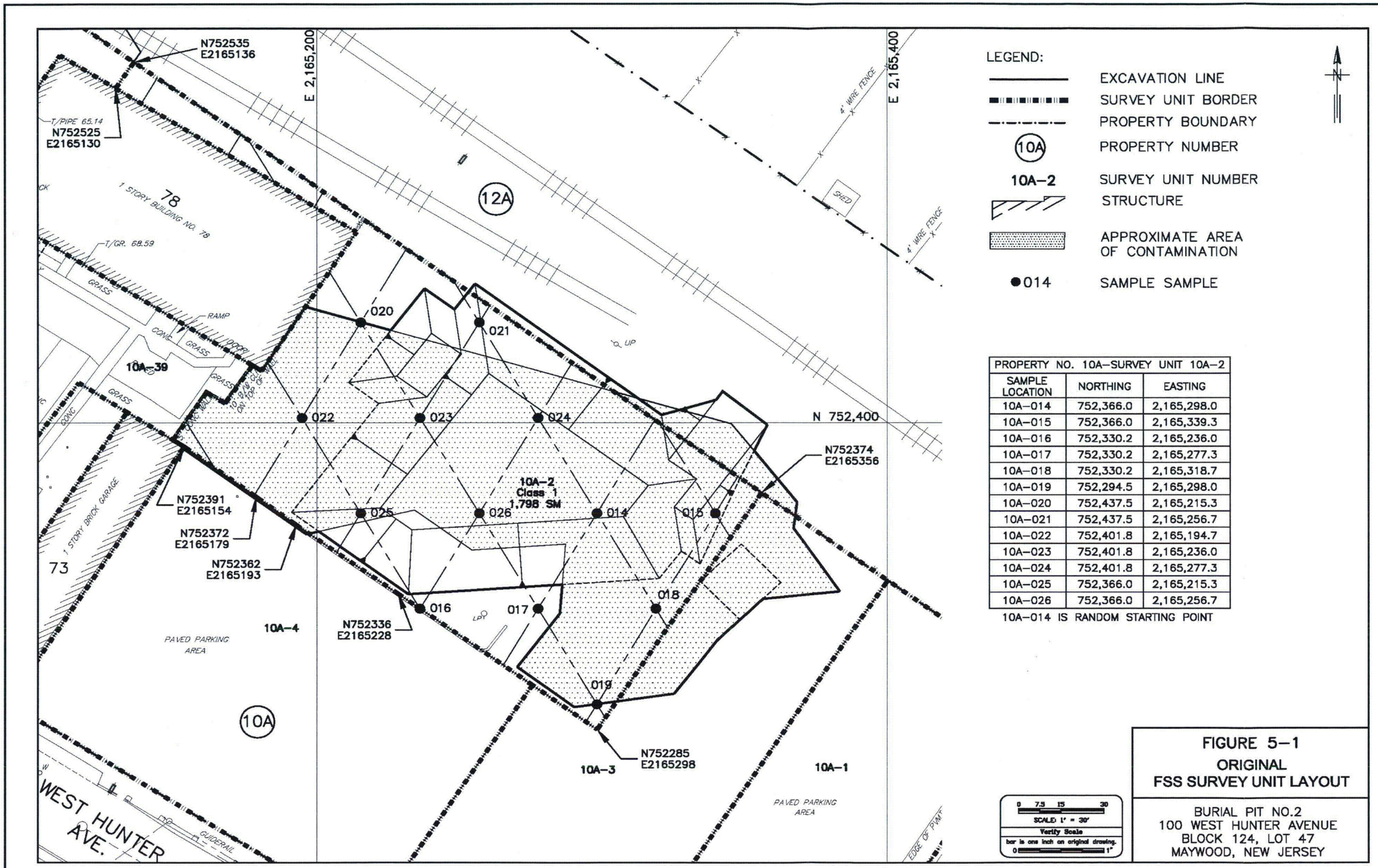


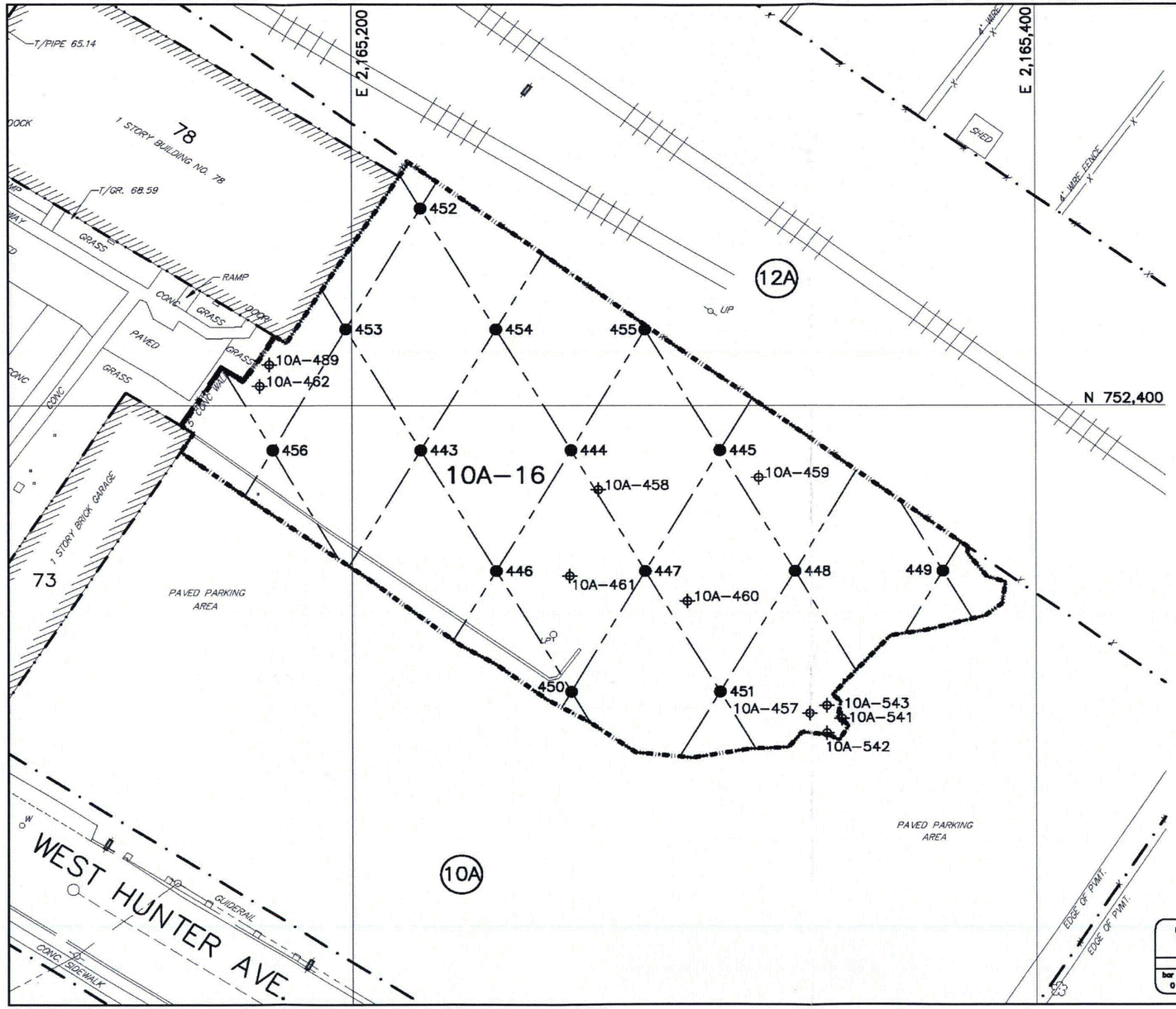
PROPERTY NO. 10A–SURVEY UNIT 10A–2		
SAMPLE LOCATION	NORTHING	EASTING
10A–014	752,366.0	2,165,298.0
10A–015	752,366.0	2,165,339.3
10A–016	752,330.2	2,165,236.0
10A–017	752,330.2	2,165,277.3
10A–018	752,330.2	2,165,318.7
10A–019	752,294.5	2,165,298.0
10A–020	752,437.5	2,165,215.3
10A–021	752,437.5	2,165,256.7
10A–022	752,401.8	2,165,194.7
10A–023	752,401.8	2,165,236.0
10A–024	752,401.8	2,165,277.3
10A–025	752,366.0	2,165,215.3
10A–026	752,366.0	2,165,256.7

10A–014 IS RANDOM STARTING POINT

FIGURE 5–1
ORIGINAL
FSS SURVEY UNIT LAYOUT

BURIAL PIT NO.2
100 WEST HUNTER AVENUE
BLOCK 124, LOT 47
MAYWOOD, NEW JERSEY

Figure 5-1
Original FSS Survey Unit Layout



PROPERTY NO. 10A–SURVEY UNIT 10A–16

SAMPLE LOCATION	NORTHING	EASTING
10A–443	752,386.0	2,165,220.0
10A–444	752,386.0	2,165,263.6
10A–445	752,386.0	2,165,307.3
10A–446	752,348.3	2,165,241.8
10A–447	752,348.3	2,165,285.5
10A–448	752,348.3	2,165,329.1
10A–449	752,348.3	2,165,372.7
10A–450	752,310.5	2,165,263.6
10A–451	752,310.5	2,165,307.3
10A–452	752,461.5	2,165,220.0
10A–453	752,423.7	2,165,198.2
10A–454	752,423.7	2,165,241.8
10A–455	752,423.7	2,165,285.5
10A–456	752,386.0	2,165,176.4
BIAS SAMPLES		
10A–457	752,303.8	2,165,333.4
10A–458	752,373.7	2,165,271.7
10A–459	752,377.5	2,165,318.6
10A–460	752,338.9	2,165,297.8
10A–461	752,346.7	2,165,263.2
10A–462	752,406.0	2,165,172.6
10A–489	752,412.7	2,165,175.4
10A–541	752,302.1	2,165,343.0
10A–542	752,297.6	2,165,338.5
10A–543	752,306.2	2,165,338.5

FIGURE 5–2
AS-BUILT
FSS SURVEY UNIT LAYOUT

BURIAL PIT NO.2
100 WEST HUNTER AVENUE
BLOCK 124, LOT 47
MAYWOOD, NEW JERSEY

Figure 5-2
As-Built FSS Survey Unit Layout

5.6.1 Survey Unit 10A-16

5.6.1.1 Survey Unit Design and Systematic Sampling

Class 1 SU 10A-16 was originally identified as SU 10A-2 in the FSS Plan and was designed to be 1,798 square meters (m^2) in area and contain 13 systematic sample locations. Sequencing of remediation on the 100 West Hunter Avenue Property resulted in this SU being re-identified as 10A-16. The final "as-built" area of SU 10A-16 was 2,069 m^2 and contained 14 systematic sample locations as illustrated in **Figure 5-2**.

All 14 systematic samples were collected between October 22, 2009 and March 10, 2010 using surface sampling techniques. **Table 5-1** presents the results of the systematic samples collected in SU 10A-16; all sample results were below their respective Unrestricted Use (residential) DCGLs.

5.6.1.2 Gamma Walkover Survey and Bias Sampling

A 100 percent GWS was performed in SU 10A-16 in accordance with the requirements of the MFSSP (USACE 2001d). Shielded gamma count rates ranged from 5,072 cpm to 31,277 cpm, averaging 11,994 cpm with a standard deviation of 2,307 cpm. The maximum gamma count rate (31,277 cpm) was observed at bias sample location 10A-458. Based on the maximum count rate of 31,277 cpm (shielded), no additional samples were required in order to address potential small areas of elevated activity per MARSSIM (EPA 2000b). GWS results and bias sample locations are presented on **Figure 5-3**.

Ten (10) bias samples were collected within SU 10A-16 between October 22, 2009 and March 10, 2010 using surface sampling techniques. **Table 5-2** presents the results of the bias samples; all sample results were below their respective Unrestricted Use (residential) DCGLs. The "+3 sigma" GWS maps, which were used to help identify bias sample locations, are presented in **Appendix I**. Bias sample coordinates are presented on **Figure 5-2** and in **Appendix J**.

5.6.1.3 Final Status Survey Data Evaluation

All sample results for SU 10A-16 are below their respective Unrestricted Use (residential) DCGLs. Therefore the SU meets release criteria, and the comparison to background concentrations using the WRS test is not required. The area identified as SU 10A-16 can be released for Unrestricted Use (residential) per the ROD (USACE, 2003).

All FSS analytical data pertaining to SU 10A-16 met all data quality objective (DQO) requirements as specified by the MFSSP (USACE 2001d) and the CDQMP (USACE 2009b). 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 contain the analytical results and associated laboratory QC for SU 10A-16: 09G-0494, 09G-0499, 09G-0504, 09G-0509, 09G-0513, 09G-0517, and 10G-0121. The associated data validation reports for each data package are included in **Appendix F**.

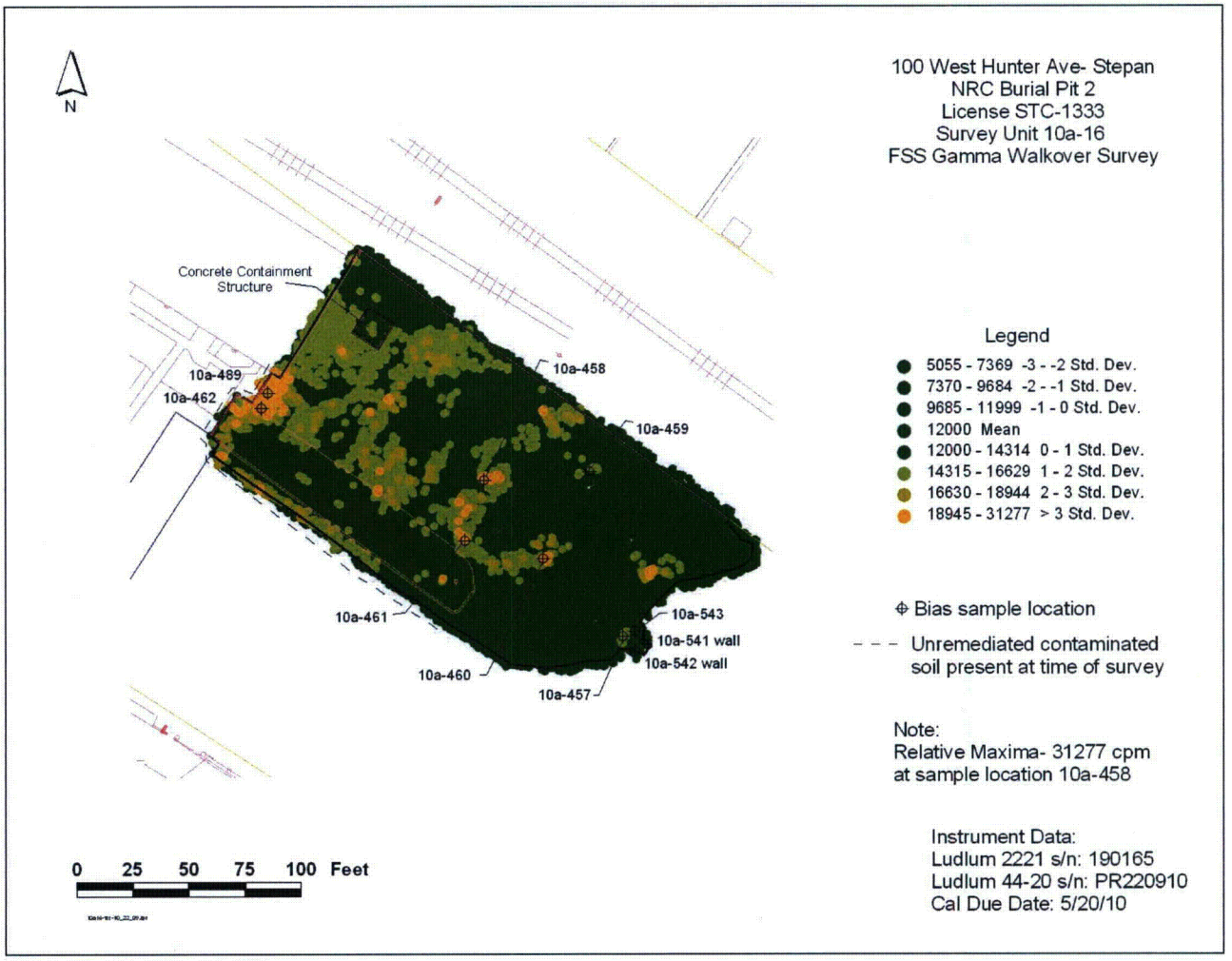


Figure 5-3
Gamma Walkover Survey Results of SU 10A-16 with GPS

Table 5-1
Systematic Soil Sample Results – Survey Unit 10A-16

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-443	0 to 0.5	10a-056864	1.57	0.09	0.02		1.75	0.17	0.03		1.53	0.36	0.17		3.32	0.19
10A-444	0 to 0.5	10a-056875	1.38	0.10	0.03		2.85	0.21	0.03		1.49	0.55	0.23		4.24	0.24
10A-445	0 to 0.5	10a-056878	1.03	0.06	0.01		1.20	0.13	0.02		0.55	0.68	0.21	J(1,2,3)	2.24	0.14
10A-446	0 to 0.5	10a-056863	1.02	0.07	0.02		1.16	0.15	0.03		0.58	0.31	0.16		2.18	0.17
10A-447	0 to 0.5	10a-056876	0.98	0.06	0.02		0.80	0.11	0.02		1.04	0.55	0.19		1.78	0.13
10A-448	0 to 0.5	10a-056877	1.02	0.07	0.01		0.91	0.11	0.03		0.77	0.36	0.14		1.93	0.13
10A-449	0 to 0.5	10a-056879	0.87	0.06	0.02		0.99	0.14	0.03		0.98	0.31	0.14		1.86	0.15
10A-450	0 to 0.5	10a-056866	0.97	0.06	0.01		0.98	0.12	0.02		0.75	0.74	0.19	J(1,4)	1.95	0.13
10A-451	0 to 0.5	10a-056873	0.97	0.08	0.02		0.93	0.15	0.03		0.88	0.34	0.16		1.90	0.17
10A-452	0 to 0.5	10a-056869	1.08	0.07	0.02		1.04	0.16	0.03		0.57	0.31	0.15		2.12	0.18
10A-453	0 to 0.5	10a-056870	1.23	0.08	0.02		1.26	0.17	0.04		0.38	0.47	0.19	J(3)	2.48	0.18
10A-454	0 to 0.5	10a-056867	1.42	0.08	0.02		2.22	0.20	0.03		2.37	0.58	0.26		3.64	0.21
10A-455	0 to 0.5	10a-056868	1.13	0.08	0.02		1.05	0.15	0.03		1.08	0.32	0.14		2.17	0.17
10A-456	0 to 0.5	10a-056871	0.92	0.07	0.02		0.88	0.14	0.03		0.79	0.38	0.16		1.80	0.16

Notes:
σ = sigma, standard deviation.
ft bgs = feet below ground surface.
MDC = minimum 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-16

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-457	0 to 0.5	10a-056887	0.91	0.07	0.02		1.05	0.15	0.03		1.02	0.36	0.15		1.97	0.16	0.33
10A-458[a]	0 to 0.5	10a-056918	0.94	0.06	0.01		0.94	0.13	0.03		1.01	0.51	0.19		1.88	0.14	0.24
10A-459	0 to 0.5	10a-056916	0.93	0.07	0.02		1.21	0.14	0.03		1.20	0.32	0.15		2.14	0.16	0.50
10A-460	0 to 0.5	10a-056917	1.30	0.10	0.03		2.02	0.25	0.05		0.40	0.42	0.25	J(3)	3.32	0.27	1.68
10A-461	0 to 0.5	10a-056883	1.34	0.08	0.02		1.91	0.16	0.03		1.00	1.09	0.24	J(1,3)	3.25	0.18	1.61
10A-462	0 to 0.5	10a-056919	1.23	0.08	0.02		2.15	0.19	0.04		0.75	0.57	0.21	J(1)	3.37	0.21	1.73
10A-489	0 to 0.5	10a-056920	1.51	0.10	0.02		2.02	0.21	0.03		0.60	1.14	0.31	J(1,3)	3.53	0.23	1.89
10A-541$_w$	0 to 0.5	10a-057080	1.04	0.09	0.02		0.98	0.15	0.04		0.93	0.27	0.13		2.02	0.18	0.38
10A-542$_w$	2.75 to 3.25	10a-057081	0.90	0.08	0.02		0.80	0.12	0.03		0.72	0.30	0.13		1.70	0.14	0.06
10A-543	0 to 0.5	10a-057082	0.99	0.08	0.02		1.24	0.15	0.03		1.06	0.33	0.15		2.22	0.17	0.58

Notes: σ = sigma, standard deviation
ft bgs = feet below ground surface.
MDC = minimum 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).

5.7 FINAL STATUS SURVEY SUMMARY AND CONCLUSIONS

5.7.1 Sample Summary

FSS activities at Burial Pit No. 2 were contained within a single Class 1 SU as illustrated on **Figure 5-2**. **Table 5-3** summarizes the FSS sampling activities within Burial Pit No. 2.

Table 5-3
FSS Sample Summary

Survey Unit Info			Systematic		Bias	
Survey Unit	Area (m^2)	Class	No. of Locations	No. of Regular Samples	No. of Locations	No. of Regular Samples
10A-16	2,069	1	14	14	10	10

QC samples were also taken along with regular samples at the minimum frequencies prescribed by the CDQMP (USACE 2009b). In total, 24 systematic and bias samples were collected, along with 4 field duplicate samples and 1 USACE QA split sample (a sample sent off-site for independent analysis to a USACE contract laboratory). The property-wide collection frequency requirement for field duplicate samples is 10 percent; therefore, the frequency of collection for field duplicate samples (16.7 percent) satisfies the minimum required by the CDQMP. One USACE QA split sample was collected from Burial Pit No. 2 representing a frequency of 4.2 percent. Although this falls short of the prescribed property-wide frequency of 5 percent, this does not indicate a deviation from the CDQMP because Burial Pit No. 2 is only a small part of the entire 100 West Hunter Avenue Property, and property-wide sampling statistics indicate the required frequency is satisfied. Also note that five additional split samples were collected and transferred to the NRC for analysis (refer to the NRC report 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. Note that all results from the 24 regular FSS samples, 4 field duplicate samples, 1 USACE QA split sample, and 5 NRC split samples were below their respective Unrestricted Use (residential) DCGLs. **Table 5-4** summarizes the QC and QA samples that were taken in support of FSS activities.

Table 5-4
QC and QA Sample Summary

Sample Type	Total Number of Samples
Regular Samples	24
Field Duplicate Samples	4
USACE QA Split Samples	1
NRC Split Samples	5
Samples > Release Criteria	0

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. **Table 5-5** summarizes the statistics for the single Burial Pit No. 2 SU.

The relative shift was calculated according to Equation 1:

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

Where:

$\Delta =$ The shift, equal to the DCGL – LBGR

σ = The standard deviation of the data set

DCGL = Derived Concentration Guideline Level. Equal to 5.0 pCi/g Ra226 + Th-232, and 49.0 pCi/g U-238 for Unrestricted Use (residential)

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):

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

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 2001d). 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.

Table 5-5
Retrospective Sample Frequency Evaluation (SU 10A-16)

Isotope(s)	LBGR (Median)	Standard Deviation	Relative Shift	P_r Value	Required No. of Locations (N/2)	Actual No. of Locations
Ra-226 + Th-232	2.14	0.77	3.72	0.993329	8	14
U-238	0.83	0.52	92.48	1.000000	8	14

5.7.3 Burial Pit No. 2 Status

Remedial and restorative activities are complete for Burial Pit No. 2. 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. 2 were accessible and all FUSRAP contamination was removed. The analytical data presented in this PRAR demonstrate compliance with the Unrestricted Use (residential) release criteria as set forth in the ROD, thereby ensuring that the substantive requirements of NJAC 7:28-12.8(a) and 10 CFR 20.1402 are not exceeded. No FUSRAP-related contamination remains within the historical footprint of Burial Pit No. 2, and Burial Pit No. 2 can be released for Unrestricted Use (residential) per the ROD (USACE 2003).

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6.0 PERFORMANCE STANDARDS/QUALITY ASSURANCE AND QUALITY CONTROL

6.1 PERFORMANCE STANDARDS

Table 6-1 compares select RAOs with results of the work completed at Burial Pit No. 2.

Table 6-1
Performance Results Compared with Remedial Action Objectives

Remedial Action Objectives	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."	4,504 in situ yd^3 of material were removed from Burial Pit No. 2 and disposed off site at a licensed disposal facility. All contamination was accessible and no FUSRAP-related waste in excess of the Unrestricted Use (residential) clean-up criteria remains within Burial Pit No. 2 footprint (survey unit 10A-16).
Verify that Burial Pit No. 2 satisfies the Restricted Use (commercial) Release criteria.	MARSSIM FSS Null Hypothesis "rejected" for the survey unit. All regions of Burial Pit No. 2 were accessible and meet the ROD RAOs for Unrestricted Use (residential) (the ALARA goal of the Restricted Use [commercial] criteria).
Comply with ARARs:	The remedial action complied with all applicable ARARs as detailed:
10 CFR 20.1402 (25 mrem/yr NRC exposure limit)	Compliance attained through remediation for Burial Pit No. 2.
NJAC 7:9.6 (point source water discharge limitations)	All potentially impacted water was transported to the MISS, treated, and discharged in compliance with BCUA permits.
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. 2 area.
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 the 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 2009b). QA/QC information related to FSS and backfill activities at Burial Pit No. 2 is presented in this report as follows:

Appendix D—Data Packages for Backfill Samples

Appendix F—Data Validation Reports

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. **Table 6-2** summarizes how well the PARCC parameters for Burial Pit No. 2 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 percent within a given analytical batch. Ten (10) associated laboratory replicates were analyzed by the laboratory (9 of which were performed on 10A-16 FSS samples). All laboratory replicate pair results were within absolute difference control limits as specified in the CDQMP (USACE 2009a). The results of the laboratory replicates are presented in **Appendix G**, and 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 frequency of 10 percent. Four (4) FSS field duplicate samples were collected from Burial Pit No. 2 along with 24 regular samples for a collection frequency of 16.7 percent. All FSS field duplicate results were within absolute difference control limits as specified in the *Data Quality Evaluation Guidance* (USACE 2009a) and the CDQMP (USACE 2009b). 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 (organics), or from the laboratory replicate results (inorganics). Based on these results the CDQMP DQO for precision is satisfied. MS/MSD precision and laboratory replicate precision are discussed in **Appendix L**. Field duplicate pair results are presented 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 (LCS) 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. **Appendix L** (QCSR) provides detailed information regarding method and batch QC. These indicate excellent accuracy for Burial Pit No. 2 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 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 2001d) statistically ensures that samples collected and analyzed are representative of the residual contamination for a given SU. Similarly, the more homogeneous the collected sample, the greater likelihood that a representative sample aliquot will be taken from the sample container by the lab technician for analysis. Maywood FSS samples are dried and ground. The grinding process homogenizes the sample, and a fairly large percentage of the sample – typically 40 percent or more – is used for analysis. Representativeness is not an easily quantified parameter. However, the precision and accuracy parameters provide an indication of representativeness of the sample aliquot taken by the lab technician, because these parameters depend to an extent on method preparation. Field duplicates are also used as a measure of representativeness as well as precision (see **Section 6.2.1.1**). Because 100 percent of the field duplicate samples collected from Burial Pit No. 2 passed duplicate QC criteria, there is a high confidence that the samples collected are representative of the SU activity. In conclusion, because the preparation method yields representative aliquots, the MARSSIM-based sampling approach provides an acceptable statistical representation of an SU, the associated precision and accuracy parameters are within USACE QC limits, and the field duplicates are 100 percent acceptable, the CDQMP DQO for sample representativeness is satisfied.

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 percent as presented in the CDQMP (USACE 2009b) was met for radiological analyses as no data were rejected (100 percent completeness). Chemical analyses, when broken down by the categories of elemental analysis, semi-volatile organic compounds, volatile organic compounds, and polychlorinated biphenyl organic compounds, also satisfy the 95 percent completeness

requirement; however, due to the relatively low number of samples analyzed for chemical parameters (nine backfill samples), some specific analytes did not meet the completeness requirement. Upon review it was determined that the few exceptions did not have a negative impact to overall data quality and that the CDQMP DQO for completeness was satisfied. Refer to **Appendix L** for specific information relating to completeness of data associated with Burial Pit No. 2.

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 certified by the State of NJ (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 indicate that the CDQMP DQO is satisfied.

USACE QA split sample collection was required at a minimum frequency of 5 percent across an entire property. One USACE QA split sample was collected from Burial Pit No. 2 representing 4.2 percent of the 24 regular samples collected. Although this falls short of the 5 percent property-wide requirement, this does not indicate a deviation from the CDQMP (USACE 2009a) because Burial Pit No. 2 is only a small part of the entire 100 West Hunter Avenue Property and property-wide sampling statistics indicate the required 5 percent minimum frequency is satisfied. The USACE QA split sample was sent to an independent USACE-approved laboratory for gamma spectroscopy analysis. The results from the independent laboratory were then compared to those of the selected contract laboratory (i.e., the UFML). The single split sample met the field duplicate acceptance criteria (i.e., it was within absolute difference control limits), thereby satisfying the DQO acceptance criterion as required by the CDQMP (USACE 2009b). Results of the USACE QA split sample data evaluation are contained in the QCSR, which is provided as **Appendix L**.

Note that an additional five split samples were collected and transferred to the NRC for analysis by their contract laboratory. These samples were not collected as part of the USACE QA Program and as such were not evaluated against USACE acceptance criteria. Results of the NRC split samples are provided in an NRC report that is included in **Appendix A**.

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 the 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 FSS Quality Control Report included in **Appendix G**, and results of the smear samples were reported on radiological survey forms included in **Appendix M**. Equipment blank results were all non-detect as described within the QCSR (**Appendix L**). 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 were 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 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 (100) percent of the analytical data collected in support of FSS and backfilling activities at Burial Pit No. 2 were 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 percent 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. 2 were validated by Kestrel Environmental Technologies, Inc. based in Freeport, Maine.

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

Table 6-3
Radiological Data Validation Codes

Number	Explanation
(1)	Accept the result as estimated (J). The reported result is within the analytical window for the method blank result.
(2)	Accept the result as estimated (J). The reported result is within the analytical window for the daily blank result.
(3)	Accept the result as estimated (J). The reported result is less than the 2 sigma uncertainty and greater than the MDC.
(4)	Accept the result as estimated (J). Using professional judgment, significant analytical uncertainty is indicated.

MDC = minimum detectable concentration. Laboratory data packages and data validation reports typically use "minimum detectable activity" instead of MDC; for the purposes of this PRAR, the two terms are synonymous.

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7.0 OPERATIONS AND MAINTENANCE

Remedial and backfilling activities are complete for Burial Pit No. 2. For FUSRAP waste at the FMSS properties considered to be accessible, the selected remedy in the ROD (USACE 2003) is complete excavation and off-site disposal. All FUSRAP waste in Burial Pit No. 2 was accessible and was completely remediated. The analytical data presented in this report demonstrates compliance with the Unrestricted Use (residential) release criteria as set forth in the ROD, thereby ensuring that the substantive requirements of New Jersey Administrative Code 7:28-12.8(a) and 10 CFR 20.1402 are not exceeded. No FUSRAP-related contamination remains within the historic footprint of Burial Pit No. 2, and the remedial action has been completed.

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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. A number of 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 representatives of the Stepan Company and NYSW[1] was conducted prior to, during, and following the remedial action. This interaction included numerous meetings and site walkovers at the properties and extensive review of remedial designs and restoration plans and specifications. Coordination issues included the remediation schedule and phasing, coordination of rail movements, employee vehicle parking and pedestrian access during the remediation, information requests from property employees, and restoration plans. In addition, a real estate right-of-entry agreement was executed between the Government and NYSW to cover the duration of the remedial action. In accordance with the right-of-entry agreement, FMSS project personnel were also briefed on NYSW safety requirements for working within the railroad right-of-way. Insurance coverage as required by NYSW was also obtained. A right-of-entry agreement was not required with Stepan Company as property access was granted by the 2004 Settlement Agreement (USDOJ 2004) between the U.S. Government and Stepan Company.

Public outreach for the remedial action included notification letters hand-delivered to residences on West Central Avenue directly north and also east and west of the Burial Pit No. 2 site. Twenty-eight (28) letters were delivered in June 2009 prior to the start of remedial excavations. The letters provided some background on the FMSS, described the scope and anticipated off-site impacts of the remedial action, and included a point of contact for further information. The letters prompted some nearby residents to contact the FUSRAP Public Information Center. Those contacts were addressed by the FMSS Community Relations Manager with support from other FMSS personnel as needed. Borough of Maywood officials and representatives of the Stepan and NYSW properties were copied on the letters for background in the event they received calls from the public regarding the remedial action.

Another nearby resident contacted the FMSS Community Relations Manager and Stepan Company representatives in the summer of 2010 while the remediation was underway. The resident expressed concerns about construction noise, obtrusive after-hours lighting, and loss of screening vegetation between her home and the Stepan property. FMSS and Stepan jointly addressed these concerns by adjusting light fixtures, modifying truck staging practices, planting evergreens to replace removed vegetation (with approval by NYSW), and installing privacy fencing.

[1] The proximity of Burial Pit No. 2 to the adjacent NYSW right-of-way necessitated coordination of remedial actions with NYSW in order to achieve remedial objectives. Concurrent remediation performed on the NYSW property will be documented in a separate PRAR specific to that property.

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