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Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for Maywood, New Jersey

U.S. Department of Energy

0489-0613.1

110601

Bechtel

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Job No. 14501, FUSRAP Project
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U.S. Department of Energy
Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, TN 37831-8723

Attention: Susan M. Cange, Site Manager
Former Sites Restoration Division

Subject: FUSRAP - Maywood Site - Transmittal of WP-IP Ancillary Documents

Dear Ms. Cange:

Enclosed for your use are publication copies of the ancillary documents for the Maywood work plan-implementation plan. Included are two field sampling plans, a quality assurance project plan, a health and safety plan, and a community relations plan. All comments received from reviewers have been incorporated into these documents.

Copies of each of these documents will be placed in the administrative record for the Maywood site.

Sincerely,

M. E. Redmon

M. E. Redmon
Project Manager - FUSRAP

MER:ebs:1346
Enclosure: As stated

ACTION REQ'D [ ] YES [X] NO DUE DATE _____
RESPONSE TO CHRON NO. _____
☐ FFA ☐ Permit ☐ Milestone ☐ OcR ☐ CCN ☐ CAR ☐ Mid-Yr ☐ Yr-End ☐ Periodic Rpt

DOE/OR/21949-193.5

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-91OR21949

Quality Assurance Project Plan for the Remedial Investigation/ Feasibility Study-Environmental Impact Statement for the Maywood Site

Maywood, New Jersey

November 1993

DOE/OR/21949-193.5
Rev. 1

QUALITY ASSURANCE PROJECT PLAN FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY-ENVIRONMENTAL IMPACT STATEMENT FOR THE MAYWOOD SITE

MAYWOOD, NEW JERSEY

NOVEMBER 1993

Prepared for

United States Department of Energy

Oak Ridge Operations Office

Under Contract No. DE-AC05-91OR21949

By

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

QUALITY ASSURANCE PROJECT PLAN FOR THE

MAYWOOD SITE

MAYWOOD, NEW JERSEY

FUSRAP

Bechtel National, Inc.

for

United States Department of Energy

Oak Ridge Operations Office

David S. Allison
BNI Project Quality Assurance Manager

BNI Program Manager

Gustav K. Prior 11/5/93
DOE Director, Former Sites
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FOREWORD

This plan has been prepared to document the scoping and planning process performed by the U.S. Department of Energy (DOE) to support remedial action activities at the Maywood site, located in northern New Jersey in the boroughs of Maywood and Lodi and the township of Rochelle Park. Remedial action at the Maywood site is being planned as part of DOE's Formerly Utilized Sites Remedial Action Program.

Under the Comprehensive Environmental Response, Compensation, and Liability Act, a remedial investigation/feasibility study must be undertaken to support the decision-making process for evaluating remedial action alternatives. Consistent with U.S. Environmental Protection Agency guidance for conducting a remedial investigation/feasibility study, the work plan-implementation plan (1) contains a summary of information currently known about the Maywood site, (2) presents a conceptual site model that identifies potential routes of human exposure to site contaminants, (3) identifies data gaps, and (4) summarizes the process and proposed studies that will be used to fill the data gaps.

Other plans have been developed to direct field investigations to resolve the data gaps identified in the work plan-implementation plan. The other plans are the quality assurance project plan, the health and safety plan, the community relations plan, and the field sampling plans. Because the field work is phased, two separate field sampling plans address the field investigations. One field sampling plan directs field work for the radiological and chemical remedial investigation, and the other directs the geological investigation of the Maywood Interim Storage Site.

The work described in this plan was performed between 1989 and 1991; the plan accurately represents the work that was performed. Authorization was given by DOE to proceed with the work using draft documents due to the lengthy review cycle that was

necessary for approval by all agencies involved and the need to use available funding to perform the work. The review is now complete, and the plan has been approved for final publication.

CONTENTS

CONTENTS

(continued)

CONTENTS

(continued)

FIGURES

TABLES

REVISION CONTROL INDEX

REVISION CONTROL INDEX

(continued)

REVISION CONTROL INDEX

(continued)

REVISION CONTROL INDEX
FIGURES

TABLES

ACRONYMS

AA	atomic absorption
AEC	Atomic Energy Commission
BNAE	base/neutral and acid extractable
BNI	Bechtel National, Inc.
CLP	Contract Laboratory Program
DOE	Department of Energy
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
FSRD	Former Sites Restoration Division
FUSRAP	Formerly Utilized Sites Remedial Action Program
GC/MS	gas chromatography/mass spectrometry
ICPAES	inductively coupled plasma atomic emission spectrophotometry
ICV	initial calibration verification
MISS	Maywood Interim Storage Site
PCB	polychlorinated biphenyl
RI/FS-EIS	remedial investigation/feasibility study- environmental impact statement
RPD	relative percent difference
TCL	Target Compound List
TMA/E	Thermo Analytical/Eberline

DISTRIBUTION

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1.0 PROJECT DESCRIPTION

In 1974, the Atomic Energy Commission (AEC), a predecessor agency of the U.S. Department of Energy (DOE), instituted the Formerly Utilized Sites Remedial Action Program (FUSRAP). The objective of FUSRAP is to identify and clean up or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains from activities carried out under contract to the Manhattan Engineer District and AEC. In addition, Congress authorized DOE to undertake remedial actions at four other sites where commercial operations had radioactively contaminated the environment. One of these four sites is located in Maywood, New Jersey.

Operations at the former Maywood Chemical Works facility in Maywood resulted in contamination of numerous properties in Maywood, Rochelle Park, and Lodi, including the property previously owned by Maywood Chemical Works (now owned by the Stepan Company); the DOE-owned property referred to as the Maywood Interim Storage Site (MISS); and residential, commercial, and governmental vicinity properties. To organize and segment the investigation and remedial actions at these properties, DOE has grouped them into four operable units:

- The Stepan Company property
- The MISS property
- Residential properties
- Commercial or governmental properties

The Maywood site comprises these four operable units.

To select a corrective action to be implemented at the Maywood site, DOE is initiating a remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS). This

process is described in detail in the Work Plan-Implementation Plan for the Remedial Investigation/Feasibility Study-Environmental Impact Statement for the Maywood Site, Maywood, New Jersey (ANL 1992). In general, the RI/FS-EIS process consists of conducting field investigations to define the nature and extent of the contamination (remedial investigation) and then performing studies to assess the relative merits and impacts of possible remedial action alternatives (feasibility study-environmental impact statement).

The RI/FS-EIS work at the Maywood site will be accomplished in accordance with the following plans:

- Work plan-implementation plan
- Community relations plan
- Sampling and analysis plan
- Health and safety plan

The sampling and analysis plan consists of two field sampling plans and the quality assurance project plan. The field sampling plans were developed to direct field investigations to resolve data gaps identified in the work plan-implementation plan. Because the field work is phased, two separate field sampling plans address the field investigations. One plan directs the field work for the radiological and chemical remedial investigations, and the other directs the geological investigation of MISS. They contain detailed information currently known about the site and describe the proposed process and studies that will be used to obtain sufficient information to fill the data gaps identified by the work plan-implementation plan. The field sampling plans are supported by the quality assurance project plan, which will be used in establishing quality controls during the work at the Maywood site. The quality controls apply to all data collection, sample analysis and validation, reporting, sample archival (as appropriate), and data evaluation activities as described in the field sampling

plans. These same procedures and controls are in effect for sampling conducted quarterly for the environmental monitoring program at the site.

1.1 PROJECT OBJECTIVES

The Comprehensive Environmental Response, Compensation, and Liability Act/National Environmental Policy Act process is being followed to determine the preferred remedial action alternative for the Maywood site. The sampling and analysis plan addresses the remedial investigation methods to be used. The nature of contaminants at the site, the degree and extent of contamination, and locations of waste burial areas will be identified during this investigation. The information obtained from this remedial investigation and from the scoping process (during which information was collected and evaluated) will provide the necessary information for the subsequent phases of the RI/FS-EIS. Based on the information collected during the remedial investigation, a feasibility study-environmental impact study will be conducted to identify the preferred remedial action.

The quality assurance project plan outlines the quality assurance/quality control requirements that will be implemented to ensure the defensibility and integrity of analytical data.

1.2 SITE DESCRIPTION

The Maywood site consists of MISS, the Stepan Company property, and numerous small vicinity properties. These properties are described in the work plan-implementation plan and the field sampling plans; therefore, they are not described again in this quality assurance project plan.

1.3 DATA COLLECTION OBJECTIVES

Additional data requirements for the remedial investigation were identified based on results of detailed study of existing reports, preliminary identification of applicable or relevant and appropriate requirements and contaminants of concern, development of the conceptual exposure model, and preliminary identification of remedial action alternatives. Collection of these data will allow a better understanding of site conditions and allow evaluation of remedial action alternatives. Detailed descriptions of these data requirements and the methods to be used for collecting the data are contained in the field sampling plans and the work plan-implementation plan for the Maywood site. The quality assurance project plan provides an overview of quality objectives and quality levels set for field sampling activities. All FUSRAP participants follow specific and detailed project procedures or instructions in accomplishing all field activities. Table 1-1 summarizes the activities to be conducted during the remedial investigation for the Maywood site and identifies the analyses to be performed. Table 1-2 summarizes the data quality levels to be achieved for sample gathering and data collection.

Table 1-1

Sampling Frequency

Operable Unit/Medium	Planned Activity	Approximate Number of Samples/Measurements	Analyses[a]	Data Quality Level
Stepan				
Soil	Identify surface radioactive contamination with walkover surveys	Not applicable	Not applicable	II
	Collect surface soil samples to confirm walkover results	50	Th-232, Ra-226, U-238	III
	Drill ~ 75 boreholes and collect subsurface soil samples to define subsurface radioactive contamination	225	Th-232, Ra-226, U-238	III
	Determine presence of Th-232 process waste	8	TCLP metals, corrosivity, lithium, TAL, lanthanides, TPH, mobile ions, TCL, TCLP organics	III/IV
	Determine presence of mixed waste	11	TCLP metals, corrosivity, lithium, reactivity, metals, lanthanides, TPH, mobile ions, total PCBs, TCLP organics, volatile organics, semivolatile organics	III/IV
	Determine whether wastes have migrated from burial areas	8	TCLP metals, corrosivity, lithium, reactivity, metals, lanthanides, TPH, mobile ions, total PCBs, TCLP organics, volatile organics, semivolatile organics	III/IV
Smears	Collect smear samples, take direct readings in buildings to confirm presence of fixed and removable radioactive contamination	500	Gross alpha and gross beta	III
Direct Radiation	Obtain exposure rate measurements for direct gamma radiation	25	Gamma exposure rate	II

Table 1-1

(continued)

Operable Unit/Medium	Planned Activity	Approximate Number of Samples/Measurements	Analyses[a]	Data Quality Level
MISS				
Soil	Drill 37 holes in storage pile to determine presence of hazardous waste	170	TCLP metals, reactivity, TPH, total PCBs	III
		37	U-238, Ra-226, Th-232	
		20	TCLP organics, corrosivity	III
	Drill 34 holes onsite to determine mixed waste within known areas of radioactive contamination	34	RCRA characteristics, TPH, total PCBs	III
	Determine presence of Th-232 chemical process contaminants within areas of radioactive contamination	17	TCL/TAL	III/IV
	Collect discrete samples from beneath known areas of radioactive contamination	34	TCL/TAL, RCRA characteristics	III/IV
Surface Water	Collect upstream and downstream water samples to determine migration of hazardous materials	10	Metals, lithium, lanthanides, mobile ions, indicator analysis (see Table 3-1)	III/IV
Sediments	Collect upstream and downstream sediments to determine migration of hazardous materials	10	Same as surface water (except indicator analysis)	III/IV
Groundwater	Collect upgradient and downgradient samples from site for Th-232 process wastes, migration from MISS	10	Mobile ions, lanthanides, metals, lithium	III/IV
Air	Collect radon flux samples for compliance with Clean Air Act	20	Radon/thoron flux rates from pile and MISS	III
		5	Radon/thoron grab samples	III

Table 1-1
(continued)

Operable Unit/Medium	Planned Activity	Approximate Number of Samples/Measurements	Analyses[a]	Data Quality Level
Building 76	Collect data for fixed and removable radioactive surface contamination	100	Direct field measurement	III
Residential/Commercial/ Governmental Vicinity Properties				
Soil	Identify surface radiological contamination with walkover surveys	Not applicable	Not applicable	II
	Collect surface soil samples to confirm walkover results	300	Th-232, Ra-226, U-238	III
	Drill ~ 10 to 15 boreholes per property (~ 140 total) and collect subsurface soil samples to define subsurface radiological contamination	420	Th-232, Ra-226, U-238	III
	Determine presence of mixed waste, Th-232 process waste	21	TCLP metals, reactivity, corrosivity, TPH, metals, mobile ions, total PCBs, lanthanides	III/IV
		2	TCLP organics	III
Sediments	Collect sediment samples from open areas of Lodi Brook (downstream) to confirm that no contaminant migration is occurring from MISS	8	Th-232, Ra-226, U-238, metals, lithium, lanthanides, mobile ions	III/IV
Direct Radiation	Obtain gamma exposure rate measurements	30	Direct gamma radiation	II

[a]TCLP - toxicity characteristics leaching procedure; TPH - total petroleum hydrocarbons; PCB - polychlorinated biphenyls; RCRA - Resource Conservation and Recovery Act; TCL - Target Compound List; TAL - Target Analyte List.

Table 1-2

Summary of Data Quality Levels Appropriate to Data Uses

Data Uses	Data Quality Level	Type of Analysis	Limitations	Data Quality
Site characterization, monitoring during implementation	I	Total organic/inorganic vapor detection using portable instruments Field test kits	Instruments respond to naturally occurring compounds	If instruments calibrated and data interpreted correctly, can indicate contamination
Site characterization, evaluation of alternatives, engineering design, monitoring during implementation	II	Variety of organics by GC; inorganics by furnace AA; XRF Tentative identification; analyte-specific Detection limits vary from low ppm to low ppb	Tentative identification Techniques/instruments limited mostly to volatiles, metals	Dependent on QA/QC steps employed Data typically reported in concentration ranges
Risk assessment, PRP determination, site characterization, evaluation of alternatives, engineering design, monitoring during implementation	III	Organics/inorganics using EPA procedures other than CLP can be analyte-specific RCRA characteristics tests	Tentative identification in some cases Can provide data of same quality as Level IV	Detection limits similar to CLP Less rigorous QA/QC
Risk assessment, PRP determination, evaluation of alternatives, engineering design	IV	TCL organics/inorganics by GC/MS; furnace AA; ICPAES Low ppb detection limit	Tentative identification of non-TCL parameters Some time may be required for validation of packages	Goal is data of known quality
Risk assessment, PRP determination	V	Nonconventional parameters Method-specific detection limits Modification of existing methods Appendix 8 parameters	May require method development modification Mechanism to obtain services requires special lead time	Method-specific

Source: EPA Data Quality Objectives for Remedial Response Activities/Development Process, EPA 540/G-87/003, March 1987.

GC - gas chromatography; QA/QC - quality assurance/quality control; AA atomic absorption; XRF - X-ray fluorescence; CLP - Contract Laboratory Program; RCRA - Resource Conservation and Recovery Act; PRP - potentially responsible party; TCL - Target Compound List; ICPAES - inductively coupled plasma atomic emission spectrophotometry.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The FUSRAP project organization and responsibilities are described in detail in the work plan-implementation plan and field sampling plans. The health and safety plan also provides a list of emergency services and assistance agencies, key site personnel, and appropriate telephone numbers. The DOE Oak Ridge Operations Office, Former Sites Restoration Division (FSRD) has responsibility for the management and technical direction of the remedial investigation.

Bechtel National, Inc. (BNI), FSRD's project management contractor, coordinates day-to-day activities to accomplish the goals of the program. BNI subcontracts much of the work related to FUSRAP and the Maywood site RI/FS-EIS. The following subcontractors will be involved in the Maywood project:

- Thermo Analytical/Eberline (TMA/E) provides health physics and industrial hygiene technicians to support field work. TMA/E personnel perform radiological surveys, radiological and chemical sampling, and radiological sample analysis.

- Roy F. Weston (Weston) provides laboratory services for analysis of chemical samples (typically collected by TMA/E).

- Hydro Group provides drilling services for collection of samples and installation of wells.

- Niagara Mapping and Boundary provides civil survey services to create property drawings, identify property boundaries, and establish grid systems.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENTS

The overall quality assurance objective is to develop and ensure implementation of procedures for field sampling, chain of custody, laboratory analysis, and reporting that will provide legally defensible data. This section defines goals for the quality assurance effort in terms of precision, accuracy, representativeness, completeness, and comparability. Quality assurance objectives can be divided into three categories: analytical requirements, data quality assurance objectives, and sample handling objectives.

3.1 ANALYTICAL REQUIREMENTS

The quality assurance objective for consideration in selecting an appropriate analytical method is that the method detection limits are adequate.

Methods for analysis of chemical, radiological, and engineering/geochemical parameters are shown in Tables 3-1, 3-2, and 3-3. The published detection limits for each method (where appropriate) and method reference numbers are also included.

3.2 DATA QUALITY ASSURANCE OBJECTIVES

Quality assurance objectives for the data collected during the sampling effort consist of the following:

- To ensure that the accuracy of the data collected meets the specific goals for the analytical method used
- To ensure that the precision of the data meets the specific goals for the analytical methods used
- To ensure completeness of the data

Table 3-1

Analytical Methods for Water

Page 1 of 2

Parameter	Analytical Technique	EPA Method No.	Published Method Detection Limit
Total uranium	Fluorometric	Uranium-01[a,b]	0.1 pCi/L[c]
Isotopic thorium	Alpha spectroscopy	Thorium-03[a,b]	0.5 pCi/L[c]
Radium-226	Emanation spectrometry	Radium-03[a,b]	0.1 pCi/L[c]
Radium-228	Liquid beta scintillation	904.0	1.0 pCi/L[c]
Metals[d,e,f]	ICPAES[g]	200.7-CLP-M	Varies
Arsenic[e]	Furnace AA	206.2-CLP-M	0.01 mg/L
Lead[e]	Furnace AA	239.2-CLP-M	0.005 mg/L
Selenium[e]	Furnace AA	270.2-CLP-M	0.005 mg/L
Thallium[e]	Furnace AA	279.2-CLP-M	0.01 mg/L
pH[h]	Electrometric	150.1	--
Chloride	Colorimetric	325.2	1 mg/L
Phosphate	Colorimetric	365.2	0.02 mg/L
Nitrate	Ion chromatography	353.1	0.3 mg/L
Specific conductance[h]	Electrometric	120.1	1 μmho/cm
Dissolved oxygen[h]	Membrane electrode	360.1	
Temperature[h]	Thermometric	170.1	--

[a]Thermo Analytical/Eberline uses laboratory procedures developed by Environmental Measurements Laboratory (EML).

[b]Modified EML procedure to accommodate the water matrix.

[c]Detection is dependent upon sample volume, detector efficiency, etc.

[d]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, zinc, and lanthanides. Arsenic, selenium, thallium, and lead analyses are by furnace atomic absorption (AA).

Table 3-1

(continued)

[e]Samples are prepared for analysis in accordance with procedures outlined in Exhibit D of the CLP-statement of work for inorganics analysis (EPA 1988b).

[f]For boron, lithium, molybdenum, and lanthanides, which are not standard CLP analyses, interference corrections are determined and reported, calibration standards are prepared and a calibration curve determined, initial calibration verification (ICV) and calibration curve verification standards are prepared at a midrange concentration, and a laboratory control sample is prepared by digesting the ICV standard.

[g]ICPAES - Inductively coupled plasma atomic emission spectrophotometry.

[h]Indicator analysis.

Table 3-2

Methods for Analysis of Soil and Sediment

Page 1 of 2

Parameter[a]	Analytical Technique[b]	EPA Method No.
Isotopic uranium	Radiochemical	U-04[c]
Isotopic thorium	Radiochemical	Th-03[d]
Isotopic radium	Radiochemical	Ra-07
Uranium-238	Gamma spectrometry	C-02[c]
Radium-226	Gamma spectrometry	C-02[c]
Thorium-232	Gamma spectrometry	C-02[c]
Metals[e,f]	ICPAES	200.7-CLP-M
Arsenic[f]	Furnace AA	206.2-CLP-M
Lead[f]	Furnace AA	239.2-CLP-M
Selenium[f]	Furnace AA	270.2-CLP-M
Thallium[f]	Furnace AA	279.2-CLP-M
Volatile organics	GC/MS	CLP-SOW[g]
Semivolatile organics	GC/MS	CLP-SOW[g]
Nitrate	Hydrazine reduction	353.1
Chloride	Titrimetric	925.1
Phosphate	Colorimetric	365.2
TCLP	Various	1311
Corrosivity	Electrometric	9045
Reactivity	Titration	9010 & 9030
TPH	Infrared (IR) spectrophotometry	9073
PCBs	GC/EC	CLP-SOW[g]

[a]TCLP - toxicity characteristics leaching procedure; TPH - total petroleum hydrocarbons; PCBs - polychlorinated biphenyls.

[b]ICPAES - Inductively coupled plasma atomic emission spectrophotometry; furnace AA - furnace atomic absorption; GC/MS - gas chromatography/mass spectrometry; GC/EC - gas chromatography/electron capture.

Table 3-2

(continued)

[c]TMA/E uses laboratory procedures developed by Environmental Measurements Laboratory-300 (EML-300).[d]Modified EML procedure to accommodate the matrix.

[e]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lithium, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, zinc, and lanthanides.

[f]Soil samples are prepared for analysis in accordance with procedures outlined in Exhibit D of the CLP-statement of work for inorganics analysis (EPA 1988b).

[g]Analysis is conducted in accordance with the procedures outlined in Exhibit D of the CLP-statement of work for organics analysis (EPA 1988c).

Table 3-3
Engineering/Geotechnical Test Methods[a]

Test	Method[b,c]
Gradation/hydrometer	ASTM D422
Cation exchange capacity	ASTM STP-805
Distribution coefficient	ASTM D4319
Atterberg limits	ASTM D4318
Unit weight (wet/dry)	DOA EM 1110-2-1906
Moisture content	ASTM D2216
Centrifuge moisture equivalent	ASTM D425
Specific gravity	ASTM D854

[a]All analyses will meet industry standard detection limits.

[b]ASTM - American Society for Testing and Materials.

[c]DOA EM - Department of Army Engineer Manual.

- To ensure that the data are representative of the medium/environment sampled
- To ensure the comparability of data sets

3.2.1 Accuracy

Accuracy is the degree of agreement between a measurement (or an average of measurements of the same property) and an accepted reference or true value. Accuracy is a measure of the bias or systematic error in a system.

The accuracy of the analytical method used will be established through analysis of method spikes, matrix spikes, and standard reference materials; these quality control samples are described in Section 9.1.

The goals for accuracy of chemical analyses are those published by the Environmental Protection Agency (EPA) for the methods being used. Table 3-4 provides the recovery limits for organics. The recovery limits will be used to determine accuracy of chemical analyses for the parameters listed. For metals, the range of recovery limits necessary to determine the accuracy of the spike will be 75 percent to 125 percent. The accuracy goal for all radiological analyses and remaining chemical analyses is 90 percent recovery or better.

3.2.2 Precision

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed as a percentage difference between individual results. Precision will be determined from the results of field duplicates, laboratory duplicates, and replicates; these quality control samples are described in Section 9.0.

Table 3-4
Recovery Limits for Organics

Fraction	Matrix Spike Compound	Matrix Spike Recovery Limits Water (%)	Matrix Spike Recovery Limits Soil/Sediment (%)	Relative Percent Difference Water (%)	Relative Percent Difference Soil/Sediment (%)
VOA[a]	1,1-Dichloroethene	61-145	59-172	14	22
VOA	Trichloroethene	71-120	62-137	14	24
VOA	Chlorobenzene	75-130	60-133	13	21
VOA	Toluene	76-125	59-139	13	21
VOA	Benzene	76-127	66-142	11	21
BNAE[b]	1,2,4-Trichlorobenzene	39-98	38-107	28	23
BNAE	Acenaphthene	46-118	31-137	31	19
BNAE	2,4-Dinitrotoluene	24-96	28-89	38	47
BNAE	Pyrene	26-127	35-142	31	36
BNAE	N-Nitroso-di-n-propylamine	41-116	41-126	38	38
BNAE	1,4-Dichlorobenzene	36-97	28-104	28	27
Acid	Pentachlorophenol	9-103	17-109	50	47
Acid	Phenol	12-89	26-90	42	35
Acid	2-Chlorophenol	27-123	25-102	40	50
Acid	4-Chloro-3-methylphenol	23-97	26-103	42	33
Acid	4-Nitrophenol	10-80	11-114	50	50
Pesticide	Lindane	56-123	46-127	15	50
Pesticide	Heptachlor	40-131	35-130	20	31
Pesticide	Aldrin	40-120	34-132	22	43
Pesticide	Dieldrin	52-126	31-134	18	38
Pesticide	Endrin	56-121	42-139	21	45
Pesticide	4,4'-DDT	38-127	23-134	27	50

[a]VOA - volatile organics analysis.

[b]BNAE - base/neutral and acid extractable.

The goals for precision in chemical analyses are those published by EPA for the methodology being used. One method to determine precision as measured for organics is to calculate the relative percent difference of the matrix spike and the matrix spike duplicates; the limits for this method are shown in Table 3-4. The following equation is used to calculate relative percent difference:

$$\text{Relative percent difference} = \frac{|R_1 - R_2|}{(R_1 + R_2)/2},$$

where

R_1 = sample value, and

R_2 = replicate value.

Surrogate spike recovery for organics will also be used to judge precision; recovery limits for this method are shown in Table 3-5. The final measure of precision will be comparison of the relative percent differences of duplicates. For metals and organics, the relative percent difference must be 20 percent or less. The precision goal for all radiological analyses is a 10 percent difference between individual values of duplicate samples and pertains to all radiological analyses.

3.2.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct, normal conditions. For manual sampling and analytical methods, completeness is based on the number of valid samples collected over a specified period.

Table 3-5

Surrogate Spike Recovery Limits

Fraction	Surrogate Compound	Water (%)	Low/Medium Soil (%)
VOA[a]	Toluene	88-110	81-117
VOA	4-Bromofluorobenzene	86-115	74-121
VOA	1,2-Dichloroethane	76-114	70-121
BNAE[b]	Nitrobenzene	35-114	23-120
BNAE	2-Fluorobiphenyl	43-116	30-115
BNAE	p-Terphenyl	33-141	18-137
BNAE	Phenol	10-94	24-113
BNAE	2-Fluorophenol	21-100	25-121
BNAE	2,4,6-Tribromophenol	10-123	19-122
Pesticide	Dibutylchlorendate	24-154	20-150

[a]VOA - volatile organics analysis.

[b]BNAE - base/neutral and acid extractable.

The following equation is used to calculate completeness:

$$\text{Completeness} = \frac{NA_t}{NP_t} \times 100 \ ,$$

where

NA_t = the number of actual valid samples over a given time, t,

and

NP_t = the number of possible samples over a given time, t.

The goal for completeness of radiological analysis is 95 percent for all parameters of all samples.

The objective for compliance of analyses performed by Weston is that 80 percent of the data be usable without qualification. The ability to meet or exceed the completeness objective will be dependent on the nature of samples submitted for analysis.

3.2.4 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent the medium and environment where the samples were obtained. To ensure representativeness, the sampling locations have been selected with a random sampling process; more detail on the sampling locations is provided in the field sampling plans.

3.2.5 Comparability

Comparability expresses the confidence with which one data set can be compared with another. For this investigation, comparability will be ensured through use of EPA-designated reference or equivalent sampling procedures and analytical methods and certified calibration standards.

3.3 SAMPLE HANDLING

The quality assurance objectives for the sample handling portion of the field activities are to verify that decontamination, packaging, and shipping do not introduce variables into the sampling chain that could cause validity of the samples to be questionable. To fulfill these quality assurance objectives, trip, field, and method blank quality control samples will be used; these samples are described in Section 9.1. If analysis of any quality control sample indicates that variables have been introduced into the sampling chain, all samples shipped with the questionable quality control sample will be evaluated for the possibility of contamination.

4.0 SAMPLING PROCEDURES

This section provides a brief overview of sampling procedures, techniques, equipment, and records. For detailed information, see Section 2.0 of the field sampling plans and Table 1-1 of this document.

4.1 SAMPLING PROGRAM OVERVIEW

The sampling program for the Maywood site remedial investigation is presented in detail in the field sampling plans. Table 1-1 summarizes the types and numbers of samples to be collected and the analyses to be performed on each type of sample. Refer to the field sampling plans for a detailed discussion of sampling activities, locations, frequency, and techniques; sample handling and preservation, packaging, and shipping; decontamination procedures; and analytical procedures. The analytical parameters for various media are shown in Table 4-1.

4.2 SAMPLING TECHNIQUES

Soil, water, sediment, and air samples will be collected in accordance with the field sampling plans and EPA's A Compendium of Superfund Field Operations Methods (EPA 1987b). The specific sampling procedures to be followed are identified in the field sampling plans.

Tables 4-2 and 4-3 provide information on preservation methods, holding times, and types of containers needed for the applicable chemical parameters.

Table 4-1

Analytical Parameters for Various Media

Page 1 of 2

Parameter	Soil	Ground-water	Surface Water	Filtered Surface Water	Sediment	Air
Radiological						
Isotopic uranium	O	--	--	--	--	--
Isotopic thorium	O	--	--	--	--	--
Isotopic radium	O	--	--	--	--	--
Thorium-232	O	O	--	--	O	--
Radium-226	O	O	--	--	O	--
Uranium-238	O	O	--	--	O	--
Radon	--	--	--	--	--	O
Thoron	--	--	--	--	--	O
Metals						
ICPAES[a,b]	O	O	O	X	O	--
Lithium	O	O	O	X	O	--
Lanthanides	O	O	O	O	O	--
Mobile Ions						
Phosphate	O	O	O	X	O	--
Chloride	O	O	O	X	O	--
Nitrate	O	O	O	X	O	--
Organics						
Volatile organics	O	--	--	--	--	--
Semivolatile organics	O	--	--	--	--	--
Hazardous Waste						
TCLP metals[c]	O	--	--	--	--	--
TCLP organics	O	--	--	--	--	--
Corrosivity	O	--	--	--	--	--
Reactivity	O	--	--	--	--	--
TPH[d]	O	--	--	--	--	--
Total PCBs[e]	O	--	--	--	--	--

Table 4-1

(continued)

Page 2 of 2

Parameter	Soil	Ground-water	Surface Water	Filtered Surface Water	Sediment	Air
Engineering and Geotechnical						
Gradation/ hydrometer	O	--	--	--	O	--
Cation exchange capacity	O	--	--	--	O	--
Distribution coefficient	O	--	--	--	O	--
Atterberg limits	O	--	--	--	--	--
Specific gravity	O	--	--	--	--	--
Unit weight (wet/dry)	O	--	--	--	--	--
Moisture content	O	--	--	--	--	--
Centrifugal moisture equivalent	O	--	--	--	--	--
Miscellaneous Indicators						
Temperature	--	--	O	--	--	--
pH	--	--	O	--	--	--
Specific conductance	--	--	O	--	--	--
Dissolved oxygen	--	--	O	--	--	--

O - Analysis required.
X - Analysis is contingent on other results.
-- - Analysis not required.

[a]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, and zinc. Analyses for arsenic, selenium, thallium, and lead are by furnace atomic absorption.
[b]ICPAES - inductively coupled plasma atomic emission spectrophotometry.
[c]TCLP - toxicity characteristics leaching procedure.
[d]TPH - total petroleum hydrocarbons.
[e]PCBs - polychlorinated biphenyls.

Table 4-2

Preservatives, Containers, and Maximum Holding Times[a,b,c,d]

Analyte	Matrix/ Treatment[e]	Container	Quantity/Size of Bottles	Maximum Holding Time
Metals[f]	Water/adjust to pH <2 with HNO_3	Polyethylene	1/1 L	180 days
	Soil and sediment	Glass	1/250-ml wide-mouth jar	180 days
TC[g] Metals	Liquid waste/ unpreserved	Polyethylene or glass, amber	1/1-L polyethylene or 950-ml jar	see Table 4-3
	Soil and sediment	Glass, amber	1/950-ml jar	see Table 4-3
TC - VOA	Liquid waste/ unpreserved		2/40-ml VOA	see Table 4-3
	Soil and sediment		1/125-ml VOA	see Table 4-3
TC-BNAE/Pest./Herb.	Water/ unpreserved	Glass, amber	3/950-ml jar	see Table 4-3
	Soil and sediment	Glass, amber	1/950-ml jar	see Table 4-3
Total petroleum hydrocarbons	Soil	Glass, clear	1/125-ml wide-mouth jar	28 days
Dissolved oxygen, pH, and temperature	Water	Polyethylene or glass	1/500-ml wide-mouth jar	On-site analysis
Specific conductance	Water	Polyethylene or glass	1/500-ml jar	On-site analysis
Nitrate, phosphate, chloride	Water	Polyethylene	1/500-ml jar	NO_3 - 48 hours, PO_3 - 48 hours, Cl^- - 28 days
	Soil and sediment	Glass	1/250-ml jar	None
Volatile organics	Soil	Glass vial with Teflon septum	2/120-ml wide-mouth vials	10 days
	Water	Glass vial with Teflon septum	2/40-ml vials	10 days
Semivolatile organics and total PCBs[h]	Soil	Glass, amber	1/500-ml wide-mouth jar	10 days for extractions/ 40 days after extraction
Alpha spectrometry	Soil	Polyethylene	1/500-ml wide-mouth jar	6 months
Gamma spectrometry	Soil	Polyethylene	1/500-ml wide-mouth jar	6 months

Table 4-2
(continued)

[a]American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 17th edition, 1989.

[b]American Society for Testing and Materials, 1985 Annual Book of ASTM Standards, Section 11, Volume 11.02, "Water and Environmental Technology," 1985.

[c]All bottles shipped to the site by Weston for chemical sample collection will be new, certified precleaned bottles purchased from Eagle Pitcher. Analytical results for each bottle shipment are available upon request from Eagle Pitcher.

[d]Holding times for CLP analyses are measured from validated time of sample receipt (VTSR) at the lab. All other holding times are measured from time of collection.

[e]All samples will be shipped to the laboratory at 4°C.

[f]Metals analysis includes inductively coupled plasma atomic emission spectrophotometry, lithium, and lanthanides.

[g]TCLP - toxicity characteristics leaching procedure.

[h]Triple volume is required for QC analyses.

Table 4-3

Toxicity Characteristic Leaching Procedure

Maximum Sample Holding Times

Parameter	Maximum Holding Times (days)			Total Elapsed Time (days)
	Field Collection to TCLP Extraction	TCLP Extraction to Preparative Extraction	Preparative Extraction to Determinative Analysis	
Volatiles	14	NA[a]	14	28
BNAE/Pest./Herb.	7	7	40	54
Mercury	28	NA	28	56
Metals, except mercury	180	NA	180	360

[a]Not applicable.

4.3 EQUIPMENT

Equipment will be identified for sampling, decontamination, and personal protection (as appropriate) and will be made available onsite before field activities begin.

4.4 RECORDS

Information regarding samples collected, measurements taken, and observations of events and conditions that could affect data quality will be recorded during field activities. These records may consist of preformatted data collection forms generally used in the performance of a particular activity. These records are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the data collection process, help qualify data, and refresh the memory of field personnel.

All original data collected in the field are considered permanent records and are recorded with waterproof ink in field notebooks and on sample identification tags, chain-of-custody records, and other data forms. All of these documents are authenticated by date and signature of the originator. Errors are corrected by crossing a single line through the error and entering the correct information. Corrections are initialed and dated by the person making the correction.

5.0 SAMPLE CUSTODY

Identification and documentation of the history of possession of a sample from collection through analysis and ultimate disposition is important to ensure that the validity of the sample has not been compromised. Chain-of-custody procedures provide for sample labeling and tracking reports that contain the following types of information:

- Unique sample identification
- Documentation of specific reagents or supplies that become an integral part of the sample (preservatives, absorbing reagents, filters, etc.)
- Sample preservation methods
- Sample custody logs

The objective of sample custody procedures is to ensure the traceability of a sample from the time it is collected until it (or its derived data) is documented in a report.

5.1 LABORATORY NOTIFICATION OF SAMPLING ACTIVITIES

Weston is subcontracted by BNI to perform chemical analyses for all FUSRAP sites, including the Maywood site. Because the project involves simultaneous work at multiple sites, the subcontract is set up on a unit-price, pay-item basis, with various analyses listed in the subcontract by pay-item number and various options available. The subcontract is updated as necessary.

Before sampling begins, a staff member in the BNI Oak Ridge office obtains a copy of the analytical services notification form and completes the form, with assistance from the BNI/Weston liaison. Figure 5-1 is an example of the completed form. This form is checked by the BNI/Weston liaison to ensure completeness before it is submitted to the laboratory.

WESTON / EDTB

Analytical Services Notification

Bechtel Subcontr 14501-191-SC-205

SIGNATURE OF BECHTEL/WESTON LIAISON: John P. Doe

DATE: 9/9/90

WORK ORDER NUMBER:	SITE:	AREA:	DATA CODE:
999	138	MISS	CH-SOIL

PRIORITY LEVEL	MATRIX	TOTAL NO. SAMPLES	DATE CONTAINERS ARE NEEDED BY	DATE SAMPLES WILL BE RETURNED FOR ANALYSIS
6	SOIL	26	10/9/90	10/18/90

SIGNATURE OF INITIATOR: Jane E. Doe

DATE ORDERED: 9/8/90

DATA TO: JANE E DOE

ELECTRONIC DATA TRANSFER: YES [X] NO [ ]

CHARGE CODE: 138A03333

RESPONSIBLE PERSON AND ADDRESS TO SHIP CONTAINERS TO:

FRANK SAMPLER
BNI
259 MOUNTAIN AVE
MIDDLESEX, NJ 08846

COMMENTS/INSTRUCTIONS:

* FULL CLP PACKAGES REQUIRED

ANALYSES REQUIRED

ITEM	DESCRIPTION
1.1.1	VOA
1.2.1	BNAE
1.7.1	PEST/PCB
5.0	ICPAES
5.36	RARE EARTHS
2.3	As-AA
2.7	Pb-AA
2.10	Se-AA
2.12	Tl-AA

PINK: BECHTEL/WESTON LIAISON

YELLOW: INITIATOR

WHITE: WESTON

Figure 5-1
Completed Analytical Services Form

Upon receipt of the form, the laboratory determines the number of sample containers needed and ships them to the site. A copy of the completed form is sent to field sampling personnel. Generic information is copied to the request for analytical services form (Figure 5-2), including the analyses requested. This process ensures that the correct sample analyses are requested by field personnel and that the correct sample containers (containing all required preservatives) are provided to the field sampling team. Finally, the process provides early notification to Weston of upcoming sampling, thereby allowing them to appropriately stage samples.

5.2 SAMPLE IDENTIFICATION

Each sample submitted for analysis is uniquely identified to ensure timely, correct, and complete analysis for all parameters requested. BNI assigns each task a sequence of sample identification numbers. For example, the sample identifier 138-MP-0001 may be the first number in the sequence for chemical samples taken from the Maywood interim storage pile. The FUSRAP site identifier for Maywood is 138, MP stands for Maywood pile, and 0001 is the first number of the sequence of samples collected from the pile. The sequence continues by a change in only the last four-digit number. The field sampling team is responsible for continuing the sequence. Other pertinent information (e.g., borehole coordinates and sample interval depth) is recorded on the chain-of custody forms. The technical group leader also maintains this information in the field documentation log books. The analytical laboratory reports results with the assigned sample identification number. A chain-of-custody record must accompany each group of samples submitted for analysis.

WHITE: BECHTEL/WESTON LIAISON YELLOW: SAMPLER PINK: WESTON THEN BECHTEL/WESTON LIAISON CANARY: WESTON

WESTON

Request for Analytical Services

Bechtel Subcontr 14501-191-SC-205

WORK ORDER NUMBER:	SITE:	AREA:	DATA CODE:

PRIORITY LEVEL	TOTAL NO. SAMPLES	TOTAL NO. BOXES	SAMPLES IN THIS BOX	DATE SHIPPED	RFW LOT #	RESULTS RECEIVED

SAMPLE NUMBER	BECHTEL ID	DESCRIPTION	MATRIX	DATE COLLECTED	NUMBER OF CONTAINERS

ANALYSES REQUIRED	
ITEM	DESCRIPTION

REASON	RELINQUISHED BY	RECEIVED BY	DATE	TIME

COMMENTS/INSTRUCTIONS:

Figure 5-2
Request for Analytical Services Form

5.3 CHAIN-OF-CUSTODY PROCEDURES

Chain-of-custody procedures are used for all samples collected during field activities. Samples for chemical analysis are handled in accordance with the EPA User's Guide to the Contract Laboratory Program (EPA 1988a).

5.3.1 Field Custody and Transfer of Custody

Samples must be traceable from the time they are collected until they, or their derived data, are documented in a report.

The custody documentation procedure is used for all samples processed through the laboratory to maintain a record of sample collection, transfer between personnel, and shipment and receipt by the laboratory. The chain-of-custody section of the appropriate analytical request form (Figures 5-2 and 5-3) is completed for each sample type after containers have been packed for shipment. Each time samples are transferred to another custodian, signatures of the persons relinquishing the sample and receiving the sample, the reason for relinquishing the sample, and the time and date must be documented. A sample is considered to be in a particular individual's custody if it is:

- In that person's physical possession
- In view of the person who takes possession
- Secured by that person so that no one can tamper with it, or secured by that person in an area to which access is restricted to authorized personnel

Under this definition, the team member who actually collects a sample is personally responsible for that sample until it is properly transferred and documented. The sampling team leader reviews all field activities to confirm that proper custody procedures were

Form 4A.1

TMA/EBERLINE
FIELD SAMPLE COLLECTION FORM
SITE ACTIVITY SAMPLES

Page of

Site WBS _____ Site Name _____ Activity Support (Job) # _____ Sampler(s) _____

Sample ID / Sample Grid Point	Sample Type (1)	Sample Time	Date of Sample	Preserved With	Purpose (2)	Depth cm [ ] ft [ ]	Analysis Required	Remarks

SAMPLE TYPE (1)

Surface Soil	SS	Rad Character	RC
Bias Soil	BS	Verification	VR
Profile Soil	PS	Quality Control	QC
Sediment Silt	SD	Hot Spot	HS
Other	OR	Resample	RS
Vegetation	VE	Background	BG
Ground Water	GW	Routine	RT
Surface Water	SW	Special	SP

Purpose (2)

"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, n.o.s., UN 2910"

CHAIN OF CUSTODY

REASON	RELNQ BY	REC'D BY	DATE	TIME

Recorded By _____

Date/Time _____

No. of Samples in this box ☐

Total No. of samples in this shipment ☐

Total No. of Boxes in this shipment ☐

Shipper: Ship to:

Figure 5-3
Field Sample Collection Form

followed. The handling, packaging, marking, labeling, and shipping of samples are discussed in the field sampling plans.

Whenever samples are split with a facility or government agency, a separate request for analytical services is prepared and marked to indicate with whom the samples are being split. The person relinquishing custody of the samples to a facility or agency must obtain the signature of a designated representative of that facility or agency. The chain-of-custody form must be completed and a copy given to the owner/operator/agent-in-charge. The original form is retained by BNI.

TMA/E routinely uses a field sample collection form (Figure 5-3), which is equivalent to the "chain-of-custody" form. This form is completed for all sample types, and specific procedures are in place for its use. The form contains all pertinent information about samples in the TMA/E laboratory, including sample identification numbers; site name, specific location, surface elevation, and depth at which the sample was taken; date the sample was collected; type and purpose of the sample and analysis required; date the sample was shipped; the names of the person who collected the sample and the TMA/E supervisor; and a chain-of-custody action. Upon receipt of samples in the laboratory, samples are checked and logged into the laboratory tracking system, and a specific laboratory number is assigned to each sample. The field sample collection form is then sent to TMA/E's Oak Ridge project office with laboratory documentation that is used to track the status of all samples.

Several copies are maintained for informational and backup purposes:

Original: Remains with the samples
Copy No. 1: Is retained at the sampling site office
Copy No. 2: Is sent to Oak Ridge during sampling
Copy No. 3: Is sent to the operations coordinator

Data packages also contain a copy of these completed forms for all samples. The TMA/E health physics operational procedures manual contains detailed information about field and laboratory custody of radiological samples.

5.3.2 Laboratory Custody Procedures

A custodian designated by the laboratory accepts custody of the samples and verifies that the information on the labels matches that on the request for analytical services form. The custodian then enters the information from the sample label into the laboratory's sample tracking system. This system uses the sample label number and, in some cases, assigns a unique laboratory number to each sample to ensure that all samples are transferred to the proper analyst(s) or stored in the appropriate secure area.

Chemical samples are distributed to the appropriate analyst(s) as described in Contract Laboratory Program (CLP) procedures. Weston laboratory personnel are responsible for samples from the time they are received until they are depleted or returned to the custodian. A laboratory custody transfer record/lab work request form is shown in Figure 5-4.

For all radiological samples, after analyses and necessary quality assurance checks have been completed in the TMA/E laboratory, the unused portions of the samples and the sample containers (vials and bottles) are retained by BNI until remedial action is complete. As prescribed by FUSRAP protocol, the independent verification contractor will archive approximately 10 percent of the samples for another 5 years (DOE 1986). The samples in this fraction are chosen randomly.

WESTON Analytics Use Only

Custody Transfer Record/Lab Work Request

WESTON

Client

Work Order

Date Rec'd. _____ Date Due _____

RFW Contact

Client Contact/Phone

WA Use Only Lab ID	Client ID/Description	Matrix	Date Collected	Refrigerator#	#/Type Container	Volume	Preservative	ANALYSES REQUESTED →

Matrix:
S - Soil
SE - Sediment
SO - Solid
W - Water
O - Oil
A - Air
WI - Wipe
DS - Drum Solids
DL - Drum Liquids
F - Fish
L - EP/TCLP Leachate
X - Other

Special Instructions:

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time

WESTON Analytics Use Only

Samples Were:
1 Shipped or Hand-Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

COC Record Was:
1 Present Upon Receipt of Samples Y N

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RFW 21-21-001/A-12/88

7-115

Figure 5-4
Custody Transfer Record/Lab Work Request

5.4 EVIDENCE FILES

Evidence files document the remedial investigation activities. These files include the work plan-implementation plan and associated documents, safety and health records, raw field and laboratory analytical data, data reduction calculations, chain-of-custody records, quality control sample data, verified results, drawings, specifications, and reports. As the project management contractor, BNI is responsible for collection, storage, maintenance, and disposition of the files. Evidence files are protected in filing cabinets and by microfilming.

6.0 CALIBRATION PROCEDURES

This section briefly describes calibration procedures for field and laboratory equipment and equipment that is out of calibration, and discusses record keeping for calibration and maintenance activities. Detailed calibration information, including procedures, schedules, and standards, can be found in guidance documents and project procedures used by BNI, TMA/E, and Weston.

6.1 FIELD EQUIPMENT

All equipment and instruments used in the field sampling program will be maintained and calibrated to operate within manufacturers' specifications and to ensure that the required traceability, sensitivity, and precision of the equipment and instruments are maintained. Normally, manufacturers' instructions are followed for calibration, calibration checks, and maintenance. Reference calibration standards are certified to be traceable to the National Institute of Standards and Technology or other acceptable standard, such as laboratory standards prepared using accepted laboratory procedures.

Measuring and test equipment that may be used in the field and require calibration includes, but is not limited to, the following:

- HNu photoionization detector - Model PI-101 with 11.7-eV lamp
- OVA flame ionization detector - Model 138GC
- Electric water level indicator
- Specific conductance meter
- pH/Eh meter
- Explosimeter/O_2 meter

- Gamma scintillometer (Eberline ESP-1 scaler with a SPA-3 probe)
- Alpha scintillation probe (Eberline AC-3)
- Beta-gamma pancake Geiger-Mueller probe (Eberline HP-210)

Detailed information on specific calibration standards and frequency of calibration for this equipment is included in Weston and TMA/E laboratory procedure manuals.

6.2 LABORATORY EQUIPMENT

For chemical analyses, all laboratory analytical equipment is calibrated by the methods and frequencies mandated in the EPA CLP-statement of work. More detail on calibration of laboratory equipment is included in the Weston laboratory quality assurance plan (Weston 1989). For radiological analyses, all laboratory equipment is requalified by analyzing spike samples of known composition. Certified standards are used for all primary calibrations (standards from the National Institute of Standards and Technology are used for most of the primary calibrations). Detailed information on calibration of radiological laboratory equipment is available in TMA/E's quality assurance manual.

6.3 EQUIPMENT OUT OF CALIBRATION

When equipment is found to be out of calibration, an evaluation is performed to determine the validity of measurements made since the last calibration. When instruments are found to be out of calibration, and measurements or tests are suspected to be invalid, such tests or measurements should be repeated. If the data were found to be affected and cannot be repeated, such data will be annotated. The calibration log book or calibration/maintenance file, as appropriate for the instrument in question, is annotated with the results of the evaluation.

6.4 CALIBRATION AND MAINTENANCE RECORDS

A calibration/maintenance file is kept on all equipment used in sampling or field analysis. The file includes the following information for equipment requiring periodic calibration and instruments requiring daily calibration:

- Name of the equipment
- Equipment identification/serial number
- Manufacturer
- Calibration frequency (daily, weekly, monthly, etc.)
- Calibration certifications provided by the manufacturer or other outside agency (periodic calibrations only)
- Date of last calibration and date when next calibration is due
- Manufacturers' operating instructions
- Manufacturers' calibration and maintenance instructions
- Local source for purchase of spare and replacement parts (when applicable)

7.0 ANALYTICAL PROCEDURES

The following sections provide an overview of the analytical procedures used to process samples. For detailed information, see Section 5.0 of the field sampling plans.

7.1 RADIOLOGICAL ANALYTICAL PROCEDURES

Soil, groundwater, surface water, and sediment samples are analyzed by TMA/E for the parameters shown in Table 4-1, using the methods specified in Tables 3-1 and 3-2. Analyses of soil and sediment samples typically are performed by gamma spectroscopy for radium-226, uranium-238, and thorium-232. Analyses of groundwater and surface water samples are performed by radon emanation for radium-226; alpha spectroscopy is usually used to analyze the samples for uranium-238 and thorium-232. In addition, selected samples will be analyzed for isotopic uranium, isotopic radium, and isotopic thorium.

7.2 CHEMICAL ANALYTICAL PROCEDURES

Analytical methods for carrying out the chemical analyses are presented in Tables 3-1 and 3-2. The methods are described in the following sources:

- Methods for Chemical Analysis of Water and Wastes (EPA 1983).

- EPA Contract Laboratory Program, Statement of Work for Inorganics Analysis and EPA Contract Laboratory Program, Statement of Work for Organics Analysis (EPA 1988b, 1988c).

8.0 DATA REDUCTION, VERIFICATION, AND REPORTING

This section presents an overview of data reduction, verification, and reporting procedures for radiological, chemical, laboratory, and field data.

8.1 DATA REDUCTION

Data reduction frequently includes computation of summary statistics and their standard errors, determination of confidence intervals, and testing of hypotheses relative to the parameters analyzed.

8.2 RADIOLOGICAL ANALYTICAL DATA

8.2.1 Procedural Detail

Samples received for analysis will be accompanied by a completed request-for-analysis form or chain-of-custody form detailing requested analyses. Chemists or technicians will perform the analyses at the instruction of the laboratory supervisor using approved analytical procedures.

The chemist or technician will then record the results of analyses in a workbook and detail all procedural modifications, deviations, or problems associated with the analyses.

8.2.2 Data Verification

Upon completion of an analytical procedure, all sample analysis data are subjected to a technical review by BNI. The analytical results are reviewed for precision, accuracy, completeness, and representativeness (see Section 3.1). Upon completion of the review, BNI

either (1) requests another measurement or resolution of questions regarding data quality, or (2) approves the data for inclusion in a final data report. Detailed information on verification of radiological data is available in TMA/E procedures that will be in place for the project.

8.2.3 Final Reporting and Report Archival

Upon successful completion of the validation process, data are examined and evaluated by project personnel and transferred to the central database. Any alteration of data in the central database is documented. Additional data relevant to the sampling episode are added as they become available.

All data generated are compared with relevant and applicable standards to aid in an environmental risk assessment.

8.3 CHEMICAL ANALYTICAL DATA

The purpose of the chemical analytical program is to receive data at a CLP level of quality. Data reports emphasize sample results and quality control. Raw instrument data are neither requested nor received unless full CLP packages are required for the sampling and analysis activities.

8.3.1 CLP Reporting Procedures

Exhibit B of the EPA CLP-statement of work for both inorganics and organics analysis (EPA 1988b, 1988c) is used as guidance for analytical, data reduction, and data reporting procedures to facilitate data validation. Non-CLP analytes are reported in accordance with appropriate EPA procedures.

8.3.2 Organics Data

Data are reported by Weston in a standard format. Target Compound List (TCL) organic compounds are reported on data summary sheets. In addition, the laboratory is required to report a maximum of 30 EPA/National Institutes of Standards and Technology Mass Spectral Library searches for nonpriority pollutant compounds and to tentatively identify and estimate the concentration of 10 volatile fraction peaks and 20 base/neutral and acid extractable (BNAE) fraction peaks.

Each routine analytical services data package includes the following:

- General information and header information, including data narrative and summary
- Organics analysis data sheets
- Surrogate recovery information
- Matrix spike/matrix spike duplicate recovery information
- Method blank summary
- Gas chromatography/mass spectrometry (GC/MS) tuning and mass calibration information
- Initial calibration data
- Continuing calibration data
- Internal standard area summary
- Pesticide evaluation standards summary
- Pesticide/polychlorinated biphenyl(PCB) standards summary
- Pesticide/PCB identification
- Raw data
- Sample shipping logs

8.3.3 Inorganics Data

Each inorganics data package includes the following:

- General information and header information, including data narrative and summary
- Cover page -- inorganics analyses data package
- Inorganics analysis data sheets
- Initial and continuing calibration verification
- Contract-required detection limit standard for atomic absorption (AA) and inductively coupled plasma atomic emission spectrophotometry (ICPAES)
- Blanks
- ICPAES interference check samples
- Spike sample recovery information
- Post-digest spike sample recovery
- Duplicates
- Laboratory control samples
- Standard addition results
- ICPAES serial dilutions
- Instrument detection limits
- ICPAES interelement correction factors
- ICPAES linear ranges
- Preparation logs
- Analysis run logs
- Raw data
- Sample shipping logs

8.3.4 Data Validation

Weston and TMA/E are required to submit the data package to BNI within a prescribed time following receipt of samples. All chemical data generated by Weston using methods specified in the CLP-statement of work are validated using EPA's National Functional Guidelines (EPA 1988d,e). Radiological data generated by TMA/E are reviewed to determine compliance with contractual requirements.

BNI retains all quality assurance/quality control documentation and releases the actual data tabulation, with a cover sheet explaining the reasons for rejecting the data, if applicable. A nonconformance report is issued for rejected data.

8.3.5 Data Processing

For security purposes, site-specific analytical data are placed in permanent storage in a BNI database. Data reviewed by project personnel and transferred to the central database cannot be altered. Additional data pertaining to the sampling episode are entered when they become available.

8.3.6 Data Reduction and Presentation

A set of tables showing only positive results is developed. All data are compared with relevant and applicable standards to aid in an environmental risk assessment of the site. All standards violations are reported, showing sample concentration, type of standard, and the standard value that was exceeded. All data generated are available upon request.

8.3.7 Final Reporting and Report Archival

Upon successful completion of the quality assurance/quality control process, data are submitted in final report form. This report consists of all pertinent sample and project information as originally provided, with sample log-in material. Specific references to analytical notations are also included.

9.0 INTERNAL QUALITY CONTROL

Quality control samples are used to assess data quality in terms of precision and accuracy and to verify that sampling procedures such as chain of custody, decontamination, packaging, and shipping do not introduce variables into the sampling process that could render the validity of the samples questionable.

In addition to using the internal quality control samples described in this section, the TMA/E laboratory participates in collaborative testing and interlaboratory comparison programs. Natural or synthetic samples containing known concentrations of radionuclides are sent to participating laboratories by an independent referee group such as the Quality Assurance Branch, National Radiation Assessment Division, U.S. EPA, Las Vegas, Nevada; the Environmental Measurements Laboratory, U.S. DOE, New York, New York; and the International Atomic Energy Agency, Vienna, Austria. After statistically comparing the data resulting from triplicate analyses of a special standard sample, the degree of analytical validity of the results is reported, and updated performance information is returned to each participant in the interlaboratory programs. These programs enable each laboratory to document precision and accuracy of radioactive measurements, identify instrumental and procedural problems, and compare performance with other laboratories.

The TMA/E laboratory is accredited by the American Association for Laboratory Accreditation; this certification is renewed annually.

Weston's standard practices manual was reviewed by BNI. The laboratory maintains an internal quality assurance program that includes the procedures described below.

For inorganics analyses, the program includes:

- Initial calibration and calibration verification
- Continuing calibration verification
- Reagent blank analyses
- Matrix spike analyses
- Duplicate sample analyses
- Laboratory control sample analyses
- Interlaboratory quality assurance/quality control

For organics analyses, the program includes:

- GC/MS instrumentation for both volatile and semivolatile compounds analysis
- Initial multilevel calibration for each TCL compound
- Matrix spike analyses
- Reagent blank analyses
- Interlaboratory quality assurance/quality control
- Continuing calibration for each TCL compound
- Addition of surrogate compounds to each sample and blanks for determining percent recovery information

Weston analyzes proficiency evaluation samples provided by EPA Region II for analytical parameters of concern to the project. As a CLP laboratory for inorganics analyses, Weston must pass EPA's blind performance evaluation testing each quarter. Technical specifications in BNI's subcontract with Weston specify quality assurance/quality control at or above a level required by the CLP.

Weston participates in programs to certify its laboratory to analyze drinking water, wastewater, and hazardous waste. Weston has certification (or pending certification) in 35 such state programs (including New Jersey). For continued certification, Weston must pass regular performance evaluation testing.

Weston's quality assurance program also includes independent overview by its project quality assurance coordinator who audits program activities quarterly.

Quality control samples are regularly prepared in the field and laboratory so that all phases of the sampling process are monitored.

9.1 QUALITY CONTROL SAMPLES

The nine types of quality controls samples used in this sampling effort are described below.

- Trip Blank: A trip blank (travel blank/transport blank) is a laboratory-grade deionized water sample (acidified to a pH of <2 with 1:1 hydrochloric acid) that is added at the laboratory, shipped to the site (where it remains unopened), and shipped back to the laboratory. Trip blanks are handled and processed in the same manner as other samples. They are identified clearly on sample tags and chain-of-custody records as trip blanks. The frequency for trip blanks is one per day when aqueous volatile organic samples are collected.

  Trip blanks can provide an indication of interferences introduced in the field, during shipment, or in the laboratory. They do not, however, provide information on matrix effects, accuracy, or precision.

- Field Blank: A field blank is a sample of deionized water that proceeds through the sample collection and analysis steps (e.g., automatic samplers and bailers) and some sampling equipment, after the sample collection equipment has been decontaminated. The field blank is handled and treated in the same manner as the other field samples.

  A field blank for analytes that require field filtering should be run through the same filtering apparatus as the sample. Field blanks are analyzed for all radiological parameters, volatile organics, semivolatile organics, PCBs, and all metals.

- Field Duplicate: A field duplicate documents the reproducibility of the analytical results and representativeness of the samples collected. Field duplicates should not be confused with splits or replicates; field duplicates require re-collection of the sample using the same procedures as for the collection of the first sample.

  For groundwater samples, it is not necessary to purge the well a second time; the duplicate is collected immediately after the first sample.

- Method Blank: A method blank (or reagent blank) measures the interferences that may be introduced during laboratory analysis. A method blank is laboratory-grade deionized water that is carried through all steps of an analytical process. Method blanks are analyzed randomly during analysis of a sample batch sequence.

  For soil analyses, a sample may be used as a method blank if previous analyses have established that the soil is not contaminated. Method blanks are also used to establish method detection limits.

- Laboratory Duplicate: A laboratory duplicate (a separate aliquot of a sample received for analysis) indicates the precision of an analytical procedure. Analysis of duplicate samples does not indicate matrix interferences or analytical accuracy. Data from duplicate sample analyses are used to determine analytical precision.

- Method Spike (fortified method blank/blank spike): A blank spike is a method blank to which a known concentration of analyte is added. Analysis of a blank spike provides a measure of analytical precision and accuracy (e.g., percent analyte recovery) and is used to establish analytical accuracy.

- Matrix Spike (fortified field sample): A matrix spike is a field sample to which a known concentration of the analyte of interest is added. Typically, an analyte is added to a sample at approximately 10 times the background concentration or at 2 to 5 times the detection limit of the analyte. Analysis of this sample provides information about the performance of an analytical method relative to a particular sample matrix (e.g., the presence or absence of analytical interferences).

The accuracy and precision of analytical results are determined by analyzing samples (furnished by BNI) and laboratory water blanks. These samples are spiked with known concentrations of the compounds of interest for all parameters for which analyses will be performed (except volatile organics, BNAEs, and PCBs, where surrogates are used).

The amount of spike material recovered from a spiked blank indicates the best result expected from the method. The recovery of these spikes is compared with the accuracy determined from the blank spikes as an indication of matrix effects. The laboratory liaison works with the laboratory quality assurance officer to establish an acceptable deviation range. Matrix spikes falling outside this range are

reanalyzed to determine whether an actual matrix effect is present or whether corrective action is required by the subcontractor.

- Standard Reference Materials: A standard reference material is a sample used to validate a particular analytical procedure. Standard reference materials usually originate from EPA, the National Institute of Occupational Safety and Health, or the National Institute of Standards and Technology.

- Splits: A split is obtained in the field by dividing an original single sample into one or more aliquots. Solid sample splits are prepared by homogenizing an aliquot of the sample large enough for the specified analysis. Each split is carried through the entire extraction and analytical process. Splits are used for performance audits.

9.2 USE OF QUALITY CONTROL SAMPLES

Quality control samples are primarily used to determine whether quality assurance objectives are being met. Table 9-1 lists quality assurance objectives, quality control samples required, and frequency for submitting the quality control samples. Section 12.0 describes assessments used to determine whether quality control objectives are met.

Table 9-1

Quality Control Sample Requirements for Maywood Site Remedial Investigation

QA[a] Objective	Type of Analysis	QC[b] Sample	Frequency
Accuracy	Chemical	Method spike	Meets CLP[c] requirements
		Matrix spike	Meets CLP requirements
		SRMs[d]	Meets CLP requirements
	Radiological	SRMs	5% or 1 minimum of all matrices
Precision	Chemical	Field duplicate	5% or 1 minimum of all matrices
		Laboratory duplicate	Meets CLP requirements
		Replicates	Meets CLP requirements
	Radiological	Field duplicate	5% or 1 minimum of all matrices
Sample handling	Chemical	Trip blank	1 per shipment per matrix (volatiles)
		Field blank	5% or 1 minimum for all matrices
		Method blank	Meets CLP requirements

[a]QA - quality assurance.

[b]QC - quality control.

[c]CLP - Contract Laboratory Program.

[d]SRMs - standard reference materials.

10.0 PERFORMANCE AND SYSTEM AUDITS

10.1 PERFORMANCE AUDITS

Performance audits are conducted regularly during field sampling and data gathering activities to assess the accuracy of the sampling and analysis system. BNI sends blind performance evaluation samples prepared by Environmental Resource Associates to Weston; these samples contain metals, volatile organics, semivolatile organics, pesticides, and PCBs. During the sampling activities, field duplicates and/or splits are prepared at a 5-percent frequency and submitted "blind" to both onsite and offsite laboratories for independent assessment of the precision of analyses. Results are evaluated by the report and data acquisition teams and reported in accordance with project procedures.

10.2 SYSTEM QUALITY ASSURANCE AUDITS

System quality assurance audits are scheduled (usually on a annual cycle) and conducted by BNI quality assurance personnel to verify adherence to field and laboratory procedures and to evaluate the appropriateness and effectiveness of the procedures. Audit team leaders and auditors are trained and certified in accordance with BNI procedures. Technical specialists participate as auditors under the direction of the audit team leader when warranted.

Schedules for conducting audits are coordinated with appropriate management and are indicated on quality assurance planning schedules. Reports are prepared for each audit conducted. Audit findings that require corrective action and followup are documented, tracked, and resolved, as verified by the project quality assurance supervisor. Details are delineated in various BNI corporate standards.

11.0 PREVENTIVE MAINTENANCE

Field equipment used during data and sample collection activities is maintained in accordance with manufacturers' instructions and schedules. Spare parts are kept on hand as necessary. Subcontractors are responsible for developing and implementing maintenance procedures and schedules for field monitoring and laboratory analytical instruments to ensure proper operation and validity and traceability of data.

12.0 DATA ASSESSMENT PROCEDURES

Data obtained using analytical procedures and quality assurance objectives described in Section 3.0, the quality control analysis in Section 9.0, and procedures for reduction and verification of data described in Section 8.0 are assessed based on information presented in the following sections.

12.1 FIELD DATA ASSESSMENT

The procedures used to assess data accuracy and precision are described below.

12.1.1 Accuracy

Spikes and standard reference materials (see Section 9.1) are used to evaluate data accuracy. Analytical results for these samples are reported with laboratory data and are calculated as percent recovery.

$$\text{Percent recovery} = \frac{T}{X} \times 100 \ ,$$

where

T = total concentration found in the spiked sample or standard reference material, and

X = actual spiked concentration added to the sample.

Mean and standard deviation are calculated and plotted on quality control charts. Recovery limits are those provided by EPA for the methods used for chemical analysis, and 10 percent for the methods used for radiological samples. Accuracy is defined in Section 3.2.1 of this document.

12.1.2 Precision

Duplicate samples (see Section 9.1) are used as a relative measure of the precision of sample collection and analysis processes. Precision is defined in Section 3.2.2 of this document. The precision of the data is evaluated by calculation; the relative percent difference, percent ratio, and standard deviation are plotted on quality control charts.

The relative percent difference and percent ratio for the duplicate pairs and the standard deviation of the relative percent differences are calculated for each duplicate pair as follows:

$$\text{Relative percent difference } \frac{|X_1 - X_2|}{\bar{X}} \times 100 ,$$

$$\text{Percent ratio} = \frac{X_1}{X_2} \times 100 ,$$

where

X_1 = concentration of sample 1 of duplicate,

X_2 = concentration of sample 2 of duplicate, and

$\bar{X}$ = mean of samples 1 and 2.

$$S = \sqrt{\frac{\sum (\bar{x}-X)^2}{N-1}} ,$$

(Beyer 1979),

where

S = standard deviation,

N = number of relative percent differences used in calculation,

X = individual calculated relative percent difference value, and

$\bar{x}$ = mean of calculated relative percent differences.

12.1.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount expected to be obtained under correct, normal conditions. Section 3.2.3 describes the method used to calculate completeness.

12.2 LABORATORY ASSESSMENT

The procedures used to assess data accuracy and precision for chemical analyses in the laboratory are those specified in CLP-statement of work. The procedures used to assess data accuracy and precision for the radiological analyses are those described for the field data assessment in Sections 12.1.1 and 12.1.2.

13.0 CORRECTIVE ACTION

The need for corrective action may be identified during review of the data, field investigations and sampling, audits, and health and safety surveillances. Corrective action is required if the correct procedures are not being followed, if contamination is being introduced into the sample chain, or if the data fail to meet the requirements for accuracy, precision, representativeness, completeness, or comparability. Nonconformance reporting is delineated in FUSRAP procedures.

13.1 RESPONSIBLE STAFF

Items identified as requiring corrective action are corrected immediately by the individual who discovers the problem. The problem and the action taken are immediately reported to the site superintendent (for site problems) or the project quality assurance supervisor (for laboratory problems). The BNI project manager ensures that all corrective actions are implemented. The need for corrective action may also be identified during audits.

13.2 CORRECTIVE MEASURES

Corrective measures consist of activities that either resolve questions about the quality of data or supply additional data to replace the questionable data. Corrective measures may consist of independent review of the data, resampling, resurveying, reanalysis, or special audits.

13.3 DOCUMENTATION

If a problem can be immediately resolved and the quality of the affected data is not in question, the problem and corrective action will be noted in a logbook. A nonconformance

report will be issued if the problem cannot be immediately resolved or the quality of the data is questionable. A quality audit finding report will be issued for problems discovered during an audit.

The purpose of the nonconformance report is to document the problem, possible consequences, suggested corrective action, and a schedule for implementing the corrective action. The quality audit finding report serves the same purpose, except that it is generated only as a result of an audit finding.

14.0 QUALITY ASSURANCE REPORTS

Quality assurance activity reports are prepared monthly by the project quality assurance supervisor to document and report the accomplishment and scheduling of system audits, surveillance activities, quality assurance program plan and procedure preparation or revision, indoctrination and training, and other significant activities. Activity reports are issued to the program manager, deputy program manager, BNI manager of quality assurance, and the Oak Ridge quality assurance manager.

Quality assurance management review meetings regarding the status of implementation of the quality assurance program plan are conducted periodically by the project quality assurance supervisor to advise project managers, functional managers, and other interested managers. Management review meetings are conducted to identify quality assurance program accomplishments or items requiring action, to schedule action, to verify action, and to report status. Quality assurance management review meetings are documented in a report of the meeting. Quality assurance reports discussed in this section are delineated in the BNI Quality Assurance Department procedures, Sections 1.0 and 2.0.

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