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 St. Louis Site

St. Louis, Missouri

July 1993

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

ST. LOUIS, MISSOURI

JULY 1993

Prepared for

United States Department of Energy

Oak Ridge Operations Office

Under Contract No. DE-AC05-91OR21949

By

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QUALITY ASSURANCE PROJECT PLAN FOR THE ST. LOUIS SITE ST. LOUIS, MISSOURI

FUSRAP

Bechtel National, Inc.

for

United States Department of Energy

Oak Ridge Operations Office

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St. Louis Site

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St. Louis Site

EPA concurrence is given in EPA 1992.

FOREWORD

A work plan-implementation plan (WP-IP) has been prepared to document the actions and evaluations made during the scoping and planning phase of the remedial investigation/feasibility study-environmental impact statement (RI/FS-EIS) conducted at the St. Louis, Missouri, site. Remedial action at the St. Louis site is being planned as part of the Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program.

Because portions of the St. Louis site are on the Environmental Protection Agency's (EPA) National Priorities List (NPL), the response actions (i.e., removal actions and remedial actions) to be carried out by DOE at the site are subject to review by EPA, the Missouri Department of Natural Resources, and the public under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act. Section 120(a)(1) of CERCLA, as amended, clarified the applicability of CERCLA to hazardous sites owned or controlled by federal departments and agencies; the law requires that remedial actions at hazardous DOE sites must satisfy the requirements of CERCLA. Executive Order 12580 delegated to DOE the authority to conduct CERCLA response actions at sites under its control. Consistent with this order, DOE is the lead agency for remedial actions at the St. Louis site. DOE plans and activities for the site are being overseen by EPA Region VII, and a formal interagency agreement coordinating DOE's and EPA's respective roles has been signed. The major elements of the agreement are described in Subsection 1.4.2 of the WP-IP.

CERCLA requires that an RI/FS be performed to support the evaluation and selection of remedial action alternatives. In addition, DOE activities must be conducted in compliance with the National Environmental Policy Act (NEPA), which requires consideration of the environmental consequences of a proposed action as part of its decision-making process. It is DOE policy to

integrate the requirements of the CERCLA and NEPA processes for remedial actions at sites for which it has responsibility. Under this policy, the CERCLA process is supplemented, as appropriate, to meet the procedural and documentational requirements of NEPA up to and including preparation of an environmental impact statement (EIS) or environmental assessment, as appropriate. The WP-IP (1) summarizes site-specific background and characterization data, (2) identifies the types and amounts of contaminants at the site and presents a conceptual site model that identifies potential routes of human exposure to these contaminants, (3) identifies data gaps and delineates how planned activities will satisfy data needs, and (4) describes the approach that will be used to evaluate potential remedial action alternatives. The WP-IP also includes descriptions of project organization and project controls and delineates schedules for tasks to be performed to fulfill the requirements of both CERCLA and NEPA.

Other plans are developed to direct field investigations to resolve the data gaps identified in the WP-IP. The other plans are the field sampling plan, the quality assurance project plan (QAPjP), the health and safety plan, and the community relations plan. The field sampling plan directs the field work for all radiological, chemical, and geological remedial investigation activities for the St. Louis site. The QAPjP is written in conjunction with the field sampling plan; together they comprise the sampling and analysis plan.

Most of the remedial investigation at the St. Louis site was completed before the site was placed on the NPL; therefore this QAPjP serves two purposes: (1) it summarizes the quality assurance practices that were in effect while work was being completed, and (2) it describes the protocols necessary to achieve the data quality objectives defined for the remaining data collection, sample analysis and validation, and data evaluation activities to be conducted to fill data gaps identified in the WP-IP.

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ACRONYMS

AA	atomic absorption
ASTM	American Society for Testing and Materials
BNAE	base/neutral and acid extractable
BNI	Bechtel National, Inc.
CAR	corrective action request
CCC	continuing calibration compound
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CRP	community relations plan
DI	deionized (water)
DOA EM	Department of the Army Engineer Manual
DOE	Department of Energy
DOE-ORO	Department of Energy Oak Ridge Operations Office
EIS	environmental impact statement
EML	Environmental Measurements Laboratory
EP	extraction procedure
EPA	Environmental Protection Agency
FSP	field sampling plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
GC/MS	gas chromatography/mass spectrometry
HISS	Hazelwood Interim Storage Site
HSP	health and safety plan

ACRONYMS

(continued)

ICPAES	inductively coupled plasma atomic emission spectrophotometry
MCAR	management corrective action report
NCR	nonconformance report
NEPA	National Environmental Policy Act
NPL	National Priorities List
PDCC	project document control center
PCB	polychlorinated biphenyl
PQAS	project quality assurance supervisor
PRP	potentially responsible party
QAF	quality audit finding
QAPjP	quality assurance project plan
QAPmP	quality assurance program plan
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
RPD	relative percent difference
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SLAPS	St. Louis Airport Site
SLDS	St. Louis Downtown Site

ACRONYMS
(continued)

SOW	statement of work
SPCC	system performance check compound
SRM	standard reference material
TCL	Target Compound List
TCLP	toxicity characteristic leaching procedure
TMA/E	Thermo Analytical/Eberline
TOC	total organic carbon
TOX	total organic halides
VOA	volatile organics analysis
WP-IP	work plan-implementation plan
XRF	X-ray fluorescence

UNITS OF MEASURE

°C	degree Celsius (Centigrade)
cm	centimeter
eV	electron volt
g	gram
kg	kilogram
L	liter
µg	microgram
µmhos	micromhos
mg	milligram
ml	milliliter
pCi	picocurie

1.0 PROJECT DESCRIPTION

In 1974, the United States Congress authorized the Atomic Energy Commission, a predecessor agency to the U.S. Department of Energy (DOE), to institute the Formerly Utilized Sites Remedial Action Program (FUSRAP). The objective of FUSRAP, managed by DOE, is to identify, clean up, or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy.

Under FUSRAP, DOE is conducting a comprehensive review and analysis leading to remedial action for a group of properties located in Hazelwood, Berkeley, and St. Louis, Missouri. The properties, collectively referred to as the St. Louis site, are:

- The St. Louis Downtown Site (SLDS) and vicinity properties
- The St. Louis Airport Site (SLAPS) and vicinity properties
- The Latty Avenue Properties [Hazelwood Interim Storage Site (HISS), Futura Coatings, Inc., and vicinity properties]

To select a remedial action to be implemented at the St. Louis site, DOE is conducting 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 St. Louis Site, St. Louis, Missouri (BNI 1993). 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 remaining RI/FS-EIS work at the St. Louis site will be accomplished in accordance with the following plans:

- Work plan-implementation plan (WP-IP)
- Field sampling plan (FSP)
- Quality assurance project plan (QAPjP)
- Community relations plan (CRP)
- Health and safety plan (HSP)

The sampling and analysis plan (SAP) consists of the FSP and the QAPjP. The FSP directs the field work for the remedial investigation of the radiological and chemical contaminants present at the St. Louis site. It contains detailed information about the site and describes the proposed process and studies that will be used to obtain sufficient information to fill the data gaps identified by the WP-IP. The FSP is supported by the QAPjP, which will be used in establishing quality controls during the work at the St. Louis 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 FSP.

1.1 PROJECT OBJECTIVES

Requirements of both the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Environmental Policy Act (NEPA) are being addressed in determining the preferred remedial action alternative for the St. Louis site. The SAP addresses the RI methods to be used. The nature of contaminants present at the site and the degree and extent of contamination will be identified during this investigation. The information obtained from this RI 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 RI, an FS-EIS will be conducted to identify the preferred remedial action.

This QAPjP outlines the quality assurance/quality control (QA/QC) requirements that will be implemented to ensure the defensibility and integrity of analytical data.

1.2 SITE DESCRIPTION

The properties comprising the St. Louis site (SLDS, SLAPS, the Latty Avenue Properties, and numerous vicinity properties) are thoroughly described in the WP-IP (BNI 1993); therefore, they are not described again in this QAPjP.

1.3 DATA COLLECTION OBJECTIVES

Additional data requirements for the RI were identified based on results of previously collected RI data, preliminary identification of applicable or relevant and appropriate requirements and contaminants of concern, development of the conceptual site 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 FSP and the WP-IP for the St. Louis site. The QAPjP provides an overview of quality objectives and quality levels set for field sampling activities. All FUSRAP participants follow specific, detailed project procedures and instructions in accomplishing all field activities. Table 1-1 summarizes the data gap sampling activities to be conducted at the St. Louis 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 Activities and Frequency

Property/Medium[a]	Planned Activity[b]	Approximate Number of Samples/Measurements	Analyses[c]	Analytical Support Level[d]
SLDS				
Soil	Drill boreholes to define horizontal and vertical boundaries of contamination	43	U-238, Ra-226, Th-232, Th-230	III
	Collect background samples in the vicinity of SLDS for chemical analyses	10	VOA, BNAE, Metals	IV
	Analyze archived samples to determine if differential migration of actinium and protactinium is occurring	5	U-235, Th-231, Pa-231, Ac-227, Th-227	III
	Collect samples to determine presence of RCRA waste	30	TCLP total	III
	Collect specific sampling intervals from well borings and deep boring for radiological analyses	31	U-238, Ra-226, Th-230, Th-232	III
	Collect specific sampling intervals from well borings and deep boring for chemical analyses	17	TCLP Total	III
	Collect specific sampling intervals from well borings	16	Hydraulic conductivity, porosity, grain size distribution, moisture content, cohesion, cation exchange capacity	N/A[e]
	Collect specific sampling intervals from 3 well borings for suitability testing W10S, W13S, W16S	6	Suitability testing	N/A
Sediment	Collect sediment samples to determine extent of radioactive contamination in Mississippi River	10	U-238, Ra-226, Th-230, Th-232	III
Drains and Process Lines	Collect debris, sediment, and scale from process lines and drains	160	U-238, Ra-226, Th-232, Th-230	III

Table 1-1
continued

Property/Medium[a]	Planned Activity[b]	Approximate Number of Samples/Measurements	Analyses[c]	Analytical Support Level[d]
Groundwater	Collect background samples in vicinity of SLDS from upgradient well chemical analysis (W01S)	1	VOA, BNAE, Metals	IV
	Collect samples from newly installed wells for chemical analyses	8	VOA, BNAE, Metals	IV
	Collect samples from newly installed wells for radiological analyses	8	Total, U, Ra-226, Th-230, Th-232	III
SLDS Vicinity Properties				
Norfolk & Western Railroad/soil	Drill boreholes to define horizontal boundaries of contamination	25	U-238, Ra-226, Th-232, Th-230	III
	Analyze archived samples to determine vertical boundaries of contamination	18	U-238, Ra-226, Th-232, Th-230	III
St. Louis Terminal Railroad Association/soil	Drill boreholes to define horizontal boundaries of contamination	16	U-238, Ra-226, Th-232, Th-230	III
	Analyze archived samples to determine vertical boundaries of contamination	9	U-238, Ra-226, Th-232, Th-230	III
Chicago, Burlington, and Quincy Railroad/soil	Drill boreholes to define horizontal boundaries of contamination	9	U-238, Ra-226, Th-232, Th-230	III
	Analyze archived samples to determine vertical boundaries of contamination	16	U-238, Ra-226, Th-232, Th-230	III
Thomas & Proetz Lumber Company/soil	Drill boreholes to define horizontal boundaries of contamination	10	U-238, Ra-226, Th-232, Th-230	III
	Analyze archived samples to determine vertical boundaries of contamination	6	U-238, Ra-226, Th-232, Th-230	III
McKinley Iron/soil	Drill boreholes to define horizontal boundaries of contamination	15	U-238, Ra-226, Th-232, Th-230	III

Table 1-1
continued

Property/Medium[a]	Planned Activity[b]	Approximate Number of Samples/Measurements	Analyses[c]	Analytical Support Level[d]
	Analyze archived samples to determine vertical boundaries of contamination	14	U-238, Ra-226, Th-232, Th-230	III
PVO Foods/soil	Drill boreholes adjacent to PVO to determine presence of contamination	4	U-238, Ra-226, Th-232, Th-230	III
SLAPS				
Soil	Collect background samples in the vicinity SLAPS for chemical analyses	10	VOA, BNAE, metals	IV
	Analyze archived samples to determine if differential migration of actinium and protactinium is occurring	5	U-235, Th-231, Pa-231, Ac-227, Th-227	III
	Collect samples to determine presence of RCRA waste	30	TCLP Total	III
	Collect specific sampling intervals from well borings for radiological analyses	15	U-235, Ra-226, Th-230, Th-232	III
	Collect specific sampling intervals from well borings for chemical analyses	10	TCLP Total	III
	Collect specific sampling intervals from well borings for geotechnical analyses	10	Hydraulic conductivity, porosity, grain size distribution, moisture content, cohesion, cation exchange capacity	N/A
	Collect specific sampling intervals from 3 well borings for suitability testing B53W12D, B53W17D, B53W18D	6	Suitability testing	N/A
Groundwater	Collect background samples in vicinity of SLAPS from upgradient well for chemical analysis (B53W20S)	1	VOA, BNAE, Metals	IV
	Collect samples from newly installed wells for chemical analyses	5	VOA, BNAE, Metals	IV
	Collect samples from newly installed wells for radiological analyses	5	Total U, Ra-226, Th-230, Th-232	III

Table 1-1
continued

Property/Medium[a]	Planned Activity[b]	Approximate Number of Samples/Measurements	Analyses[c]	Analytical Support Level[d]
Vegetation	Collect samples for data on assimilation of thorium	6	Th-230	III
HISS and SLAPS Associated Haul Roads and Vicinity Properties				
	Drill boreholes to refine horizontal boundaries of contamination	25	U-238, Ra-226, Th-232, Th-230	III
	Collect specific sampling intervals from borings for radiological analyses	15	U-238, Ra-226, Th-232, Th-230	III
	Collect specific sampling intervals from borings for chemical analyses	10	TCLP Total	III
	Collect specific sampling intervals from well borings for geotechnical analyses	10	Hydraulic conductivity, porosity, grain size distribution, moisture content, cohesion, cation exchange capacity	N/A
	Collect specific sampling intervals from 3 well borings for suitability testing (HISS17S, HISS19S, HISS20S)	6	Suitability testing	N/A
Groundwater	Collect samples from newly installed wells for chemical analyses	9	VOA, BNAE Metals	IV
	Collect samples from newly installed wells for radiological analyses	9	Total U, Ra-226, Th-230, Th-232	III
Surveys	Conduct limited surveys, radon and exposure rate measurements	12	Radon-222, PIC exposure measurement, alpha, beta-gamma, smears, and count rate measurements	N/A

[a]SLDS - St. Louis Downtown Site; SLAPS - St. Louis Airport Site; HISS - Hazelwood Interim Storage Site.

[b]RCRA - Resource Conservation and Recovery Act.

[c]VOA - volatile organic analysis; BNAE - base/neutral and acid extractable; TCLP - toxicity characteristic leaching procedure; PIC - pressurized ionization chamber.

[d]These levels are based on EPA 1987b.

[e]N/A = not applicable.

Table 1-2

Summary of Data Quality Levels Appropriate to Data Uses

Data Uses	Analytical Support Level	Type of Analysis	Limitations	Data Quality
Site characterization, monitoring during implementation	Level 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	Level 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	Level III	Organics/inorganics analysis using EPA or equivalent 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	Level 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	Level 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 1987a.

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; ppm - parts per million; ppb - parts per billion.

It is important to note that this QAPjP is specific for the remaining sampling to be conducted at the St. Louis site. Appendix A provides a description of QA/QC procedures employed during the remedial investigation conducted at the site before the site was placed on the National Priorities List (NPL). This appendix is included for informational purposes only.

Appendix B is a brief summary of the QA evaluation of data collected at the site to date. It provides the data in a site-specific format and includes a brief summary of the review process used for all data collected at the site.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

FUSRAP project organization and responsibilities are described in detail in the WP-IP and FSP. The HSP provides a list of emergency services and assistance agencies, key site personnel, and appropriate telephone numbers. The DOE Oak Ridge Operations Office (DOE-ORO) Former Sites Restoration Division has responsibility for the management and technical direction of the remedial investigation. DOE-ORO has contracted Bechtel National, Inc. (BNI) and Science Applications International Corporation (SAIC) to assist in the performance of FUSRAP. BNI serves as project management contractor, and SAIC serves in an independent role as environmental studies contractor. Oak Ridge National Laboratory and Argonne National Laboratory are also contracted by DOE-ORO to act as technical support contractors.

BNI subcontracts much of the work related to FUSRAP and the St. Louis site RI/FS-EIS. The following subcontractors will be involved in the St. Louis 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 analyses.

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

- Consulting Engineers and Land Surveyors provides civil survey services to create property drawings, identify property boundaries, and establish grid systems.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENTS

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

3.1 ANALYTICAL REQUIREMENTS

The QA objective for consideration in selecting an appropriate analytical method is that the method detection limits must be adequate.

Methods for analyses of chemical, radiological, and engineering/geochemical parameters are shown in Tables 3-1, 3-2, and 3-3. The regulatory or published detection limits for each method (as appropriate) and method reference numbers are also included. Detection limits will meet or exceed those specified by the U.S. Environmental Protection Agency (EPA) in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846), 3rd edition (EPA 1986) or the statements of work (SOWs) [Statement of Work for Inorganics, Multimedia, Multi-Concentration, Document Number ILM0 2.0, and Statement of Work for Organics, Multi-Media, Multi-Concentration, Document Number OLM0 1.0] (EPA 1988b-c).

3.2 DATA QUALITY OBJECTIVES

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

Table 3-1
Analytical Methods for Water

Parameter	Analytical Technique	EPA Method No. Sample Preparation	EPA Method No. Sample Analysis	Sample Size for Analysis	Regulatory/Published Method* Detection Limit
Radiological					
Thorium-230	Alpha spectroscopy	--	Th-01[a]	1 L	0.5 pCi/L*
Thorium-232	Alpha spectroscopy	--	Th-01[a]	1 L	0.5 pCi/L*
Radium-226	Emanation/ scintillation	--	Ra-05[a]	1 L	0.5 pCi/L*
Total uranium	Kinetic phosphorescence analysis	--	--[a]	50 ml	0.03 µg/L*
Metals					
ICPAES metals[b,c]	ICPAES	3010	6010	100 ml	2 - 5000 µg/L[d]
Arsenic	Furnace atomic absorption	7060	7060	100 ml	10 µg/L
Lead	Furnace atomic absorption	3020	7421	100 ml	5 µg/L
Selenium	Furnace atomic absorption	7740	7841	100 ml	5 µg/L
Thallium	Furnace atomic absorption	3020	3020	100 ml	10 µg/L
Mercury	Cold vapor	7470	7470	100 ml	0.2 µg/L
Organics					
Volatile organics	GC/MS*	5030	8240	5 ml	10 µg/L analyte
BNAE[f] organics	GC/MS	3520	8270	1 L	10 µg/L analyte
Miscellaneous Indicators					
Temperature	Thermometric	--	120.1	--	--
pH	Electrometric	--	150.1	--	--
Specific conductivity	Electrometric	--	120.1	--	0.5 µmhos/cm*

Table 3-1
(continued)

Parameter	Analytical Technique	EPA Method No. Sample Preparation	EPA Method No. Sample Analysis	Sample Size for Analysis	Regulatory/Published Method[a] Detection Limit
Level IV (Statement of Work) Parameters					
Organics					
Volatile organics	GC/MS	624CLP-M	624CLP-M	5 ml	10 µg/L
BNAE organics	GC/MS	625CLP-M	625CLP-M	1 L	10 µg/L
Metals					
ICPAES metals	IPCAES	[g]	200.7CLP-M	100 ml	5-5000 µg/L
Arsenic	Furnace atomic absorption	[g]	206.2CLP-M	100 ml	10 µg/L
Lead	Furnace atomic absorption	[g]	239.2CLP-M	100 ml	3 µg/L
Selenium	Furnace atomic absorption	[g]	270.2CLP-M	100 ml	5 µg/L
Thallium	Furnace atomic adsorption	[g]	279.2CLP-M	100 ml	10 µg/L
Mercury	Cold vapor	245.1CLP-M	245.1CLP-M	100 ml	0.2 µg/L

[a]TMA/E uses laboratory procedures developed by Environmental Measurements Laboratory-300 (EML-300)(DOE-1990). EML is currently developing a procedure for kinetic phosphorescence analysis of total uranium.
[b]ICPAES - Inductively coupled plasma atomic emission spectrophotometry.
[c]Includes aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, and zinc.
[d]Range of detection limits.
[e]GC/MS - Gas chromatography/mass spectrometry.
[f]BNAE - base/neutral and acid extractable.
[g]Sample prepared according to methods described in the Statement of Work for Inorganics, Multi-media, Multi-concentration Document Number ILM0 2.0, Exhibit D, Section III (EPA 1988b).

Table 3-2
Analytical Methods for Soil, Sediment, and Vegetation

Parameter	Analytical Technique	EPA Method No. Sample Preparation	EPA Method No. Sample Analysis	Sample Size for Analysis	Regulatory/Published Method* Relative Detection Limit
Radiological					
Thorium-227	Alpha spectrometry	QAP-001[a]	Th-01[a]	1.0 g	0.5 pCi/g*
Thorium-230	Alpha spectrometry	QAP-001[a]	Th-01[a]	1.0 g	0.5 pCi/g*
Thorium-231[b]					
Thorium-232	Gamma spectrometry	QAP-001[a]	C-02[a]	500 g	0.5 pCi/g*
Radium-226	Gamma spectrometry	QAP-001[a]	C-02[a]	500 g	0.5 pCi/g*
Uranium-235	Alpha spectrometry	QAP-001[a]	U-02[a]	1.0 g	0.5 pCi/g*
Uranium-238	Gamma spectrometry	QAP-001[a]	C-02[a]	500 g	5.0 pCi/g*
Actinium-227	Gamma spectrometry	QAP-001[a]	C-02[a]	500 g	5.0 pCi/g*
Protactinium-231[c]					
Metals[d]					
ICPAES metals[d,e]	ICPAES	3050	6010	1-2 g	1-1000 mg/kg
Arsenic	Furnace atomic absorption	3050	7060	1-2 g	2 mg/kg
Lead	Furnace atomic absorption	3050	7421	1-2 g	1 mg/kg
Selenium		3050	7740	1-2 g	1 mg/kg
Thallium		3050	7841	1-2 g	2 mg/kg
Organics					
Volatile organics	GC/MS[f]	5030	8240	Varies depending on level	10 µg/kg
BNAE[g] organics	GC/MS	3550	8270	2-30 g	330 µg/kg
Hazardous Waste					
TCLP[h]	Various	In accordance with 40 CFR 261	1311	100 g + 2 L extraction solution	Less than Maximum Contaminant Level (MCL)

Table 3-2
(continued)

Parameter	Analytical Technique	EPA Method No. Sample Preparation	EPA Method No. Sample Analysis	Sample Size for Analysis	Regulatory/Published Method* Relative Detection Limit
Level IV (Statement of Work) Parameters					
Organics					
Volatile organics	GC/MS	624CLP-M	624CLP-M	Varies depending on level	10 µg/kg
BNAE organics	GC/MS	624CLP-M	624CLP-M	2-30 g	330 µg/kg
Metals					
ICPAES metals	ICPAES	[i]	200.7CLP-M		1-1000 mg/kg
Arsenic	Furnace atomic absorption	[i]	206.2CLP-M		2 mg/kg
Lead	Furnace atomic absorption	[i]	239.2CLP-M		1 mg/kg
Selenium	Furnace atomic absorption	[i]	270.2CLP-M		1 mg/kg
Thallium	Furnace atomic absorption	[i]	279.2CLP-M		2 mg/kg

[a]QAP - TMA/Eberline Corporate Quality Assurance Procedure; modified EML (DOE 1990) procedure to accommodate the matrix.

[b]Because of the short half-life of thorium-231, the assumption is made that thorium-231 is in equilibrium with uranium-235.

[c]Protactinium-231 activity is based on equilibrium of uranium-235 and actinium-227. Based on the equilibrium of these isotopes, either the actinium-227 number is used or an ingrowth calculation is performed to determine the protactinium-231 activity.

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

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

[f]GC/MS - Gas chromatography/mass spectrometry.

[g]BNAE - Base/neutral and acid extractable.

[h]TCLP - toxicity characteristic leaching procedure.

[i]Sample prepared according to methods described in the Statement of Work for Inorganics, Multi-media, Multi-concentration, Document Number ILM02.0, Exhibit D, Section III (EPA 1988b).

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 precision of the data meets the performance criteria specified for the analytical methods used

- To ensure that the accuracy of the data collected meets the performance criteria specified for the analytical method used

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

- To ensure completeness of the data

- To ensure the comparability of data sets

3.2.1 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 analytical results for field duplicates, laboratory duplicates, and replicates; these QC samples are described in Section 9.0.

The goals for precision in chemical analyses are those published by EPA in the statements of work for organics and inorganics (EPA 1988b-c). One method to determine precision as measured for organics is to calculate relative percent difference (RPD) between matrix spikes and matrix spike duplicates; the limits for this method are shown in Table 3-4. The following equation is used to calculate RPD:

Table 3-4
Precision and Accuracy Limits for Analytes

Fraction	Matrix Spike Compound	Matrix Spike Recovery Limits (accuracy) Water (%)	Matrix Spike Recovery Limits (accuracy) Soil/Sediment (%)	Relative Percent Difference Limit (precision) Water (%)	Relative Percent Difference Limit (precision) 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
TCLP[c]	All TCLP parameters	50-150[d]	--	50[d]	--
Metals	19 metals (water)/ 17 metals (soil)	75-125	75-125	20	35
Radio-nuclides		±2 sigma	±2 sigma	±2 sigma	±2 sigma
Field duplicates		N/A	N/A	≤35	≤35

[a]VOA - Volatile organics analysis.
[b]BNAE - Base/neutral and acid extractable.
[c]TCLP - Toxicity characteristic leaching procedure.
[d]Recoveries pertain to leachate.

$$\text{Relative percent difference} = \frac{|D_1 - D_2|}{D_1 + D_2} \times 200$$

where

D_1 = concentration of matrix spike, and
D_2 = concentration of matrix spike duplicate.

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 RPD between duplicates. For metals in soils, the RPD must be 35 percent or less; in water, the RPD must be 20 percent or less. The precision goal for all radiological analyses is a difference of ±2 sigma between individual values from duplicate samples and pertains to all radiological analyses of soil, sediment, water, and vegetation samples. For radiological analyses, a difference of ±3 sigma will be deemed acceptable if ±2 sigma is not achievable, and a note to this effect will be made on the report of analysis.

3.2.2 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 real-time accuracy of the analytical method used will be evaluated through routine analysis of method spikes, matrix spikes, and standard reference materials (SRMs); these QC samples are described in Subsection 9.1.

The goals for accuracy of chemical analyses are those published by 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

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.

metals, matrix spike recoveries will be assessed against a 75 to 125 percent recovery window unless the indigenous concentration in the sample is greater than four times the amount spiked. The accuracy goal for all radiological analyses and remaining chemical analyses is a 10 percent difference between the measured and reference values.

3.2.3 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 FSP.

3.2.4 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. 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 results over a given time, t, and

NP_t = the number of total results over a given time, t.

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

The objective for completeness 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 analyses.

If these completeness goals are not met, data will be evaluated through independent review, or resampling will be initiated.

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 QA objectives for the sample handling portion of the field activities are to verify that decontamination, packaging, and shipping are not introducing variables into the sampling chain that could make the validity of the samples questionable. To fulfill these QA objectives, trip, rinse, and method blank QC samples will be used, as described in Subsection 9.1. If analysis of any QC sample indicates that target analytes or compounds are being introduced into the sampling chain, all samples shipped with that QC 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 FSP and Table 1-1 of this document.

4.1 SAMPLING PROGRAM OVERVIEW

The program for the remaining sampling to fill data gaps at the St. Louis site is presented in detail in the FSP. Table 1-1 summarizes the types and numbers of samples to be collected and the analyses to be performed on each type. Refer to the FSP 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, groundwater, and sediment samples will be collected in accordance with the FSP and EPA's A Compendium of Superfund Field Operations Methods (EPA 1987b). The specific sampling procedures to be followed are identified in the FSP.

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

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.

Table 4-1
Analytical Parameters for Various Media

Parameter	Soil	Groundwater	Sediment
Radiological[a]			
Thorium-230	O	O	O
Thorium-232	O	O	O
Radium-226	O	O	O
Uranium-238	O	---	O
Total uranium	---	O	---
Metals			
ICPAES[b,c]	O	O	---
Organics			
Volatile organics	O	O	---
BNAE[d] organics	O	O	---
Hazardous Waste			
TCLP[e] total	O	---	---
Miscellaneous Indicators			
Temperature	---	O	---
pH	---	O	---
Specific conductivity	---	O	---

O - Analysis required.
--- - Analysis not required.

[a]Includes parameters analyzed for in the environmental monitoring program.

[b]ICPAES - inductively coupled plasma atomic emission spectrophotometry.

Table 4-1

(continued)

[c]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.

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

[e]TCLP - toxicity characteristic leaching procedure.

Table 4-2

Preservatives, Containers, and Maximum Holding Times[a]

Analyte/Test	Matrix	Container	Quantity/Size of Bottles	Storage/ Preservation	Maximum Holding[b] Time
Radionuclides					
U-238, Ra-226	Soil and sediment	Polyethylene	1/500-ml wide-mouth jar	--	None
Th-232, Th-230	Water	Polyethylene	1/gallon cubitainer	HNO_3 to pH<2	6 months
Metals					
ICPAES[c]	Soil and sediment	Glass, amber	1/250-ml wide-mouth jar	4°C	180 days
AA[d]	Soil and sediment	Glass, amber	1/250-ml wide-mouth jar	4°C	180 days
ICPAES	Water	Polyethylene	1/100-ml jar	HNO_3 to pH<2, 4°C	180 days
AA	Water	Polyethylene	1/100-ml jar	HNO_3 to pH<2, 4°C	180 days
Mercury-cold vapor	Water	Polyethylene	1/100-ml jar	HNO_3 to pH<2, 4°C	28 days
Volatile organics	Soil	Glass vial with Teflon septum, sealed caps	2/120-ml wide-mouth vials	4°C	14 days
	Water	Glass vial with Teflon septum, sealed caps	2/40-ml jar vials	HCl to pH<2, 4°C	14 days
Base/neutral and acid extractable organics	Soil	Glass, amber	1/500-ml wide-mouth jar	4°C	7 days for extractions/ 40 days after extraction
	Water	Glass, amber	1000-ml jar	4°C	7 days for extractions/ 40 days after extraction
TCLP[e] (metals, organics), corrosivity, reactivity (sulfide/cyanide)	Soil	Glass, amber	1/500-ml wide-mouth jar	4°C	See Table 4-3
pH and temperature	Water	Polyethylene or glass	1/500-ml wide-mouth jar	--	Onsite analysis
Specific conductivity	Water	Polyethylene or glass	1/500-ml jar	--	Onsite analysis
	Soil and sediment	Glass	1/250-ml jar	--	None
Geotechnical (Gradation/hydrometer, cation exchange capacity, distribution coefficient, Atterberg units, unit weight, moisture content, centrifuge moisture equivalent, specific gravity.)	Soil	Shelby tube	1	Ends sealed with paraffin; tube stood upright.	None

Table 4-2
(continued)

Sources: APHA 1989; ASTM 1985; EPA 1986, 1990.

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

[b]Although EPA has not promulgated holding times for soil samples, all soils shall be assessed against the holding time criteria for water samples.

[c]Inductively Coupled Plasma Atomic Emission Spectrophotometry; includes analysis for aluminum, antimony, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, molybdenum, nickel, potassium, silver, sodium, vanadium, and zinc.

[d]Atomic absorption (furnace) for arsenic, selenium, thallium, and lead.

[e]TCLP - toxicity characteristic leaching procedure.

Table 4-3
Maximum Holding Times for Toxicity
Characteristic Leaching Procedure Samples

Parameter	Maximum Holding Times (days) Field Collection to TCLP Extraction	TCLP Extraction to Preparative Extraction	Preparative Extraction to Determinative Analysis	Total Elapsed Time (days)
Volatile organics	14	N/A[a]	14	28
BNAE[b] organics/ Pesticides/ Herbicides	14	7	40	61
Mercury	28	N/A	28	56
Metals, except mercury	180	N/A	180	360

[a]N/A - Not applicable.

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

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 pre-formatted data collection forms (see Subsection 5.4) 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 chain of custody (history of possession) of a sample from collection through analyses and ultimate disposition 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:

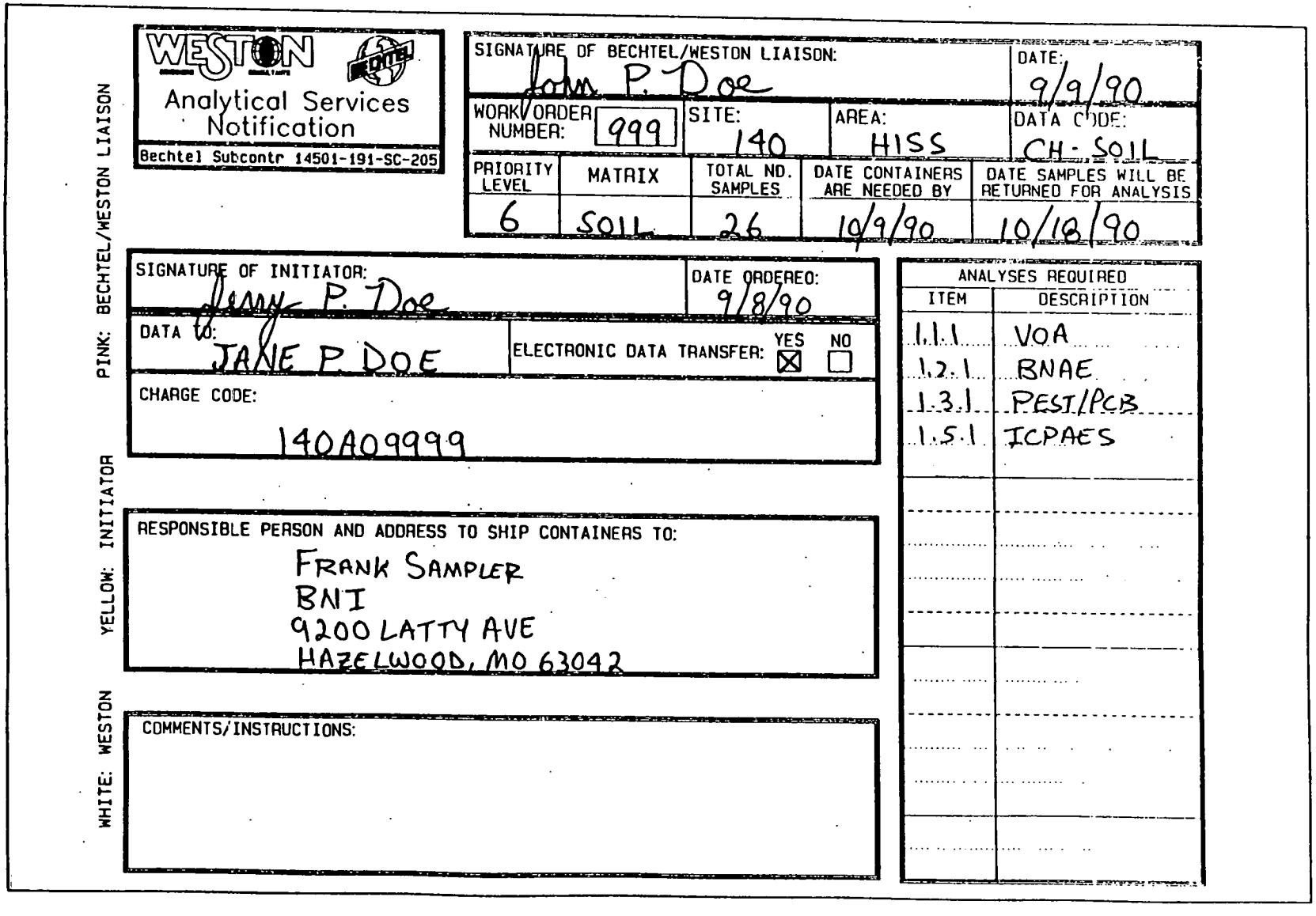
- Unique identification of the sample
- Documentation of specific reagents or supplies that become an integral part of the sample (preservatives, absorbing reagents, filters, etc.)
- Sample preservation methods
- Sample custody logs

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 St. Louis site.

Before chemical 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. The form is checked by the BNI/Weston liaison to ensure completeness before it is submitted to the laboratory. Upon receipt of the form, the laboratory determines the number of sample



WESTON / BECHTEL

Analytical Services Notification

Bechtel Subcontr 14501-191-SC-205

PINK: BECHTEL/WESTON LIAISON
YELLOW: INITIATOR
WHITE: WESTON

SIGNATURE OF BECHTEL/WESTON LIAISON: John P. Doe — DATE: 9/9/90

WORK ORDER NUMBER: 999 — SITE: 140 — AREA: HISS — DATA CODE: 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 P. Doe — DATE ORDERED: 9/8/90

DATA TO: JANE P DOE — ELECTRONIC DATA TRANSFER: YES ☒ NO ☐

CHARGE CODE: 140A09999

RESPONSIBLE PERSON AND ADDRESS TO SHIP CONTAINERS TO:

FRANK SAMPLER
BNI
9200 LATTY AVE
HAZELWOOD, MO 63042

COMMENTS/INSTRUCTIONS:

ANALYSES REQUIRED

ITEM	DESCRIPTION
1.1.1	VOA
1.2.1	BNAE
1.3.1	PEST/PCB
1.5.1	ICPAES

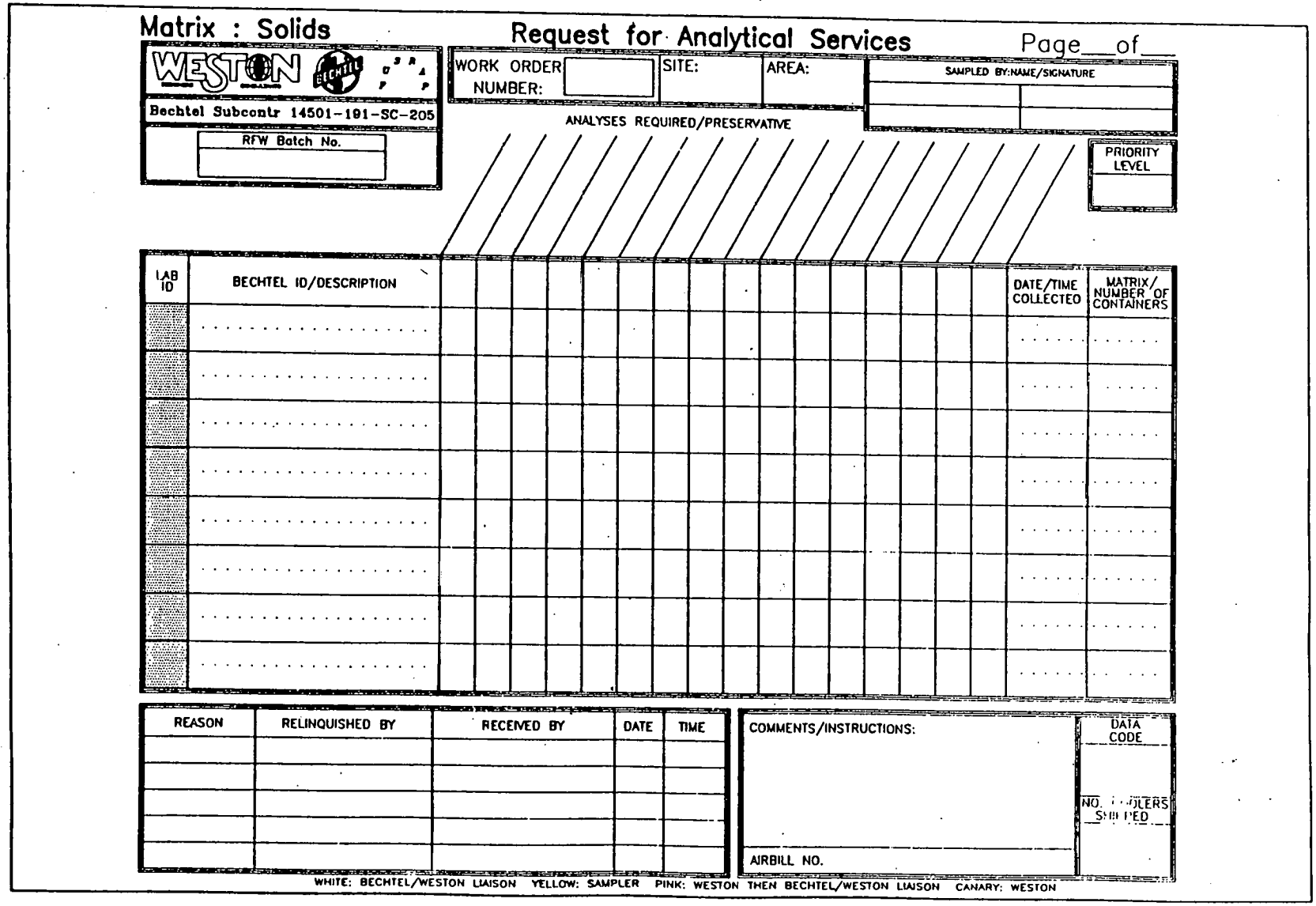
Figure 5-1
Completed Analytical Services Notification Form

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 sample analyses.

Radiological analyses are performed under a subcontract with TMA/E, which maintains a dedicated Oak Ridge FUSRAP staff. A member of this staff participates on the St. Louis project team on a day-to-day basis. Requests for upcoming analyses are coordinated with the TMA/E analytical laboratories through the Oak Ridge TMA/E FUSRAP staff. The St. Louis project team member for TMA/E also coordinates with the field sampling crew to provide needed supplies and support.

5.2 SAMPLE IDENTIFICATION

Each sample submitted for analyses is uniquely identified to ensure timely, correct, and complete analyses for all parameters requested. BNI assigns each task a sequence of sample identification numbers. Other pertinent information (e.g., borehole coordinates and sample interval depth) is also recorded on the chain-of-custody forms. This information is also maintained by the technical group leader in the field documentation log books. The analytical laboratory reports results with the assigned sample identification number. A chain-of-custody record accompanies each group of samples submitted for analyses.



Matrix : Solids

Request for Analytical Services Page__of__

WESTON BECHTEL D'APPOLONIA

Bechtel Subcontr 14501-191-SC-205

RFW Batch No.

WORK ORDER NUMBER:

SITE:

AREA:

SAMPLED BY:NAME/SIGNATURE

ANALYSES REQUIRED/PRESERVATIVE

PRIORITY LEVEL

LAB ID	BECHTEL ID/DESCRIPTION	DATE/TIME COLLECTED	MATRIX/ NUMBER OF CONTAINERS

REASON	RELINQUISHED BY	RECEIVED BY	DATE	TIME

COMMENTS/INSTRUCTIONS:

DATA CODE

NO. [illegible] SHIPPED

AIRBILL NO.

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

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 analyses 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

TMA/EBERLINE
FIELD SAMPLE COLLECTION FORM
SITE ACTIVITY SAMPLES

Form 4A.1

Page of

Site WBS 140 Site Name HISS Activity Support (Job) # B999 Sampler(s) A. BBBBB

Sample ID / Sample Grid Point	Sample Type (1)	Sample Time	Date of Sample	Preserved With	Purpose (2)	Depth cm [ ] ft [x]	Analysis Required	Remarks
2169106 752196 140HS0001	SS	0800	9/19/90	N/A	RC	0-1	U-238, RA-226, TH-230	BOREHOLE B0023
2169106 752196 140HS0002	PS	0810				1-2		
2169106 752196 140HS0003		0815				2-3		
2169106 752196 140HS0004		0825				3-4		
2169106 752196 140HS0005		0835				4-5		
2169106 752196 140HS0006		0840				5-6		
2169106 752196 140HS0007		0845				6-7		

SAMPLE TYPE (1)

		Purpose (2)	
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

"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
PACK & SHIP	E.FFFF	G.HHHH	9/19/90	1600
ANALYSIS	G.HHHH	FED X	9/19/90	1700

Recorded By CC.DDDD
Date/Time 9/19/90/0900
No. of Samples in this box 7
Total No. of samples in this shipment 7
Total No. of Boxes in this shipment 1

Shipper: Ship to:

Figure 5-3
Field Sample Collection Form

reviews all field activities to confirm that proper custody procedures were followed. The handling, packaging, marking, labeling, and shipping of samples are discussed in the FSP.

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. Specific procedures are in place for use of this form, and it is completed for all sample types. The form contains all pertinent information about samples in the TMA/E laboratory, including sample identification number; site name, specific location, surface elevation, and depth at which the sample was collected; 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. When samples are received in the laboratory, they 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 the BNI Oak Ridge office during sampling
Copy No. 3:	Is sent to the operations coordinator

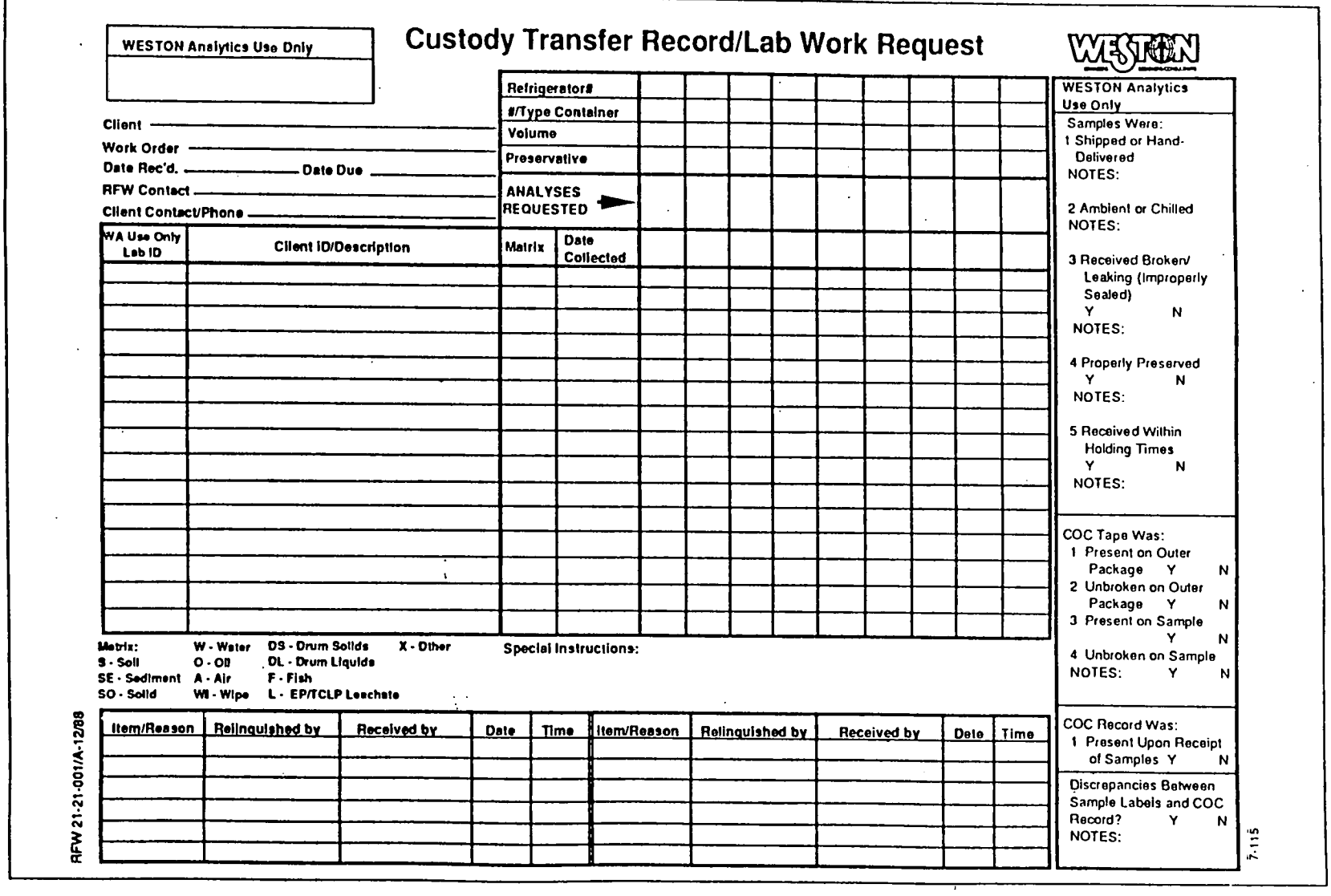
Data packages also contain copies of these completed forms for all samples. The TMA/E health physics operational procedures manual contains detailed information regarding field and laboratory custody of radiological samples.

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 the samples from the time they are received until they are depleted or returned to the custodian. A laboratory custody transfer record/laboratory work request form is shown in Figure 5-4.

For radiological samples, after all analyses and necessary QA 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 5 years after certification that the property is radiologically clean (DOE 1986). The samples to be archived 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:
W - Water
S - Soil
O - Oil
SE - Sediment
A - Air
SO - Solid
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 RI activities. These files include the WP-IP and associated documents, safety and health records, raw field and laboratory analytical data, data reduction calculations, chain-of-custody records, QC 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. A project document control center (PDCC) is maintained at the BNI office in Oak Ridge, Tennessee, to carry out this responsibility. Each document is assigned a unique file number that is entered into the PDCC computerized database for rapid identification and retrieval of the document. All documents are protected in filing cabinets and by microfilming. This system ensures that no documents are lost or misplaced and provides for the maintenance of the evidence files.

6.0 CALIBRATION PROCEDURES

This section briefly describes calibration procedures for field and laboratory equipment, addresses 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. Manufacturers' instructions are followed for calibration, calibration checks, and maintenance. Reference calibration standards used are certified traceable to the National Institute of Standards and Technology or other acceptable standards such as laboratory standards prepared using approved laboratory procedures. Instrument operability and calibration are verified by the user before the instrument is used. Instrument checklists, calibration badges, and logbooks are employed to document and indicate that instruments are properly maintained and calibrated.

Field equipment that requires 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/Oxygen 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 Test Methods for Evaluating Solid Waste (SW-846) (EPA 1986). More detail on calibration of laboratory equipment is included in the Weston laboratory quality assurance plan (Weston 1989). For radioloqical 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; it is maintained at the site by technicians and verified by site supervision. 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 (for 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 subsections provide an overview of the analytical procedures used to process samples. For detailed information, see Section 5.0 of the FSP.

7.1 RADIOLOGICAL ANALYSIS PROCEDURES

Soil, groundwater, and sediment samples are analyzed by TMA/E for the radiological 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 and by kinetic phosphorescence analysis for total uranium. Analyses of groundwater samples are performed by radon emanation for radium-226 and alpha spectroscopy for thorium-232.

7.2 CHEMICAL ANALYSIS PROCEDURES

Analytical methods for carrying out the chemical analyses are presented in Tables 3-1 and 3-2. The methods are described in Methods for Chemical Analysis of Water and Wastes (EPA 1983) and Test Methods for Evaluating Solid Waste (SW-846) (EPA 1986). Level IV analyses will be conducted in accordance with the statements of work for organics and inorganics (EPA 1988b-c).

7.3 ENGINEERING/GEOTECHNICAL PROCEDURES

Methods used for engineering and geotechnical parameters are presented in Table 3-3. These methods are designed to be consistent with standards promulgated by the American Society for Testing and Materials (ASTM) and the Department of the Army.

8.0 DATA REDUCTION, VERIFICATION, AND REPORTING

This section presents an overview of data reduction, verification, and reporting procedures for radiological and chemical 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 related to the parameters analyzed.

8.2 RADIOLOGICAL ANALYTICAL DATA

8.2.1 Procedural Detail

Upon receipt of samples for analyses (accompanied by a completed request-for-analysis form and/or chain-of-custody form specifying the analyses to be performed), chemists and/or technicians perform the analyses (at the instruction of the laboratory supervisor) using approved analytical procedures.

The chemist/technician then records the results of analyses in the parameter workbook and details all procedural modifications, deviations, or problems associated with the analyses.

8.2.2 Data Validation

Upon completion of an analytical procedure, all resulting data are subjected to a technical review by BNI. The analytical results are reviewed for precision, accuracy, representativeness, completeness, and comparability (see Subsection 3.2). 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 BNI 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.

8.3 CHEMICAL ANALYTICAL DATA

Data reports emphasize analytical results and quality control. Raw instrument data are neither requested nor received except where full CLP packages are required for sampling and analyses. For the St. Louis data gap sampling effort, CLP packages will be required for all chemical analyses specified at a data quality objective of Level IV.

8.3.1 CLP Reporting Procedures

Exhibit B of the EPA CLP-SOW for both organics and inorganics analyses (EPA 1988b-c) is used as guidance for analytical and 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 CLP format. The laboratory is required to report a maximum of 30 EPA/National Institutes of Health 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 CLP 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 with associated system performance check compound (SPCC) and continuing calibration compound (CCC) information
- Continuing calibration data with associated SPCC and CCC information
- 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-digestion 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 CLP-SOW methods are validated using BNI procedures consistent with the functional guidelines for evaluating inorganics/organics analyses (EPA 1988a). Radiological data generated by TMA/E are reviewed to determine compliance with contractual requirements.

BNI retains all QA/QC documentation and releases the actual data tabulation, with a cover sheet explaining the reasons for rejecting the data, if applicable.

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 are protected from alteration. Additional data pertaining to the sampling episode are entered when they become available.

8.3.6 Data Reduction and Presentation

A set of data tables showing sampling results is generated. All measurements exceeding standards are reported to DOE and all appropriate federal, state, and local agencies, showing sample concentration, type of standard, and the standard value that was exceeded. All data generated are available upon request.

9.0 INTERNAL QUALITY CONTROL

QC 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 are not introducing variables into the sampling chain that could render the validity of the samples questionable.

In addition to using the internal QC 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 a statistical comparison of the data resulting from triplicate analyses of a special standard sample is performed, 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 has been approved for accreditation by the American Association for Laboratory Accreditation; this certification is renewed annually. A copy of the current accreditation, as well as performance evaluation results, is maintained on file at the BNI Oak Ridge office.

Weston's standard practices manual was reviewed and accepted by BNI. The laboratory maintains an internal QA 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 QA/QC

For organics analyses, the program includes:

- Initial multilevel calibration for each TCL compound
- Matrix spike analyses
- Reagent blank analyses
- Interlaboratory QA/QC
- Continuing calibration for each TCL compound
- Addition of surrogate compounds to each sample and blanks for determining percent recovery information

Weston participates in federal and state programs for certification to analyze drinking water, wastewater, and/or hazardous waste. Weston has certification (or pending certification) in 35 such state programs. For continued certification, Weston must pass regular performance evaluation testing.

Weston's QA program also includes independent overview by its project QA coordinator and a corporate vice president who audits program activities quarterly.

QC 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 QC samples used in this sampling effort are described below.

- Trip Blank: A trip blank (travel blank/transport blank) is a laboratory-grade deionized (DI) 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 collection 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.

- Rinse Blank: A rinse blank is a sample of DI 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 rinse blank is handled and treated in the same manner as the other field samples.

  Rinse blanks are analyzed for all radiological parameters, volatile organics, semivolatile organics, and all metals.

- Field Duplicate: A field duplicate documents the precision of analytical results. Field duplicates should not be confused with splits; field duplicates require recollection

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 DI water that is carried through all steps of an analytical process. Method blank(s) are analyzed randomly during analysis of a sample batch sequence.

  For soil analyses, a weight of water equivalent to the weight of samples used is prepared and analyzed with associated samples and is evaluated for the presence of interferents or contaminants.

- 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 evaluate analytical precision. The limits to be applied during assessment are given in Table 3-4.

- Method Spike (fortified method blank/blank spike): A blank spike is a method blank to which a known concentration of analyte(s) 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. Method spike applies only to metals analytes. The associated recovery criterion is ±20 % of the known value.

- Matrix Spike (fortified field sample): A matrix spike is a field sample to which a known concentration of the analyte(s) 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 which analyses will be performed (i.e., 19 metals, 5 volatile organics, 11 BNAEs, and 6 pesticides/PCBs). The limits for recovery are given in Table 3-4. Surrogates are used for all samples, blanks, and standards that are analyzed for organics.

- Standard Reference Materials: An SRM is a standard used to validate a particular analytical procedure. SRMs usually originate from EPA, the National Institute of Occupational Safety and Health, or the National Institute of Standards and Technology. SRMs are used as measures of both accuracy and precision.

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

QC samples are used primarily to determine whether QA objectives are being met. Table 9-1 lists QA objectives in the form of QC samples required and frequency for submitting the QC samples. Section 12.0 describes assessments performed to determine whether QC objectives are met. See Table 3-4 for data quality objectives.

Table 9-1
Quality Control Sample Requirements for the St. Louis 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
		SRMs	Meets CLP requirements
	Radiological	Field duplicate	5% or 1 minimum of all matrices
		SRMs	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 to Weston; these samples contain metals, volatile organics, semivolatile organics, pesticides, and PCBs. Twice each month during the sampling activities, field duplicates and/or splits are prepared and submitted "blind" to both on-site and off-site laboratories for independent assessment of the precision of analyses. Results are evaluated by the BNI laboratory liaison and/or designee and reported in accordance with project procedures.

10.2 SYSTEM QUALITY ASSURANCE AUDITS

System QA audits are scheduled (usually on a annual cycle) and conducted by BNI QA 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 QA planning schedules. Audit reports are prepared for each audit conducted. Audit findings that require corrective action and follow-up are documented, tracked, and resolved, as verified by the project quality assurance supervisor (PQAS). Details on the processing of audit findings 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. Instruments requiring service are sent to TMA/E Oak Ridge. Instrument repair and maintenance records are maintained at the TMA/E Oak Ridge facility. Subcontractors are responsible for developing and implementing maintenance procedures and schedules for field monitoring and laboratory analytical instruments to ensure their proper operation and the validity and traceability of data.

12.0 DATA ASSESSMENT PROCEDURES

Data obtained using analytical procedures and QA objectives described in Section 3.0, the QC analyses 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. Data assessment will be in accordance with the functional guidelines for evaluating inorganic and organic analyses (EPA 1988d-e).

12.1 FIELD DATA ASSESSMENT

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

12.1.1 Accuracy

SRMs and spikes (see Subsection 9.1) are used to evaluate the accuracy of data. Analytical results for these samples are reported with laboratory data and are calculated as percent recovery.

$$\text{SRM percent recovery} = \frac{T}{SA} \times 100 ,$$

$$\text{Matrix spike percent recovery} = \frac{(SSR - SR)}{SA}$$

where

T = total concentration found in the SRM,

SSR = spiked sample result (concentration found in the spiked sample),

SR = sample result (concentration found in the unspiked sample), and
SA = actual spiked concentration added to the sample.

Spike and SRM results are compared against accepted recovery criteria, and the associated data are then appropriately qualified. Accepted recovery criteria for chemical analyses are specified by EPA analytical methods (see Table 3-4) and are ±2 sigma from the mean activity or from reference activity, as applicable, for radiological analytical methods. Accuracy is defined in Subsection 3.2.2 of this document.

12.1.2 Precision

Duplicate samples and SRMs (see Subsection 9.1) are used to provide a relative measure of the precision of sample collection and analyses processes. Precision is defined in Subsection 3.2.1 of this document. The acceptability of data precision is determined by evaluation of RPD, percent ratio, and standard deviation. Control charts plotting these parameters are employed to monitor sampling and analytical performance. Control charts will use the limits established in Table 3-4. After review of the precision parameters, associated data are appropriately qualified.

The RPD and percent ratio for the duplicate pairs are calculated for each duplicate pair as follows:

$$\text{Relative percent difference} = \frac{X_1 - X_2}{\overline{X}} \times 100$$

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

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.

Standard deviation of the RPDs is calculated as follows (Beyer 1979):

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

where

S = standard deviation,

N = number of RPDs used in calculation,

X = individual calculated RPD value, and

$\bar{x}$ = mean of calculated RPDs.

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. Subsection 3.2.3 describes the method used to calculate completeness.

12.2 LABORATORY ASSESSMENT

The procedures used to assess accuracy and precision of data resulting from chemical analyses in the laboratory are those specified in SW-846 (EPA 1986). The procedures used to assess

accuracy and precision of data resulting from the radiological analyses are those described in Subsections 12.1.1 and 12.1.2. for the field data assessment.

13.0 CORRECTIVE ACTION

Conditions that adversely affect the quality or integrity of data are identified promptly and corrected as soon as practicable. Controls have been implemented for identifying, documenting, evaluating, and correcting identified quality problems.

The need for corrective action may be identified during review of data, field investigations and sampling, audits, and environmental health and safety surveillances. Corrective action will be taken if defined procedures are not being followed; if contamination is being introduced into the sample chain; if the data fail to meet the requirements for precision, accuracy, representativeness, completeness, or comparability; or if the quality of data is otherwise found to be unacceptable or indeterminate.

13.1 RESPONSIBILITIES

Any individual who discovers a condition that could adversely affect the quality or integrity of data must promptly initiate the corrective action process. The PQAS is in charge of all corrective actions.

13.2 CORRECTIVE ACTIONS

Corrective actions are activities that resolve questions about the quality of the data or supply replacement data. Based on predetermined limits for acceptability of data, corrective actions may call for resampling, independent review of the data, resurveying, reanalysis of samples, and/or auditing laboratory procedures.

To ensure appropriate and complete resolution of the problem, established procedures will be followed when corrective actions are being performed. Procedures for performing corrective action

specify the use of one or more of the following integrated methods: performance of an independent data review, completion of a nonconformance report (NCR), completion of a corrective action request (CAR), and completion of a management corrective action report (MCAR).

13.2.1 Independent Data Review

Environmental technology specialists will examine and evaluate data specific to their tasks and specialties. The reviewer will use a pre-established checklist applicable to the review task to examine the data for acceptability. If the reviewer identifies any anomalies, the data will be subjected to additional independent review to determine whether the data may be used and/or whether an NCR should be prepared. This review and the resulting actions are recorded in accordance with the controlling procedure and retained in project records.

13.2.2 Nonconformance Report

If results of the documented independent review indicate that the data are unacceptable, an NCR will be initiated. The NCR is prepared in accordance with the controlling procedure and forwarded to the appropriate technical organization for dispositioning. When appropriate, the disposition should also address ways to prevent or minimize recurrence of the problem. NCRs are retained in project records.

13.2.3 Corrective Action Request

CARs are initiated as a result of surveillances and audits of data collection and analysis activities. CARs are issued and controlled to provide a documented mechanism for identifying programmatic issues that affect data quality. The CAR process

requires that any cited nonconformances be remediated and that measures to prevent recurrence of the problem be identified. When the problem is determined to be significant, the CAR will also include a root cause analysis to ensure that the corrective actions taken are appropriate. CARs are retained in project records. The PQAS is responsible for ensuring that appropriate corrective actions are performed.

13.2.4 Management Corrective Action Report

MCARs are initiated as a result of surveillances and audits of data collection and analysis activities. MCARs are used to report conditions that require the attention, involvement, and awareness of off-project management or that may become reportable to a regulatory agency. The MCAR provides a documented mechanism to achieve review by the most senior level of management when determined necessary. MCARs are retained in project document records.

14.0 QUALITY ASSURANCE REPORTS

QA activity reports are prepared monthly by the PQAS to document and report the accomplishment and scheduling of system audits, surveillance activities, preparation or revision of quality assurance program plans (QAPmP) and procedures, indoctrination and training, and other significant activities. QA activity reports are issued to the program manager, deputy program manager, BNI manager of QA, and the Oak Ridge QA manager.

QA management review meetings regarding the status of implementation of the QAPmP are conducted periodically by the PQAS to advise project managers, functional managers, and other interested managers. Management review meetings are conducted to identify quality program accomplishments or items requiring action, to schedule action, to verify action, and to report status. Each QA management review meeting is documented in a report of the meeting. QA reports discussed in this section are delineated in the BNI Quality Assurance Department procedures, Sections 1.0 and 3.0.

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APPENDIX A
OVERVIEW OF QA PRACTICES
DURING PREVIOUS CHARACTERIZATION WORK
AT THE ST. LOUIS SITE

INTRODUCTION

As part of the quality assurance project plan (QAPjP) for the St. Louis site, and based on discussions with the Environmental Protection Agency, DOE has agreed to provide, for informational purposes, a comparison of previous quality assurance (QA) practices with the procedures defined for the current QA program. Table A-1 summarizes past QA practices and current QAPjP requirements. This appendix provides a brief overview of the QA practices in effect during early characterization efforts at the St. Louis site.

It should be noted that in the early stages of the FUSRAP program the primary goal of the project was to locate and clean up only radioactive contamination. DOE has since expanded the program to include any chemicals that are mixed with radioactive waste or that can be linked directly to MED activities. Another factor that led to modifications in the QA program was the placement of the St. Louis Airport Site (SLAPS) and the Latty Avenue Properties on the National Priorities List in October 1989. This appendix follows the format of the QAPjP and documents any major differences between previous QA practices and the current QA program presented in the body of the QAPjP. The text of the QAPjP is referenced for those parts of the program that have not changed significantly since initiation of work at the St. Louis site in 1982.

Table A-1

Comparison of Past QA Practices

and Current QAPjP Requirements

	Appropriate QAPjP Section	Past Practices Consistent with Current QAPjP Requirements	Past Practices Differ from Current QAPjP Requirements
1.0	Project Description	X	
1.1	Project Objectives		X
1.2	Site Description	X	
1.3	Data Collection Objectives		X
2.0	Project Organization and Responsibilities	X	
3.0	Quality Assurance Objectives for Measurements	X	
3.1	Analytical Requirements	X	
3.2	Data Quality Assurance Objectives	X	
3.2.1	Accuracy	X	
3.2.2	Precision	X	
3.2.3	Completeness	X	
3.2.4	Representativeness	X	
3.2.5	Comparability	X	
3.3	Sample Handling	X	
4.0	Sampling Procedures	X	
4.1	Sampling Program Overview	X	
4.2	Sampling Techniques	X	
4.3	Equipment	X	
4.4	Records	X	
5.0	Sample Custody	X	
5.1	Laboratory Notification of Sampling Activities	X	
5.2	Sample Identification		X
5.3	Chain-of-Custody Procedures		X
5.3.1	Field Custody and Transfer of Custody		X
5.3.2	Laboratory Custody Procedures		X
5.4	Evidence Files	X	
6.0	Calibration Procedures	X	
6.1	Field Equipment	X	
6.2	Laboratory Equipment	X	
6.3	Equipment Out of Calibration	X	
6.4	Calibration and Maintenance Records	X	
7.0	Analytical Procedures	X	
7.1	Radiological Analysis Procedures	X	
7.2	Chemical Analysis Procedures	X	

Table A-1

(continued)

	Appropriate QAPjP Section	Past Practices Consistent with Current QAPjP Requirements	Past Practices Differ from Current QAPjP Requirements
8.0	Data Reduction, Verification and Reporting	X	
8.1	Data Reduction	X	
8.2	Radiological Analytical Data	X	
8.2.1	Procedural Detail	X	
8.2.2	Data Validation	X	
8.2.3	Final Reporting and Archival	X	
8.3	Chemical Analytical Data	X	
8.3.1	CLP Reporting Procedures		X
8.3.2	Organics Data		X
8.3.3	Inorganics Data		X
8.3.4	Data Validation		X
8.3.5	Data Processing	X	
8.3.6	Data Reduction and Presentation	X	
9.0	Internal Quality Control	X	
9.1	Quality Control Samples	X	
9.2	Use of Quality Control Samples	X	
10.0	Performance and System Audits	X	
10.1	Performance Audits	X	
10.2	System Audits	X	
11.0	Preventive Maintenance	X	
12.0	Data Assessment Procedures	X	
12.1	Field Data Assessment	X	
12.1.1	Accuracy	X	
12.1.2	Precision	X	
12.1.3	Completeness	X	
12.2	Laboratory Assessment	X	
13.0	Corrective Action	X	
13.1	Responsible Staff	X	
13.2	Corrective Measures	X	
13.3	Documentation	X	
14.0	Quality Assurance Reports	X	

1.0 PROJECT DESCRIPTION

Refer to Section 1.0 of the QAPjP.

1.1 Project Objectives

The St. Louis site was not placed on the NPL until October 1989; therefore, work conducted before this date was directed by "characterization plans" rather than by the CERCLA-RI/FS documentation described in this section (i.e., a field sampling plan, a quality assurance project plan, a WP-IP, a community relations plan, and a health and safety plan). Each portion of work was planned and conducted using these characterization plans rather than a consolidated sampling and analysis plan. These documents have been made available to EPA for historical documentation of the work that has been conducted at the site to date.

1.2 Site Description

Refer to Section 1.2 of the QAPjP.

1.3 Data Collection Objectives

The objectives of data collection documented in the QAPjP apply only to the remaining sampling to fill data gaps.

The overall objectives of data collection are to determine the extent and nature of the contamination at the St. Louis site and use the data in a feasibility study to determine a final remedial action and disposition of the waste at the site. A detailed description of the overall objectives for the remedial investigation is given in Section 1.2 of the WP-IP.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

Refer to Section 2.0 of the QAPjP.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENTS

Refer to Section 3.0 of the QAPjP.

3.1 Analytical Requirements

Refer to Section 3.1 of the QAPjP.

3.2 Data Quality Assurance Objectives

Refer to Section 3.2 of the QAPjP.

3.2.1 Accuracy

Refer to Section 3.2.1 of the QAPjP.

3.2.2 Precision

Refer to Section 3.2.2 of the QAPjP.

3.2.3 Completeness

Refer to Section 3.2.3 of the QAPjP.

3.2.4 Representativeness

Refer to Section 3.2.4 of the QAPjP.

3.2.5 Comparability

Refer to Section 3.2.5 of the QAPjP.

3.3 Sample Handling

Refer to Section 3.3 of the QAPjP.

4.0 SAMPLING PROCEDURES

Refer to Section 4.0 of the QAPjP.

4.1 Sampling Program Overview

Refer to Section 4.1 of the QAPjP.

4.2 Sampling Techniques

Refer to Section 4.2 of the QAPjP.

4.3 Equipment

Refer to Section 4.3 of the QAPjP.

4.4 Records

Refer to Section 4.4 of the QAPjP.

5.0 SAMPLE CUSTODY

Refer to Section 5.0 of the QAPjP.

5.1 LABORATORY NOTIFICATION OF SAMPLING ACTIVITIES

Refer to Section 5.1 of the QAPjP.

5.2 SAMPLE IDENTIFICATION

Each sample submitted for analysis was uniquely identified to ensure timely, correct, and complete analysis for all parameters requested and to support the use of analytical data in potential enforcement actions. A chain-of-custody record accompanied each chemical sample submitted for analysis; a field sample collection form accompanied each radiological sample.

5.3 CHAIN OF CUSTODY PROCEDURES

The sample custody forms and procedures that BNI uses have changed since characterization activities were first conducted at the St. Louis site under FUSRAP. The following text contains a brief description of the forms and processes that were used before October 1989.

At the St. Louis site, a custody documentation procedure was used for the 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 A-1 and A-2) was completed for each sample type after containers were packed for shipment.

TMA/E routinely used the field sample collection form shown in Figure A-2; it is equivalent to a chain-of-custody form. This form was used for all sample types, and specific procedures were established for its use. The form contains all pertinent information about samples in the TMA/E laboratory, including sample identification number; site name, specific location, surface elevation, and depth at which the sample was collected; date the

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	AFW LOT #	RESULTS RECEIVED

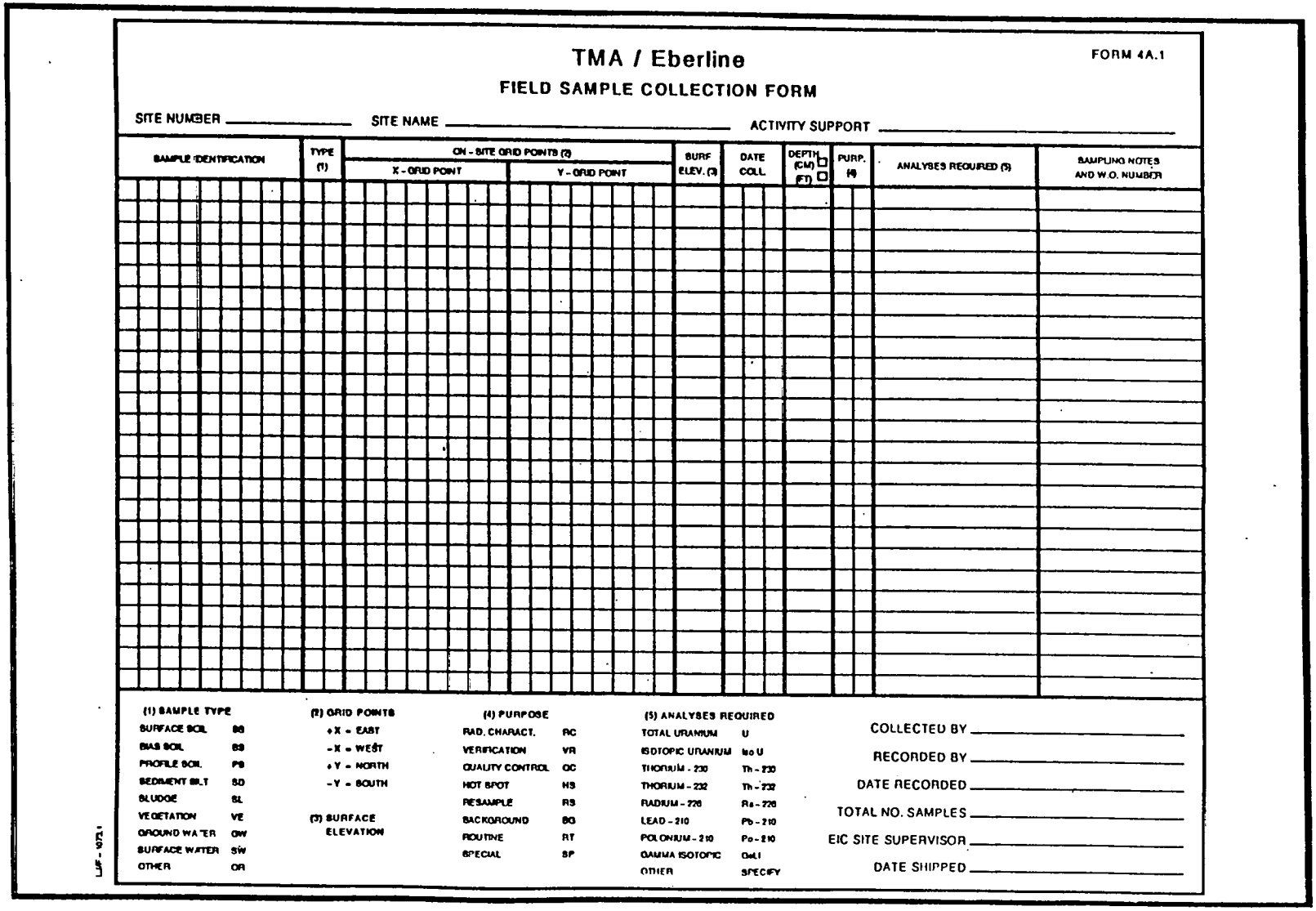
SAMPLE NUMBER	BECHTEL ID	DESCRIPTION	MATRIX	DATE COLLECTED	NUMBER OF CONTAIN

ANALYSES REQUIRED	
ITEM	DESCRIPTION

REASON	RELINQUISHED BY	RECEIVED BY	DATE	TIME

COMMENTS/INSTRUCTIONS:

Figure A-1
Request for Analytical Services Form



TMA / Eberline

FORM 4A.1

FIELD SAMPLE COLLECTION FORM

SITE NUMBER _____ SITE NAME _____ ACTIVITY SUPPORT _____

SAMPLE IDENTIFICATION	TYPE (1)	ON - SITE GRID POINTS (2) X - GRID POINT	ON - SITE GRID POINTS (2) Y - GRID POINT	SURF ELEV. (3)	DATE COLL.	DEPTH (CM) ☐ (FT) ☐	PURP. (4)	ANALYSES REQUIRED (5)	SAMPLING NOTES AND W.O. NUMBER

(1) SAMPLE TYPE

SURFACE SOIL	SS
BIAS SOIL	BS
PROFILE SOIL	PS
SEDIMENT SILT	SD
SLUDGE	SL
VEGETATION	VE
GROUND WATER	GW
SURFACE WATER	SW
OTHER	OR

(2) GRID POINTS

+X = EAST
-X = WEST
+Y = NORTH
-Y = SOUTH

(3) SURFACE ELEVATION

(4) PURPOSE

RAD. CHARACT.	RC
VERIFICATION	VR
QUALITY CONTROL	QC
HOT SPOT	HS
RESAMPLE	RS
BACKGROUND	BG
ROUTINE	RT
SPECIAL	SP

(5) ANALYSES REQUIRED

TOTAL URANIUM	U
ISOTOPIC URANIUM	Iso U
THORIUM - 230	Th - 230
THORIUM - 232	Th - 232
RADIUM - 226	Ra - 226
LEAD - 210	Pb - 210
POLONIUM - 210	Po - 210
GAMMA ISOTOPIC	Gm.I
OTHER	SPECIFY

COLLECTED BY _____

RECORDED BY _____

DATE RECORDED _____

TOTAL NO. SAMPLES _____

EIC SITE SUPERVISOR _____

DATE SHIPPED _____

LMF - 107.1

Figure A-2
Field Sample Collection Form

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 chain-of-custody documentation.

5.3.1/5.3.2 Field/Laboratory 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 was used at the St. Louis site to maintain a record of sample collection, transfer between personnel, and shipment and receipt by the laboratory (Figure A-3). This procedure was used for sample documentation by Roy F. Weston, Inc. (the FUSRAP chemical analysis subcontractor) for all samples processed through the Weston laboratory. Each time samples were 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 were documented.

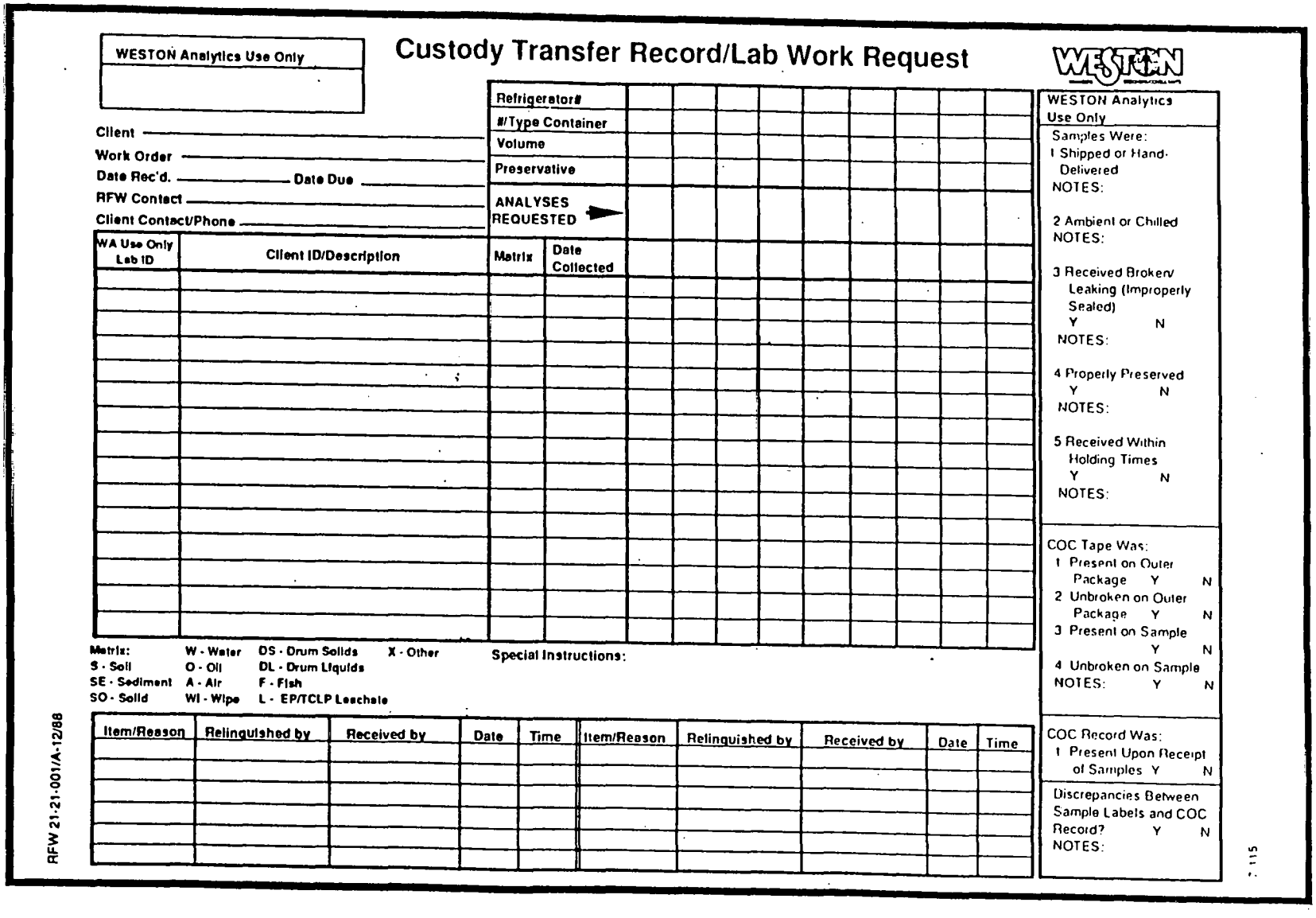
When radiological samples were received in the TMA/E laboratory, they were checked and logged into the laboratory tracking system, and a specific laboratory number was assigned to each sample. The field sample collection form was then sent to TMA/E's Oak Ridge project office with laboratory documentation that was used to track the status of all samples.

5.4 Evidence Files

Refer to Section 5.4 of the QAPjP.

6.0 CALIBRATION PROCEDURES

Refer to Section 6.0 of the QAPjP.



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:
W - Water
S - Soil
SE - Sediment
SO - Solid
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

Figure A-3
Custody Transfer Record/Lab Work Request

6.1 Field Equipment

Refer to Section 6.1 of the QAPjP.

6.2 Laboratory Equipment

Refer to Section 6.2 of the QAPjP.

6.3 Equipment out of Calibration

Refer to Section 6.3 of the QAPjP.

6.4 Calibration and Maintenance Records

Refer to Section 6.4 of the QAPjP.

7.0 ANALYTICAL PROCEDURES

Refer to Section 7.0 of the QAPjP.

7.1 Radiological Analytical Procedures

Refer to Section 7.1 of the QAPjP.

7.2 Chemical Analytical Procedures

Refer to Section 7.2 of the QAPjP.

8.0 DATA REDUCTION, VERIFICATION, AND REPORTING

Refer to Section 8.0 of the QAPjP.

8.1 Data Reduction

Refer to Section 8.1 of the QAPjP.

8.2 Radiological Analytical Data

Refer to Section 8.2 of the QAPjP.

8.2.1 Procedural Detail

Refer to Section 8.2.1 of the QAPjP.

8.2.2 Data Validation

Refer to Section 8.2.2 of the QAPjP.

8.2.3 Final Reporting and Archival

Refer to Section 8.2.3 of the QAPjP.

8.3 Chemical Analytical Data

Refer to Section 8.3 of the QAPjP. Note: No CLP packages were requested during previous characterization activities at the St. Louis site.

8.3.1 CLP Reporting Procedures

Data reports emphasized sample results and quality control. Raw instrument data were neither requested nor received. CLP packages were not requested for chemical analyses conducted in previous characterization activities.

8.3.2 Organics Data

Data were reported by Weston in a standard format. Target Compound List (TCL) organic compounds were reported on data summary sheets. In addition, the laboratory was required to report a maximum of 30 EPA/National Institutes of Health Mass Spectral Library searches for non-TCL 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 included the following:

- General information and header information, including data narrative and summary
- Cover page -- laboratory chronicle
- Organics analysis data sheets
- Surrogate recovery information
- Matrix spike/matrix spike duplicate recovery information
- Method blank data
- Sample shipping logs (chain-of-custody form)

8.3.3 Inorganics Data

Each inorganics data package included the following:

- General information and header information, including data narrative and summary
- Cover page -- laboratory chronicle
- Inorganics analysis data sheets
- Blank data
- Spike sample recovery information
- Duplicate sample data
- Laboratory control samples
- Sample shipping logs (chain-of-custody)

8.3.4 Data Validation (Verification)

Weston and TMA/E were required to submit the data package to BNI within a prescribed time following receipt of samples. Data packages submitted to BNI from Weston and TMA/E were reviewed and checked by project personnel in the BNI Oak Ridge office.

Reviews were conducted through the use of checklists, which were found in BNI project instructions. These checklists varied according to analyses, matrix, and type of data collected. In general, the data review checklists addressed the following issues:

- Data completeness (i.e., were results provided for all requested samples/parameters, including spikes, blanks, and replicates?)
- Quality control analytical results (i.e., were these results provided and were they adequate?)
- Reasonableness of data (e.g., trend analysis, historical information, exposure potential, etc.)
- Acceptability of format for data submitted
- Acceptable types of methods used for review (e.g., comparative studies, statistical or mathematical analyses, projection modeling)

If, as a result of the review, the reviewer identified any data anomalies or inadequacies, the data were subjected to an independent review. The method for conducting an independent review was documented in BNI project instructions and procedures. The independent review was conducted to determine whether the data

could be used and/or whether data should be rejected. Independent checking of the review was performed before any data were determined to be unacceptable or acceptable with anomalies.

8.3.5 Data Processing

Refer to Section 8.3.5 of the QAPjP.

8.3.6 Data Reduction and Presentation

Refer to Section 8.3.6 of the QAPjP.

9.0 INTERNAL QUALITY CONTROL

Refer to Section 9.0 of the QAPjP.

9.1 Quality Control Samples

Previous documentation defined 11 types of QA samples that were used in the field work at St. Louis; only nine types of QC samples are listed in this QAPjP. (Matrix spike duplicates and surrogates were defined separately in the previous documentation.) It should also be noted that the previous definition of a "replicate" is actually the definition of a "split;" this has been changed in the current QAPjP (Section 9.1). The previous list of QC samples and definitions is provided in the following paragraphs for information and comparison purposes.

QC samples were regularly prepared in the field and laboratory so that all phases of the sampling process were monitored. Listed below are the 11 types of QC samples that were used during characterization of the St. Louis site:

- A **trip blank** (also known as travel blank or transport blank) is a laboratory-grade deionized (DI) water sample (acidified to a pH of less than 2 with 1:1 hydrochloric acid) added at the laboratory, shipped to the site (where it remains unopened), and shipped back to the laboratory. These samples are handled and processed in the same manner as other field samples. They are identified clearly on sample tags and chain-of-custody records as trip blanks. The sampling 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.

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

  A rinse blank for analytes that require field filtering is passed through the same filtering apparatus as the sample. Rinse blanks are analyzed for the same radiological parameters, volatile organics, semivolatile organics, PCBs, and metals for which the field samples are analyzed.

- A **field duplicate** ensures the reproducibility of the analytical results and the representativeness of the samples collected. Field duplicates should not be confused with replicates; field duplicates require re-collection of the

sample using the same procedures as for 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.

- A **method blank** (or reagent blank) measures the interferences that may be introduced during laboratory analysis. A method blank is laboratory-grade DI water, which may contain reagents used in the method, that is carried through all steps of an analytical process. Method blank(s) are analyzed randomly during analysis of a sample batch sequence. Method blanks are analyzed for the same chemical parameters that the field samples are analyzed for.

  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.

- 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. Duplicates are analyzed for the same parameters that the field samples are analyzed for (except TOC and TOX).

- A **method spike** (also known as fortified method blank or blank spike) is a method blank to which a known concentration of analyte(s) 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.

- A **matrix spike** (or fortified field sample) is a field sample to which a known concentration of the analyte(s) 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.

  The amount of spike material recovered from a matrix spike indicates the best result expected from the method. The recovery of these spikes is compared with the accuracy determined from the method spikes as an indication of matrix effects. The laboratory liaison works with the laboratory QA officer to establish an acceptable deviation range. Matrix spikes falling outside this range are reanalyzed to determine if an actual matrix effect is present or if corrective action is required by the subcontractor.

- A **matrix spike duplicate** (or fortified field sample) is prepared in the same manner as a matrix spike. They are compared and used to determine the long-term precision and accuracy of the analytical method for volatile organics, semivolatile organics, metals, and pesticides/PCBs.

- A **surrogate** is a sample spiked with surrogate compounds before sample preparation to provide a means of evaluating laboratory performance and estimating the efficiency of the

analytical technique. Surrogate recoveries are analyzed for volatile organics, semivolatile organics, and pesticides/PCBs.

- **Standard reference materials (SRMs)** are standards used to validate a particular analytical procedure. SRMs usually originate from EPA, the National Institute of Occupational Safety and Health, or the National Institute of Standards and Technology.

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

All 11 types of QC samples were used during collection and analysis of the chemical samples at the St. Louis site; only laboratory duplicates and SRMs were required for radiological samples.

10.0 Performance and System Audits

Refer to Section 10.1 of the QAPjP.

10.2 System Quality Assurance Audits

Refer to Section 10.2 of the QAPjP.

11.0 Preventive Maintenance

Refer to Section 11.0 of the QAPjP.

12.0 Data Assessment Procedures

Refer to Section 12.0 of the QAPjP.

12.1 Field Data Assessment

Refer to Section 12.1 of the QAPjP.

12.1.1 Accuracy

Refer to Section 12.1.1 of the QAPjP.

12.1.2 Precision

Refer to Section 12.1.2 of the QAPjP.

12.1.3 Completeness

Refer to Section 12.1.3 of the QAPjP.

12.2 Laboratory Assessment

Refer to Section 12.2 of the QAPjP.

13.0 Corrective Action

Refer to Section 13.0 of the QAPjP.

13.1 Responsible Staff

Refer to Section 13.1 of the QAPjP.

13.2 Corrective Measures

Refer to Section 13.2 of the QAPjP.

13.3 Documentation

Refer to Section 13.3 of the QAPjP.

14.0 Quality Assurance Reports

Refer to Section 14.0 of the QAPjP.

APPENDIX B
DATA EVALUATION SUMMARY

QA DATA EVALUATION SUMMARY

Chemical Data

To ensure that chemical data were of sufficient quality for use in evaluating the extent of contamination at the St. Louis site, each data package was reviewed for accuracy, precision, and completeness. The following subsections summarize the results of these reviews.

Data Packages. The soil and water data packages contained:

- Results for RCRA characteristics, mobile ions, volatile organics, semivolatile organics, metals, pesticides/PCBs, TOC, and TOX (as requested). The metals fraction of RCRA characteristics included arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The organics fraction included endrin, lindane, methoxychlor, toxaphene, 2,4-D, and 2,4,5-TP.

- Trip blanks for all samples shipped to the laboratory within a 24-hour period.

- Field blanks for all analytes.

- A minimum of one method blank or 10 percent of the total number of samples.

- A minimum of one replicate per batch.

- A minimum of one matrix spike sample or 10 percent of the samples, where applicable.

- One matrix spike duplicate sample or 10 percent of the samples, where applicable.

After the data package was assembled, the laboratory manager for Weston, or his representative, summarized the QC results and described any problems encountered during sample analysis. If all QA procedures had been followed, the data package was sent to BNI for review and use.

The accuracy and precision of the analytical results were determined by analyzing spiked samples and laboratory water blanks and/or surrogate compounds spiked into the sample. The samples and blanks were spiked with known concentrations of the compounds of interest. The recovery of these spikes was then compared to the accuracy determined from the blank spikes as an indication of matrix effects. Matrix spikes falling outside an acceptable range were reanalyzed. All data packages were approved by the Weston laboratory manager as complying with Weston's QA program.

The precision of the analytical procedure was also ensured by analyzing laboratory duplicates. Data from duplicate sample analyses were used to determine whether a particular analytical procedure was within control limits on a database established to chart day-to-day variations in the precision or accuracy of routine analyses. The duplicate analyses for all of the final data packages were within the control limits. All data packages were approved by the Weston laboratory manager as complying with Weston's QA program.

The completeness of the data was verified by checking the sample identification numbers on the final analytical reports against the samples recorded on the chain-of-custody forms. All of the samples collected for analysis were analyzed, and the final results (following reanalysis where necessary) were determined to be acceptable. After all analyses were complete, the samples (if radioactively contaminated) were returned to TMA/E for storage.

Nonradioactively contaminated samples were sent by the laboratory for commercial disposal.

The following subsections present the results of the BNI reviews for each property.

St. Louis Downtown Site. Radiological and chemical characterization was conducted in two separate phases. Phase I was performed primarily to identify areas of radioactive contamination. Phase II was conducted to define the dimensional boundaries of the contamination and to fill data gaps identified during evaluation of Phase I data. Chemical sampling was incorporated into both phases of the investigation to determine whether hazardous chemicals were associated with the radioactivity. A total of 103 data packages (sets of samples collected in one day and sent to the laboratory for analysis) were generated during the Phase I and II investigations. These data packages consisted of 200 sets of soil samples and 28 sets of water samples. Of the 38 sets of samples analyzed for semivolatile organics, 11 were for scans only. The chain of custody was maintained for 223 of the 228 chain-of-custody forms. Based on the BNI review of the data sets, all of the results were acceptable.

St. Louis Airport Site. Radiological and chemical characterization was conducted in two separate phases. Phase I was performed to identify areas of radioactive contamination, and Phase II was performed to identify areas of chemical contamination. A total of 49 data packages were generated during the Phase I and II investigations. These data packages consisted of 33 sets of soil samples and 22 sets of water samples. Of the three sets of samples analyzed for semivolatile organics, two were for scans only. The chain of custody was maintained for all of the 55 chain-of-custody forms. Seventeen sets of soil sample results (three RCRA characteristics, two mobile ions, two volatile organics, six semivolatile organics, and four metals) were returned to the

laboratory for reanalysis. Analytical results were rejected because one or more of the following QC samples were unacceptable: surrogate recoveries, matrix spike recoveries, and/or matrix spike duplicate recoveries. Resampling and reanalysis were undertaken, and the BNI review of the subsequent data packages verified that all of the reanalysis results were acceptable.

St. Louis Airport Site Vicinity Properties. Radiological and chemical characterization was conducted in two separate phases. Phase I was performed to identify areas of radioactive contamination, and Phase II was performed to identify areas of chemical contamination. A total of 20 data packages were generated during the Phase I and II investigations. These data packages consisted of 32 sets of soil samples and one set of water samples. Of the four sets of samples analyzed for semivolatile organics, three were for scans only. The chain of custody was maintained for 29 of the 33 chain-of-custody forms. Three sets of analytical results for soil samples (one mobile ions, one EP Tox, and one EP Tox organics) were returned to the laboratory for reanalysis. Analytical results were rejected because one or more of the following QC samples were unacceptable: surrogate recoveries, matrix spike recoveries, and/or matrix spike duplicate recoveries. The BNI review of the subsequent data packages showed that all of the final results were acceptable.

Hazelwood Interim Storage Site/Futura Coatings. Radiological and chemical characterization was conducted in two separate phases. Phase I was performed to identify areas of radioactive contamination, and Phase II was performed to identify areas of chemical contamination. A total of 36 data packages were generated during the Phase I and II investigations. These data packages consisted of 80 sets of soil samples and 33 sets of water samples. Of the five sets of samples analyzed for semivolatile organics, two were for scans only. The chain of custody was maintained for

109 of the 113 chain-of-custody forms. Eight sets of analytical results for soil samples (one RCRA characteristics, one mobile ions, one volatile organics, three metals, one EP Tox, one EP Tox organics) were returned to the laboratory for reanalysis. Sample results were rejected because one or more of the following QC samples were unacceptable: surrogate recoveries, matrix spike recoveries, and/or matrix spike duplicate recoveries. Based on the BNI review of the subsequent data packages, all of the final results were acceptable.

Radiological Data

To ensure that radiological data were of sufficient quality for use in evaluating the extent of contamination at the St. Louis site, each data package was reviewed for accuracy, precision, and completeness. The following subsections describe the results of these reviews.

Soil, Water, and Sediment Data. The soil, water, and sediment data packages contained:

- Results for uranium-238, radium-226, thorium-230, and thorium-232 (as requested)
- Duplicate sample counts for one sample in each batch of 20 or less
- Analytical results of SRMs for each of the radionuclides

In addition, special requests were made for source term analysis of other radionuclides of interest. After each data package was assembled, the TMA/E lab manager reviewed the package to assess compliance with contractual requirements and appropriate lab QA procedures. (Detailed information on laboratory QA procedures is available in the TMA/E procedures manual.) The package was then transmitted to the Oak Ridge TMA/E office for review by the project

manager. If the project manager found discrepancies in the data, the package was returned to the laboratory for reanalysis. If it was determined that all QA procedures were followed, the data package was sent to BNI for review and use.

The accuracy of the radiological data was evaluated by counting SRMs for each radionuclide of interest with each batch of samples. The SRMs were within ±2 sigma of the reference value for all packages. Additionally, all data packages were approved by the TMA/E laboratory manager and project manager as complying with TMA/E's QA program.

The precision of each set of radiological data was evaluated by analyzing a duplicate sample for one sample in each batch of 20 or less. Results of duplicate analyses for all of the data packages were within ±2 sigma of the original analysis; however, if ±2 sigma could not be achieved, ±3 sigma was deemed acceptable, and an explanatory note was attached to the data package. Additionally, all data packages were approved by the TMA/E laboratory manager and project manager as complying with the TMA/E QA program.

The completeness of the data was verified by checking the sample identification numbers on the final analytical reports against the samples recorded on the field sample collection forms. All of the samples collected for analysis were analyzed, and the final results were determined to be acceptable.

The following subsections present the results of the BNI reviews for each property.

St. Louis Downtown Site. A total of 101 data packages (73 soil, 24 water, and 4 sediment) were generated during the Phase I and II investigations. Five data packages were submitted to the laboratory for reanalysis or corrections to the analytical reports. Based on the BNI review of the subsequent data packages, all five of the final reports were acceptable.

Five data packages were rejected and resubmitted for corrections for the following reasons:

- Sample coordinates were incorrect
- Borehole numbers were incorrect
- Information on sample depths not included
- Error term not calculated (one value only)
- Radionuclide identified incorrectly

St. Louis Airport Site. A total of 29 data packages (10 soil, 14 water, and 5 sediment) were generated during the Phase I and II investigations. Two data packages were submitted to the laboratory for reanalysis or corrections to the reports. The BNI review of the subsequent data packages showed that all of the final reports were acceptable.

Two data packages were rejected and resubmitted for corrections for the following reasons:

- Uranium-235 value was not recorded; report was not complete
- Locations for sediment samples were incorrect

St. Louis Airport Site Vicinity Properties. A total of 139 data packages (129 soil, 6 water, and 4 sediment) were generated during the Phase I and II investigations. Two data packages were submitted to the laboratory for reanalysis or corrections to the report. The BNI review of the subsequent data packages verified that all of the final reports were acceptable.

Two data packages were rejected and resubmitted for corrections for the following reasons:

- Information on property sampled not included
- Error term not calculated

Hazelwood Interim Storage Site/Futura Coatings. A total of 108 data packages (81 soil, 18 water, and 9 sediment) were generated during the Phase I and II investigations. Based on the BNI review of the data packages, all of the results were acceptable for use.

Surface Scan Survey Data. To verify that the gamma radiation walkover survey data met procedural requirements, data packages were reviewed to ensure that all instruments used were identified and properly calibrated, background radiation levels were reported and were within normal range, maps identifying results of surface scans were submitted, and survey grid systems were shown and tied to the Missouri state grid system.

The 167 data packages for the St. Louis site were reviewed by a member of the BNI St. Louis team and confirmed by a QA/QC representative. Procedural requirements were met for all data packages. When all sample analyses and necessary QA checks were completed in the laboratory, the unused portions of the samples and the sample containers were archived for retention until remedial action is complete. The independent verification contractor will archive a fraction of the samples for 5 years beyond certification of the property as radiologically clean.