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QUALITY ASSURANCE PROJECT PLAN

CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

RESPONSE ACTION CONTRACT (RAC), REGION I

For
U.S. Environmental Protection Agency

By
Tetra Tech NUS, Inc.

EPA Contract No. 68-W6-0045
EPA Work Assignment No. 043-ANLA-016P
TtNUS Project No. N0400

November 2000

TETRA TECH NUS, INC.

SDMS DocID 25916

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1.0 TITLE AND APPROVAL PAGE

Site Name/Project Name: **Centredale Manor Restoration Project**
Site Location: **North Providence Rhode Island**

Title: **Quality Assurance Project Plan**
Revision Number: 2
Revision Date: **3/01**
Page: *1* of *1*

Document Title: *Centredale Manor Restoration Project Source Area Investigation Quality Assurance Project Plan (QAPP).*

Lead Organization: *EPA*

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TABLE OF CONTENTS
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

SECTION		PAGE	REVISION
1.0	**TITLE AND APPROVAL PAGE**	**1**	**3/8/01**
2.0	**TABLE OF CONTENTS AND DOCUMENT FORMAT**	**1**	**3/8/01**
2.1	Table of Contents	1	
2.2	Document Control Format	9	
2.3	Document Control Numbering System	9	
2.4	EPA-NE QAPP Worksheet #2	10	
3.0	**DISTRIBUTION LIST AND PROJECT PERSONNEL SIGN-OFF SHEET**	**1**	**3/8/01**
4.0	**PROJECT ORGANIZATION**	**1**	**3/8/01**
4.1	Project Organizational Chart	1	
4.2	Communication Pathways	1	
4.2.1	Modifications to the Approved QAPP	2	
4.3	Personnel Responsibilities and Qualifications	2	
4.4	Special Training Requirements and Certifications	3	
5.0	**PROJECT PLANNING / PROJECT DEFINITION**	**1**	**3/8/01**
5.1	Project Planning Meetings	1	
5.2	Problem Definition/Site History and Background	2	
5.2.1	Site Location and Description	3	
5.2.2	Site History and Background	3	
5.2.3	Problem Definition	17	
6.0	**PROJECT DESCRIPTION AND SCHEDULE**	**1**	
6.1	Project Overview (Outcome of Project Scoping Activities)	1	
6.2	Contaminants of Concern	2	
6.3	Sampling and Field Data Collection Tasks	4	
6.3.1	Subsurface Investigations (Borings, Wells, Piezometers, and Geophysical Investigations	4	
6.3.2	Groundwater Sampling	15	
6.3.3	NAPL Sampling	17	
6.3.4	Air Sampling	18	
6.3.5	Wipe Sampling	18	
6.4	Analytical Tasks and Services	18	
6.5	Project Schedule	19	
7.0	**PROJECT QUALITY OBJECTIVES AND MEASUREMENT PERFORMANCE CRITERIA**	**1**	**3/8/01**
7.1	Project Quality Objectives	1	
7.1.1	Soil Sampling	1	
7.1.2	Groundwater Sampling	7	

TABLE OF CONTENTS (continued)
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISSTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

SECTION			PAGE	REVISION
		7.1.3 NAPL Sampling	9	3/8/00
		7.1.4 Air and Wipe Sampling	10	
	7.2	Project Action Limits	11	
	7.3	Measurement Performance Criteria	12	
8.0	**PROJECT DESCRIPTION AND SCHEDULE**		**1**	**3/8/00**
	8.1	Sampling Design Rationale	1	
	8.2	Soil Sampling	2	
		8.2.1 Phase 1 Soil Investigations	3	
		8.2.2 Phase 2 Soil and Bedrock Investigations	5	
	8.3	Surface Geophysics	8	
	8.4	Long Term Water Level Measurements	9	
	8.5	NAPL Sampling	10	
	8.6	Groundwater Sampling	11	
	8.7	Phase 2 – Hydraulic Conductivity Tests	12	
	8.8	Air Sampling	13	
	8.9	Wipe Sampling	13	
9.0	**SAMPLING AND DATA ACQUISITION PROCEDURES AND REQUIREMENTS**		**1**	**3/8/01**
	9.1	Phase I Subsurface Investigations (Borings, Wells, Piezometers, and Geophysical Investigations)	2	
		9.1.1 Phase 1 Soil Borings, Soil Sampling and Monitoring Well Installations	2	
		9.1.2 Phase I DPT Piezometers, Surface Water Gauges and Long-Term Water Table Measures	8	
		9.1.3 Phase I – Geophysical Surveys	10	
	9.2	Phase I Groundwater Sampling	13	
		9.2.1 Groundwater Level Measurements	13	
		9.2.2 Well Purging Procedure	14	
		9.2.3 Groundwater Sample Collection	16	
	9.3	Phase II – Soil Borings, Soil Sampling, and Monitoring Well Installations	17	
		9.3.1 Phase II – Soil Sample Collection	17	
		9.3.2 Phase II – Bedrock Coring	18	
		9.3.3 Drilling Fluids	19	
		9.3.4 Bedrock Monitoring Well Installation	20	
		9.3.5 Overburden Monitoring Well Construction	20	
		9.3.6 Well Development	22	

TABLE OF CONTENTS (continued)
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

SECTION		PAGE	REVISION
9.4	Borehole Geophysics	23	3/8/01
9.4.1	Heat Pulse Flowmeter	23	
9.4.2	Natural Gamma Ray Measurement	24	
9.4.3	Caliper Measurement	24	
9.4.4	Borehole Acoustic Televiewer	25	
9.5	Phase II – Hydraulic Conductivity Tests	26	
9.5.1	Constant Discharge Test Method	26	
9.5.2	Slug Tests	27	
9.5.3	Bedrock Packer Testing	28	
9.6	Phase II Long-Term Water Level Measurements	28	
9.7	Phase II Groundwater Sampling	29	
9.8	NAPL Sampling Procedures	30	
9.9	Air Sampling Procedures	31	
9.9.1	PUF Air Sampling Procedures	31	
9.9.2	Summa Canister Air Sampling Procedures	33	
9.10	Wipe Sampling Procedures	34	
9.11	Cleaning and Decontamination of Equipment/Sample Containers	35	
9.11.1	Decontamination Procedure	36	
9.11.2	Control and Disposal of Investigation Derived Waste (IDW)	37	
9.12	Sampling SOP Modifications	38	
9.13	Field Equipment Calibration	38	
9.14	Field Equipment Maintenance, Testing, and Inspection Requirements	39	
9.15	Inspection and Acceptance Requirements for Supplies/Sample Containers	39	
10.0	**SAMPLE HANDLING, TRACKING, AND CUSTODY REQUIREMENTS**	**1**	**3/8/01**
10.1	Sample Collection Documentation	1	
10.1.1	Field Notes	1	
10.1.2	Field Documentation Management	4	
10.2	Sample Identification and Tracking System	5	
10.3	Sample Handling and Custody	7	
11.0	**FIELD ANALYTICAL METHOD REQUIREMENTS**	**1**	**3/8/01**
12.0	**FIXED LABORATORY ANALYTICAL METHOD REQUIREMENTS**	**1**	**3/8/01**
12.1	Fixed Laboratory Analytical Methods and SOPs	1	
12.2	Fixed Laboratory Analytical Method/SOP Modification	1	
12.3	Fixed Laboratory Instrument Calibration	2	
12.4	Fixed Laboratory Instrument/Equipment Maintenance, Testing, and Inspection Requirements	2	
12.5	Fixed Laboratory Inspection and Acceptance Requirements for Supplies	2	

TABLE OF CONTENTS (continued)
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

SECTION		PAGE	REVISION
13.0	**QUALITY CONTROL REQUIREMENTS**	**1**	**3/8/01**
13.1	Sampling Quality Control	1	
13.2	Analytical Quality Control	2	
14.0	**DATA ACQUISITION REQUIREMENTS**	**1**	**3/8/01**
15.0	**DOCUMENTATION, RECORDS, AND DATA MANAGEMENT**	**1**	**3/8/01**
15.1	Project Documentation and Records	1	
15.2	Field Screening Data Package Deliverables	1	
15.3	Fixed Laboratory Data Package Deliverables	1	
15.4	Data Reporting Formats	1	
15.5	Data Handling and Management	2	
15.6	Data Tracking and Control	2	
16.0	**ASSESSMENTS AND RESPONSE ACTIONS**	**1**	**3/8/01**
16.1	Planned Assessments	1	
16.2	Assessment Findings and Corrective Action Responses	2	
16.3	Additional QAPP Non-conformances	2	
17.0	**QA MANAGEMENT REPORTS**	**1**	**3/8/01**
18.0	**VERIFICATION AND VALIDATION REQUIREMENTS**	**1**	**3/8/01**
19.0	**VERIFICATION AND VALIDATION PROCEDURES**	**1**	**3/8/01**
19.1	Verification	1	
19.2	Validation	1	
20.0	**DATA USABILITY/RECONCILIATION WITH PROJECT QUALITY OBJECTIVES**	**1**	**3/8/01**

TABLES

NUMBER		PAGE	REVISION
3-1	Distribution List	2	**3/8/01**
3-2	Example Project Personnel Sign-Off Sheet	3	**3/8/01**
4-1	Personnel Responsibilities and Qualifications	4	**3/8/01**
4-2	Special Personnel Training Requirements	5	**3/8/01**

TABLE OF CONTENTS (continued)
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

TABLES (cont'd)

NUMBER		PAGE	REVISION
5-1	Project Kickoff Meeting Attendance Sheet	22	3/8/01
5-2	First Technical Meeting Attendance Sheet	23	3/8/01
6-1	Soil – Volatile Contaminants of Concern and Other Target Analytes	21	3/8/01
6-2	Soil – Semivolatile Contaminants of Concern and Other Target Analytes	22	3/8/01
6-3	Soil-Pesticides/PCB Contaminants of Concern and Other Target Analytes	24	3/8/01
6-4	Soil – Total Metals Contaminants of Concern and Other Target Analytes	25	3/8/01
6-5	Soil - Dioxin Contaminants of Concern and Other Target Analytes	26	3/8/01
6-6	Groundwater – Volatile Contaminants of Concern and Other Target Analytes	27	3/8/01
6-7	Groundwater - Semivolatile Contaminants of Concern and Other Target Analytes	28	3/8/01
6-8	Groundwater-Pesticide/PCB Contaminants of Concern and Other Target Analytes	30	3/8/01
6-9	Groundwater - Total and Dissolved Metals Contaminants of Concern and Other Target Analytes	31	3/8/01
6-10	Groundwater-Dioxins Contaminants of Concern and Other Target Analytes	32	3/8/01
6-11	Groundwater – Alkalinity, Sulfide, and TOC Analysis	33	3/8/01
6-12	NAPL – Volatile Contaminants of Concern and Other Target Analytes	34	3/8/01
6-13	NAPL – Semivolatile Contaminants of Concern and Other Target Analytes	35	3/8/01
6-14	NAPL – Pesticide/PCB Contaminants of Concern and Other Target Analytes	37	3/8/01
6-15	NAPL – Total Metals Contaminants of Concern and Other Target Analytes	38	3/8/01
6-16	NAPL – Dioxin Contaminants of Concern and Other Target Analytes	39	3/8/01
6-17	Air – VOC Contaminants of Concern and Other Target Analytes	40	3/8/01
6-18	Air – PCB Contaminants of Concern and Other Target Analytes	41	3/8/01
6-19	Air – Dioxins Contaminants of Concern and Other Target Analytes	42	3/8/01
6-20	Wipes – PCB Contaminants of Concern and Other Target Analytes	43	3/8/01
6-21	Wipes – Dioxins Contamination of Concern and Other Target Analytes	44	3/8/01
6-22	Field and Quality Control Sample Summary	45	3/8/01
6-23	Analytical Services	49	3/8/01
6-24	Project Schedule Timeline	57	3/8/01
7-1	Soil Volatile Medium Concentration Measurement Performance Criteria	16	3/8/01
7-2	Soil Semivolatiles Low/Medium Concentration Measurement Performance Criteria	17	3/8/01
7-3	Soil Pesticide/PCB Low/Medium Concentration Measurement Performance Criteria	18	3/8/01
7-4	Soil Metals Low/Medium Concentration Measurement Performance Criteria	19	3/8/01
7-5	Soil Dioxins Low/Medium Concentration Measurement Performance Criteria	20	3/8/01
7-6	Groundwater Volatile Low/Medium Concentration Measurement Performance Criteria	21	3/8/01

TABLE OF CONTENTS (continued)
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

TABLES (cont'd)

NUMBER		PAGE	REVISION
7-7	Groundwater Semivolatile Low/Medium Concentration Measurement Performance Criteria	22	3/8/01
7-8	Groundwater Pesticide/PCB Low/Medium Concentration Measurement Performance Criteria	23	3/8/01
7-9	Groundwater Metals (Total and Dissolved) Low/Medium Concentration Measurement Performance Criteria	24	3/8/01
7-10	Groundwater Dioxins/Low Medium Concentration Measurement Performance Criteria	25	3/8/01
7-11	Groundwater Alkalinity Low/Medium Concentration Measurement Performance Criteria	26	3/8/01
7-12	Groundwater Sulfide Low/Medium Concentration Measurement Performance Criteria	27	3/8/01
7-13	Groundwater Total Organic Carbon Low/Medium Concentration Measurement Performance Criteria	28	3/8/01
7-14	NAPL Volatile Medium Concentration Measurement Performance Criteria	29	3/8/01
7-15	NAPL Semivolatile Low/Medium Concentration Measurement Performance Criteria	30	3/8/01
7-16	NAPL Pesticide/PCB Low/Medium Concentration Measurement Performance Criteria	31	3/8/01
7-17	NAPL Total Metals Low/Medium Concentration Measurement Performance Criteria	32	3/8/01
7-18	NAPL Dioxins Low/Medium Concentration Measurement Performance Criteria	33	3/8/01
7-19	Air Volatile Low/Medium Concentration Measurement Performance Criteria	34	3/8/01
7-20	Air PCB Low/Medium Concentration Measurement Performance Criteria	35	3/8/01
7-21	Air Dioxins Low/Medium Concentration Measurement Performance Criteria	36	3/8/01
7-22	Wipe PCB Low/Medium Concentration Measurement Performance Criteria	37	3/8/01
7-23	Wipe Dioxins Low/Medium Concentration Measurement Performance Criteria	38	3/8/01
8-1	Phase 1 Soil Sampling Locations, Sampling and Analysis Method/SOP Requirements	15	3/8/01
8-2	Phase 2 Soil Sampling Locations, Sampling and Analysis Method/SOP Requirements	17	3/8/01
8-3	Phase 2 NAPL Sampling Locations, Sampling and Analysis Method/ SOP Requirements	19	3/8/01
8-4	Phase 1 Groundwater Sampling Locations, Sampling and Analysis Method/SOP Requirements	20	3/8/01
8-5	Phase 2 Groundwater Sampling Locations, Sampling and Analysis Method/SOP Requirements	21	3/8/01
8-6	Air Sampling Locations, Sampling and Analysis Method/SOP Requirements	22	3/8/01
8-7	Wipe Sampling Locations, Sampling and Analysis Method SOP Requirements	23	3/8/01
8-8	Phase I Monitoring Well and Boring Locations	24	3/8/01

TABLE OF CONTENTS (continued)
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

TABLES (cont'd)

NUMBER		PAGE	REVISION
8-9	Phase II Monitoring Well and Boring Locations	25	3/8/01
9-1	Project Sampling SOP Reference	40	3/8/01
9-2	Field Sampling Equipment Calibration	41	3/8/01
9-3	Field Equipment, Maintenance, Testing, and Inspection	42	3/8/01
12-1	Fixed Laboratory Analytical Method/SOP Reference	4	3/8/01
12-2	Katahdin Laboratory Instrument Maintenance and Calibration	6	3/8/01
12-3	Triangle Labs Instrument Maintenance and Calibration	8	3/8/01
12-4	Air Toxics Laboratory Instrument Maintenance and Calibration	9	3/8/01
13-1	Soil Volatiles Field Sampling QC	3	3/8/01
13-2	Soil Semivolatiles Pesticide/PCBs Field Sampling QC	4	3/8/01
13-3	Soil Metals Field Sampling QC	5	3/8/01
13-4	Soil Dioxins Field Sampling QC	6	3/8/01
13-5	Groundwater Organics Field Sampling QC	7	3/8/01
13-6	Groundwater Metals Field Sampling QC	8	3/8/01
13-7	Groundwater Dioxin Field Sampling QC	9	3/8/01
13-8	Groundwater Alkalinity Sulfide, TOC Field Sampling QC	10	3/8/01
13-9	NAPL Organics Field Sampling QC	11	3/8/01
13-10	NAPL Metals Field Sampling QC	12	3/8/01
13-11	NAPL Dioxins Field Sampling QC	13	3/8/01
13-12	Air Volatiles Field Sampling QC	14	3/8/01
13-13	Air PCB Field Sampling QC	15	3/8/01
13-14	Air Dioxins Field Sampling QC	16	3/8/01
13-15	Wipe Pesticide/PCB Field Sampling QC	17	3/8/01
13-16	Wipe Dioxins Field Sampling QC	18	3/8/01
13-17	Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L1	19	3/8/01
13-18	Triangle Lab Method/SOP Precision and Accuracy, Dioxin-L5	21	3/8/01
13-19	Triangle Laboratory Method/SOP Precision and Accuracy, Dioxin L-11	22	3/8/01
13-20	Katahdin Laboratory Method/SOP Precision and Accuracy, Alkalinity	23	3/8/01
13-21	Katahdin Laboratory Method/SOP Precision and Accuracy, Sulfide	24	3/8/01
13-22	Katahdin Laboratory Method/SOP Precision and Accuracy, TOC	25	3/8/01
13-23	Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L15	26	3/8/01
13-24	Katahdin Laboratory Method/SOP Precision and Accuracy,VOCs-L16	28	3/8/01
13-25	Katahdin Laboratory Method/SOP Precision and Accuracy, Pesticides/PCBs	30	3/8/01
13-26	Katahdin Laboratory Method/SOP Precision and Accuracy, Metals	31	3/8/01
13-27	Triangle Laboratory Method/SOP Precision and Accuracy, Dioxin-L19	32	3/8/01
13-28	Air Toxics Laboratory Method/SOP Precision and Accuracy, VOCs	33	3/8/01
13-29	Air Toxics Laboratory Method/SOP Precision and Accuracy, PCBs-L21	34	3/8/01
13-30	Triangle Laboratory Method/SOP Precision and Accuracy, Dioxin - L22 & L24	35	3/8/01
13-31	Katahdin Laboratory Method/SOP Precision and Accuracy, Pesticides/PCBs-L23	36	3/8/01

TABLE OF CONTENTS (continued)
QUALITY ASSURANCE PROJECT PLAN
TECHNICAL ASSISTANCE
CENTREDALE MANOR RESTORATION PROJECT
NORTH PROVIDENCE, RHODE ISLAND

TABLES (cont'd)

NUMBER		PAGE	REVISION
15-1	Project Documentation and Records	4	3/8/01
15-2	Laboratory Data Package Elements	5	3/8/01
16-1	Project Assessment	3	3/8/01
17-1	QA Management Reports	3	3/8/01
19-1	Verification Tasks and Procedures	4	3/8/01
19-2	Data Validation Summary	6	3/8/01

FIGURES

NUMBER		PAGE	REVISION
4-1	Organizational Chart	6	3/8/01
5-1	Site Locus	24	3/8/01
5-2	Summary of Historical Activity and Features	25	3/8/01
6-1	Possible Locations of Borings/Monitoring Wells, Phase I	58	3/8/01
6-2	Summary of Geophysical Investigations	59	3/8/01
6-3	Possible Locations of Borings/Monitoring Wells, Phase II	60	3/8/01

APPENDICES

A	Corrective Action Forms	
B	Project Personnel Resumes	
C	Technical Specifications and Standard Operating Procedures	
D	Field Documentation Forms	
E	Notes from Planning and Technical Meetings	3/8/01

2.2 Document Control Format

The following document control format, presented in the EPA-NE QAPP Manual, will be used for this QAPP and will be included in the header of each page:

Quality Assurance Project Plan
Centredale Manor Restoration Project
Rev. 2
Date: March 2001
Page # of #

Revision numbers and dates will be updated as the QAPP is modified.

2.3 Document Control Numbering System

Controlled copies of this QAPP will be distributed by Tetra Tech NUS, Inc. (TtNUS). It is the responsibility of the document holder to maintain original versions with revisions as they are issued. The QAPP will be distributed in 3-ring binders to facilitate ease of handling and document updating. The distribution list of holders of controlled copies of this document will be maintained by TtNUS.

EPA-NE QAPP Worksheet #2 - Rev. 0
Tetra Tech NUS, Inc.

Site Name/Project Name: *CENTREDALE MANOR RESTORATION PROJECT*
Site Location: *NORTH PROVIDENCE RHODE ISLAND*
Site Number/Code: *RID981203755*
Operable Unit: *OO*
Work Assignment Number: *043-ANLA-016P*

Contractor Name: *Tetra Tech NUS, Inc.*
Contract Number: *68-W6-0045*
Contract Title: *RAC 1*

1. **Identify Guidance used to prepare QAPP:**
   Region I, EPA-NE Compendium QAPP Guidance, Attachment and/or other: ***Region I***
   EPA-New England Compendium of Quality Assurance Project Plan Guidance, October 1999, Final.

2. **Identify EPA Program:** *CERCLA*

3. **Identify approval entity: EPA-NE or State:** *EPA NE*
   or other entity:

4. **Indicate whether the QAPP is a generic program QAPP or a project specific QAPP:**
   Project Specific

5. **List dates scoping meetings were held:** *07/13/00 AND 07/27/00*

6. **List dates and titles of QAPP documents written for previous site work, if applicable:**

Title	Approval Date
Sampling and Analysis Plan Sediment Investigation	***10/99***

7. **List organizational partners (stakeholders) and connection with EPA and/or State:**

8. **List data users:** *EPA, RIDEM, Tetra Tech NUS*

9. **If any required QAPP Elements (1-20), Worksheets and/or Required Information are not applicable to the project, then circle the omitted QAPP Elements, Worksheets, and Required Information on the attached Table. Provide an explanation for their exclusion below:**
   ** Field Analytical Method Requirements. No field analysis will be performed. **

EPA-NE QAPP Worksheet #2 (continued)
Bold QAPP Elements, Worksheets, and/or Required Information that are not applicable to the project and provide an explanation on EPA-NE QAPP Worksheet #2, Item 9.

REQUIRED EPA QA/R-5 ELEMENTS	REQUIRED EPA-NE QAPP ELEMENT(S) and CORRESPONDING EPA-NE QAPP SECTION(S)	EPA-NE QAPP Worksheet #	REQUIRED INFORMATION
	Project Management and Objectives		
A1	1.0 Title and Approval Page	1	- Title and Approval Page
A2	2.0 Table of Contents and Document Format 2.1 Table of Contents 2.2 Document Control Format 2.3 Document Control Numbering System 2.4 EPA-NE QAPP Worksheet #2	2	- Table of Contents - EPA-NE QAPP Worksheet
A3	3.0 Distribution List and Project Personnel Sign-off Sheet	3 4	- Distribution List - Project Personnel Sign-off Sheet
A4, A8	4.0 Project Organization 4.1 Project Organizational Chart 4.2 Communication Pathways 4.2.1 Modifications to Approved QAPP 4.3 Personnel Responsibilities and Qualifications 4.4 Special Training Requirements/ Certification	5a 5b 6 7	- Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table
A5	5.0 Project Planning/Project Definition 5.1 Project Planning Meetings 5.2 Problem Definition/Site History and Background	8a 8b	- Project Planning Meeting Documentation - Project Scoping Meeting Attendance Sheet with Agenda - Problem Definition/Site History and Background - EPA-NE DQO Summary Form - Site Maps (historical and present)
A6	6.0 Project Description and Schedule 6.1 Project Overview 6.2 Project Schedule	9a 9b 9c 9d 10	- Project Description - Contaminants of Concern and Other Target Analytes Table - Field and Quality Control Sample Summary Table - Analytical Services Table - System Designs - Project Schedule Timeline Table
A7	7.0 Project Quality Objectives and Measurement Performance Criteria 7.1 Project Quality Objectives 7.2 Measurement Performance Criteria	11a 11b	- Measurement Performance Criteria Table
	Measurement/Data Acquisition		
B1	8.0 Sampling Process Design 8.1 Sampling Design Rationale	12a 12b	- Sampling Design and Rationale - Sampling Locations, Sampling and Analysis Method/SOP Requirements Table - Sample Location Map

EPA-NE QAPP Worksheet #2 (continued)

REQUIRED EPA QA/R-5 ELEMENTS	REQUIRED EPA-NE QAPP ELEMENT(S) and CORRESPONDING EPA-NE QAPP SECTION(S)	EPA-NE QAPP Worksheet #	REQUIRED INFORMATION
	Measurement/Data Acquisition (con.'t)		
B2, B6, B7, B8	9.0 Sampling Procedures and Requirements 9.1 Sampling Procedures 9.2 Sampling SOP Modifications 9.3 Cleaning and Decontamination of Equipment/Sample Containers 9.4 Field Equipment Calibration 9.5 Field Equipment Maintenance, Testing and Inspection Requirements 9.6 Inspection and Acceptance Requirements for Supplies/Sample Containers	13 12b 14 15	- Sampling SOPs - Project Sampling SOP Reference Table - Sampling Container, Volumes and Preservation Table - Field Sampling Equipment Calibration Table - Cleaning and Decontamination SOPs - Field Equipment Maintenance, Testing and Inspection Table
B3	10.0 Sample Handling, Tracking and Custody Requirements 10.1 Sample Collection Documentation 10.1.1 Field Notes 10.1.2 Field Documentation Management System 10.2 Sample Handling and Tracking System 10.3 Sample Custody	16	- Sample Handling, Tracking and Custody SOPs - Sample Handling Flow Diagram - Sample Container Label (Sample Tag) - Chain-of-Custody Form and Seal
B4, B6, B7, B8	**11.0 Field Analytical Method Requirements** **11.1 Field Analytical Methods and SOPs** **11.2 Field Analytical Method/SOP Modifications** **11.3 Field Analytical Instrument Calibration** **11.4 Field Analytical Instrument/ Equipment Maintenance, Testing and Inspection Requirements** **11.5 Field Analytical Inspection and Acceptance Requirements for Supplies**	**17** **18** **19**	- **Field Analytical Methods/SOPs** - **Field Analytical Method/SOP Reference Table** - **Field Analytical Instrument Calibration Table** - **Field Analytical Instrument/Equipment Maintenance, Testing and Inspection Table**
B4, B6, B7, B8	12.0 Fixed Laboratory Analytical Method Requirements 12.1 Fixed Laboratory Analytical Methods and SOPs 12.2 Fixed Laboratory Analytical Method/SOP Modifications 12.3 Fixed Laboratory Instrument Calibration 12.4 Fixed Laboratory Instrument/ Equipment Maintenance, Testing and Inspection Requirements 12.5 Fixed Laboratory Inspection and Acceptance Requirements for Supplies	20 21	- Fixed Laboratory Analytical Methods/SOPs - Fixed Laboratory Analytical Method/SOP Reference Table - Fixed Laboratory Instrument Maintenance and Calibration Table

EPA-NE QAPP Worksheet #2 (continued)

REQUIRED EPA QA/R-5 ELEMENTS	REQUIRED EPA-NE QAPP ELEMENT(S) and CORRESPONDING EPA-NE QAPP SECTION(S)	EPA-NE QAPP Worksheet #	REQUIRED INFORMATION
	Measurement/Data Acquisition (con.'t)		
B5	13.0 Quality Control Requirements 13.1 Sampling Quality Control 13.2 Analytical Quality Control 13.2.1 Field Analytical QC 13.2.2 Fixed Laboratory QC	 22a 22b 23a 23b 24a 24b	**Sampling** - Field Sampling QC Table - Field Sampling QC Table cont. **Analytical** - Field Analytical QC Sample Table - Field Analytical QC Sample Table cont. - Field Screening/Confirmatory Analysis Decision Tree - Fixed Laboratory Analytical QC Sample Table - Fixed Laboratory Analytical QC Sample Table cont.
B9	14.0 Data Acquisition Requirements	25	- Non-Direct Measurements Criteria and Limitations Table
A9, B10	15.0 Documentation, Records and Data Management 15.1 Project Documentation and Records 15.2 Field Analysis Data Package Deliverables 15.3 Fixed Laboratory Data Package Deliverables 15.4 Data Reporting Formats 15.5 Data Handling and Management 15.6 Data Tracking and Control	26	- Project Documentation and Records Table - Data Management SOPs
	Assessment/Oversight		
C1	16.0 Assessments and Response Actions 16.1 Planned Assessments 16.2 Assessment Findings and Corrective Action Responses 16.3 Additional QAPP Non-Conformances	27a 27b 27c	- Assessment and Response Actions - Project Assessment Table - Project Assessment Plan - Audit Checklists
C2	17.0 QA Management Reports	28	- QA Management Reports Table
	Data Validation and Usability		
D1	18.0 Verification and Validation Requirements		- Validation Criteria Documents *
D2	19.0 Verification and Validation Procedures	29a 29b 29c	- Data Evaluation Process - Data Validation Summary Table - Data Validation Modifications
D3	20.0 Data Usability/Reconciliation with Project Quality Objectives	30	- Data Usability Assessment

* Include Data Validation Criteria Document as an attachment to the QAPP if Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses will not be used for validating project data.

Note: Required project-specific information should be provided in tabular format, as much as practicable. However, sufficient written discussion in text format should accompany these tables. Certain sections, by their nature, will require more written discussion than others. In particular, Section 8.0 should provide an in-depth explanation of the sampling design rationale and Sections 18-20 should describe the procedures and criteria that will be used to verify, validate, and assess data usability.

3.0 DISTRIBUTION LIST AND PROJECT PERSONNEL SIGN OFF SHEET

The personnel receiving a controlled copy of the Centredale Manor Restoration Project Site QAPP are presented in Table 3-1. Each person listed in Table 3-1 will receive a copy of this Revision 0 QAPP and any subsequent revisions.

Table 3-2 provides an example of the project personnel sign-off sheet, which will be signed by all personnel working on the project. A signature on this form indicates the person has read this QAPP and is familiar with the tasks to be performed. The completed sign-off sheet will be maintained in the TtNUS project file.

Table 3-1
Distribution List
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

QAPP Recipients	Title	Organization	Telephone Number	Document Control Number
Anna Krasko	USEPA RPM/WAM	USEPA	617-918-1232	1
Andy Beliveau	USEPA Quality Assurance Chemist	USEPA	781-860-4607	2
Steve Parker	TtNUS Project Manager	Tetra Tech NUS, Inc.	978-658-7899	3
Lucy Guzman	TtNUS QA Officer	Tetra Tech NUS, Inc.	978-658-7899	4
Michael Healey	TtNUS Hydrogeologist	Tetra Tech NUS, Inc.	978-658-7899	5
Tracy Dorgan	TtNUS Field Operations Leader	Tetra Tech NUS, Inc.	978-658-7899	6

Table 3-2
Example Project Personnel Sign-off Sheet
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read	QAPP Acceptable As Written
Steve Parker	TtNUS PM	(978) 658-7899			
Lucy Guzman	TtNUS QA Officer	(978) 658-7899			
Michael Healey	TtNUS Lead Hydrogeologist	(978) 658-7899			
Tracy Dorgan	TtNUS FOL	(978) 658-7899			

4.0 PROJECT ORGANIZATION

This section discusses the project organization and personnel responsibilities.

4.1 Project Organizational Chart

A Project Organization Chart depicting the agencies and personnel companies involved with the Centredale Manor Restoration Project Site Source Area Investigation is included as Figure 4-1. EPA is the lead agency in addressing this site, with TtNUS implementing the Source Area Investigation. Names and telephone numbers are provided in the Organization Chart.

4.2 Communication Pathways

The following is a summary of the pathways to be used to transfer information and to make alterations to project methods that may be required due to unforeseen circumstances. It will be the responsibility of the TtNUS Project Manager to keep both the TtNUS project team and the EPA informed of the following:

- Schedule, deliverables, meetings, and milestones
- Recent data collected from the site
- Technical changes made to the plans and specifications
- Developments that will cause changes in the schedule

The TtNUS Project Manager will be in frequent communication with the EPA Work Assignment Manager (WAM). Any changes in the plans and specifications, field methodology, sampling protocol, or data objectives will be communicated to the WAM, in a timely manner. As appropriate, a field modification record (TtNUS Form No. 0003) (Appendix A), will be used to identify the need for a change, and a recommended course of action. Whenever possible, a critical change will not be made until EPA approval.

The TtNUS Lead Chemist will communicate directly with the field team and DAS laboratories and indirectly with the designated CLP laboratories through the EPA Region I RSCC. The Lead Chemist will provide technical guidance and assess data as they become available. The

laboratories will notify TtNUS immediately of any issues that develop with the data or quality assurance/quality control (QA/QC) requirements. The EPA will be notified if significant issues arise with the laboratories regarding data, data quality objectives, or schedule.

The FOL will notify the Lead Chemist of the daily sample shipping information and will be in daily contact with the TtNUS Project Manager. The FOL and the required Subcontractors will communicate directly onsite. During site activities, project sample logsheets, logbook notations, and weekly summary reports will be completed in the field and maintained at the TtNUS office.

4.2.1 Modifications to the Approved QAPP

This section documents the procedures that will be followed when any project activity originally described in the approved QAPP requires real-time modification to achieve the project goals.

Proposed changes will be presented to the EPA WAM by TtNUS, and followed up by a Field Modification Record or corrective action documentation. The documentation will describe why the change is necessary, the nature of the proposed change, and its impacts on the project. The change will be implemented after EPA concurrence.

When changes require immediate action, the proposed change will be briefly discussed internally by TtNUS and approved, as appropriate, by the TtNUS Project Manager or designee (i.e. QA Officer or Technical Lead). The EPA WAM will be notified as soon as possible. If immediate or timely response cannot be solicited, then the proposed action may be implemented to meet project goals and to avoid schedule delays, cost impacts, or excessive subcontractor standby times.

4.3 Personnel Responsibilities and Qualifications

Mr. George Gardner, the Program Manager, is responsible for the overall management and implementation of the RAC I contract performed in USEPA Region I. Mr. Stephen Parker will serve as the Project Manager for the work assignment, and has the primary responsibility for the implementation and execution of the work assignment, including technical quality,

oversight/review, control of costs and schedule, and implementation of appropriate quality assurance procedures during all phases.

The Field Operations Leader (FOL) is the primary party who implements the field work activities outlined in this QAPP. The FOL will report directly to the TtNUS Project Manager. Responsibilities of the FOL include: supervising TtNUS field staff and field operations; coordinating with the various subcontractors onsite; ensuring the procedures specified in the QAPP are properly implemented; identifying and documenting necessary field changes; maintaining daily schedules; and reporting to the Project Manager on a regular basis regarding the status and progress of the field activities.

The Site Safety Officer (SSO) is responsible for ensuring that the field staff adhere to the primary duties of the HASP; reporting any health and safety issues to the TtNUS Health and Safety Manager; and reporting any hazards, injuries, or decisions to stop work to the TtNUS Project Manager.

Table 4-1 lists the TtNUS Centredale Manor Restoration Project Site personnel and includes their respective roles, names, and titles. Resumes are included in Appendix B.

4.4 Special Training Requirements and Certifications

Tasks to be performed while implementing the field activities that require special training are summarized in Table 4-2.

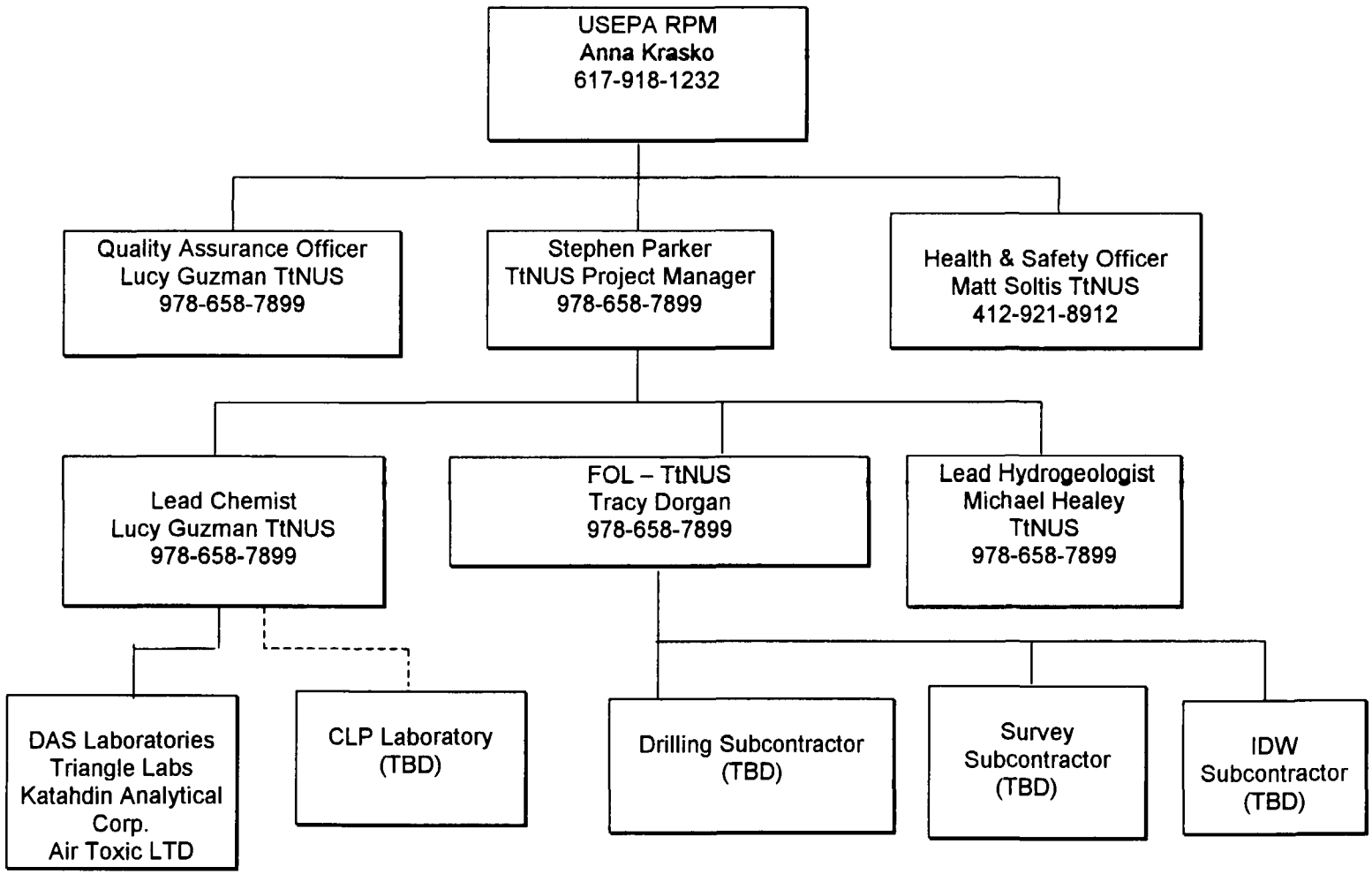
Table 4-1
Personnel Responsibilities and Qualifications
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Name	Organizational Affiliation	Responsibilities	Location of Personnel Resumes, if not included	Education and Experience Qualifications
Stephen Parker	TtNUS	PM	--	See Appendix B
Lucy Guzman	TtNUS	Lead Chemist	--	See Appendix B
Lucy Guzman	TtNUS	QA Officer	--	See Appendix B
Michael Healey	TtNUS	Lead Hydrogeologist	--	See Appendix B
Tracy Dorgan	TtNUS	FOL	--	See Appendix B

Table 4-2
Special Personnel Training Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Project Function	Specialized Training Title of Course or Description	Training Provided By	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates*
Field Sampling	40-hour OSHA training, 8 hour annual refresher training, supervisory training	Health & safety training specialists	various	All field (on site) personnel	FOL and field sampling team members	Training records are maintained by Tetra Tech NUS. (978) 658-7899

Figure 4-1
Organizational Chart
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island



5.0 PROJECT PLANNING / PROJECT DEFINITION

At the request of the U.S. EPA Region I, TtNUS will provide Technical Assistance (TA) support for the Centredale Manor Restoration Project Site located in North Providence, Rhode Island (Figure 5-1). The activities will be performed under Contract No. 68-W6-0045, Work Assignment No. 043-TATA-016P, in accordance with the objectives of the EPA Work Assignment Form (WAF), Revision No. 4, dated June 23, 2000, and the associated Statement of Work and results of the July 13, 2000 scoping meeting between EPA and TtNUS.

This section documents project planning, and identifies the environmental problems that have been already documented at the site. Background information, including summaries of former investigative activities are presented, and assembled into a conceptual model for the site.

5.1 Project Planning Meetings

Two meetings were held to discuss the scope of work described in WAF Revision 4 dated June 2000. The purpose of the study, as described in the WAF is to "conduct a study of the extent of the source area of contamination, hydrogeological setting of the site, groundwater flow, and the extent of groundwater contamination at and adjacent to the Centredale Manor and Brook Village properties with a focus on defining sources of contamination and contaminant discharges into the surface waters and wetlands".

A kickoff meeting was held by teleconference on July 13, 2000 (Table 5-1). The purpose of this meeting was to reach clarification on the scope of work, particularly regarding the extent of the groundwater modeling to be performed and the amount and purpose of air and wipe samples to be collected in the Centredale Manor building.

The outcome of these discussions focused the study to provide a conceptual groundwater model, showing input and output locations, and where contaminants could intercept the river. In addition, it was clarified that air and wipe samples would have to be collected for dioxin and PCBs from the Centredale Manor building to determine the safety of residents inside, but that quantities would be discussed at a subsequent meeting. These and other issues discussed at the meeting are summarized in the meeting notes, provided as Appendix A.

A technical project planning/scoping meeting was conducted on July 27, 2000 at EPA's Region I office to discuss and plan technical aspects of the work to be performed (Table 5-2). The purpose of the meeting was to:

- define the scope of the project,
- anticipate environmental decisions that will have to be made, and
- determine DQOs and sampling activities.

The scope of the project was defined in terms of the data needs. It was clarified that since groundwater classification is GB, drinking water standards do not apply, however, it will need to be determined where groundwater contamination is present, and where it is likely to travel over time, to identify if and what type of a remedial action is necessary. An approach to install perimeter well clusters and shallow piezometers to identify flow paths and then install borings and wells to identify contaminant presence in source areas and discharge areas was presented.

Additionally, the scope and details of air sampling in the Centredale Manor building was discussed and clarified. Meeting notes from the technical scoping meeting are provided in Appendix A.

Various informal phone conversations were also held with the EPA WAM as a part of scoping activities. Tetra Tech NUS, Inc. submitted a Draft work plan describing the proposed approach in August 2000. Approval of the work plan was received by TtNUS under WAF Revision 7, dated October 18, 2000.

5.2 Problem Definition/Site History and Background

As part of the project planning process, the site history was reviewed and former investigation reports and associated information was evaluated. This section provides a summary of those investigations, and culminates in a conceptual model of the site.

The source area is defined for the purposes of this investigation to be inclusive of tax lots 14-200 and 14-250 in the City of North providence, as well as a portion of tax lot 12-560. Lots 14-200 and 14-250 are identified by the historical records to have housed the former Metro Atlantic Chemical

corp. facility and New England Container Drum recycling facility. The air photo survey shows most of the filling and land clearing to have occurred on these lots. However, in addition, some ground disturbance and fill activities appear to have occurred on the north end of Lot 12-560, which abuts lot 14-250. The current location of Cap Area 1 covers portions of both lots 12-560 and 14-250.

5.2.1 Site Location and Description

The Centredale Manor Site is a multi-unit apartment complex that houses elderly adults. It is located at 2074 Smith Street (Route 44) in Centredale, a village of North Providence, Rhode Island. Figure 5-1 depicts the location of the site. The Centredale Manor apartment building and the adjacent apartment building known as "Brook Village", are located on the site of the former Metro-Atlantic Chemical Corporation, which operated from the 1940s to the 1970s in a former mill complex on the site. The Woonasquatucket River follows the west boundary of the site. The remains of a raceway for the former mill complex are present on the eastern boundary of the site.

5.2.2 Site History and Background

Historical records of Metro Atlantic Chemical researched by Weston (March 1999) indicate that the site manufactured hexachlorophene and that there were shipments of trichlorophenols to the site. The mill complex was destroyed by fire in the late 1970's and the apartment buildings were constructed between 1978 and 1982. During construction of the Centredale Manor building, 400 drums and 6,000 cubic yards of contaminated soil were reportedly removed from the site. Labels indicated that the drums contained caustics, halogenated solvents, polychlorinated biphenyls (PCBs), and inks.

A study conducted in June 1996 by the EPA Narragansett Laboratories and the Providence Urban Initiative Program (EPA, 1996) determined that elevated levels of dioxin were present in fish collected from the River. A subsequent study of the Woonasquatucket River conducted by the EPA Office of Environmental Measurement and Evaluation (OEME) in June 1998 found elevated concentrations of dioxins and PCBs in sediments in portions of the river and impoundments adjacent to and downstream of Centredale Manor (EPA, July 1998). Soil and sediment sampling conducted by Weston (EPA START Contract) personnel in September 1998

found dioxins at concentrations up to 10.1 ppb in sediments collected from the exposed bottom of the former Allendale Pond (Weston, March, 1999). The impoundment's dam breached in 1991 exposing the bottom sediments. Further sampling conducted in February 1999 on the Centredale Manor property also found elevated concentrations of dioxins in soils and sediment.

The findings of the investigations mentioned above, and other investigatory efforts pertaining to this area are described in the following subsections. Section 5.2.2.1 describes a summary of air photo interpretation of the source area during the period of suspected environmental activity. Section 5.2.2.2 presents a chronology of environmental investigations performed at and associated with the source area. Section 5.2.2.3 presents a summary of geological information collected through performance of borings installed as a part of site improvements since the late 1970s.

5.2.2.1 Summary of Aerial Photographic Analysis

An Aerial Photographic Analysis was performed of the source area by EPA Office of Research and Development (July, 2000). Aerial photos from 1939 to 2000 were reviewed and interpreted to identify "landscape morphology, patterns of hazardous waste disposal and other observable activities and conditions of environmental significance". Figure 5-2 depicts former site structures and features described in this section.

The analysis highlights the existence of the building complex reportedly occupied by Metro Atlantic Chemical Corporation in the north portions of the source area and varying degrees of disturbance and disposal advancing into wetlands south from that facility with time. The 1951 photo shows the presence of a probable drum recycling facility at the south end of the complex, immediately north of the current location of the Centredale Manor north parking lot. Later photos show additional buildings adjacent (south) of that facility in the current location of that parking lot. The Sanborne atlas map dated 1956 concurs with the identification of these buildings.

The photos from the 1950s and 1960s show that the former mill complex was located to the north of the existing Centredale Manor north parking lot, east of the existing Brook Village building smaller building was located on the space currently occupied by Brook Village, along with and parking areas. The raceway, located on the east boundary of the source area, is

visible as a maintained structure only in the area adjacent to the original mill building, and gives way to an apparently unimproved ditch or creek north of the drum recycling building.

In the photos taken in the 1950s, there is evidence of two waste disposal areas to the immediate west and south of the drum recycling building, in the vicinity of the Centredale Manor building and north parking lot. Drainage from the facility is evident leading west in the 1951 photo. Drainage from the waste piles to the south appear to be to the east and to the adjacent raceway. The beginnings of waste disposal is also evident in this period at the current location of the south parking lot for Centredale Manor, with drainage into the Woonasquatucket River.

Photos from the 1960s show indications of unknown activity in the location of the current south parking areas of Brook Village. This includes stained soils (possibly from westerly drainage from the drum recycling building), stacked drums and a building that first appears on the 1965 photo. This building is not present in the 1970 photo, but indications of stained soils and drums are still evident. These photos also show impoundments in the current location of the Centredale Manor parking area and Cap Area 2.

A large amount of waste disposal is evident across the site between 1962 and 1970. This is particularly evident in the area between the North parking area and the southern limit of the source area, defined by the current location of Cap Area 1. In the 1962 and 1965 photos, grading scars are evident in the current location of the Centredale Manor building. An unidentified building is shown in the 1970 photo in the southern portion of Cap Area 2. Extensive waste, grading scars and disturbed soils are evident in the current location of the northern half of Cap Area 2 in the 1963 photo, and in a strip along the west side of a roadway leading across the current location of the south parking area to the current location of Cap Area 1 throughout the period between 1962 and 1970.

The photo presented for 1979 shows cessation of waste-related activity, and sparse vegetation across the previously disturbed area. This photo also shows Brook Village developed with parking areas.

5.2.2.2 Previous Environmental Investigations Woonasquatucket River Sediment/Water Quality Analysis – OEME, July 1998

This investigation involved collection and analysis of sediments for dioxin, 1,2,4,5,7,8-hexachloro(9H)xanthene (HCX), polyaromatic hydrocarbons (PAHs), PCBs, pesticides, total organic carbon (TOC), total metals, and acid volatile sulfide/simultaneous extracted metal analysis (AVS/SEM) of copper, zinc, lead, cadmium, nickel, and mercury. Surface water was analyzed for dissolved oxygen, temperature, conductivity and pH. The purpose of the investigation was to determine the source of dioxins, HCX, and other contaminants detected in fish tissue by OEME in June 1996. Sediment and surface water samples were collected from seven impoundments of the Woonasquatucket River formed by the Esmond, Allendale, Lymansville, Manton, Dyerville, Olneyville, and the Lonigan dams. The samples were collected in depositional areas of the impoundments that had silt or clay bottoms (sediments in the Allendale Pond impoundments were exposed at the time since the dam had breached in 1991).

Dioxins and HCX were detected at all seven sample locations. The highest dioxin concentrations were detected in the sediments of the Allendale Pond and Lymansville Pond impoundments that are located adjacent to and downstream of the Centredale Manor Site, respectively. Metals were detected at all sites in varying concentrations and frequencies. The greatest cyanide concentrations (in descending order of concentration) were detected at the Esmond, Lymansville, and Allendale Pond impoundments. The highest concentrations of PAHs were detected in the Allendale Pond impoundment. The highest concentrations of PCBs were detected (in descending order of concentration) at the Dyerville, Lymansville, and Allendale dams.

The results for 2,3,7,8-tetrachloro-*p*-dioxin indicated the presence of a source between the Esmond and Allendale dams that was involved in the manufacturing of 2,4,5-trichlorophenol and hexachlorophene. Historical records indicate that the former Metro Atlantic Chemical Company received shipments of trichlorophenol and manufactured hexachlorophene at the Centredale Manor Site.

Human health and ecological risk screens were performed using the analytical results of the OEME sediment sample analysis. Constituents of Concern (COCs) identified in the sediment samples included PCBs, PAHs, and dioxins.

Results of the human health risk screen indicated that below the Allendale dam, benzo(a)pyrene and dioxins may contribute equally to total cancer risks. At the Lymansville dam, where the greatest dioxin concentrations were detected, the majority of the cancer risk is provided by dioxin. However, these risks were low given the location of the contaminants at the bottom of the impoundments that would limit a persons frequency of exposure. Since these same concentrations would pose a health hazard if they were present in a residential setting, EPA recommended that additional data for shoreline sediment samples be collected in high access areas to more accurately assess exposure to recreational users of the river.

The results of the ecological risk screen indicated that the greatest risk of metal toxicity to benthos was at the Dyerville dam location. PCB, PAH, and dioxin concentrations appeared to represent a risk of chronic exposure to benthic and pelagic communities in the River. Because the sediment sampling data was limited in lateral and vertical extent, additional sampling was recommended to better define the extent of the contamination and the corresponding ecological risks it imposed on the rivers aquatic habitat.

Expanded Site Inspection (ESI) Centredale Manor - Weston, March 1999

The ESI performed by Weston (Weston, March 1999) for the Centredale Manor Site reviewed the history of environmental contamination at the Centredale Manor Site. This section describes the findings of that report.

The report stated that the Site was the former location of the Atlantic Chemical Company and the New England Container, Inc., which was a drum recycling facility. Over 400 drums were identified on the site during the period from 1977 through 1981. Approximately 60 drums were re-located in a wetland adjacent to the Woonasquatucket River and approximately 150 drums were observed along the bank of the river. Approximately 10 open drums containing sulfuric acid were removed during this period.

During construction of the Centredale Manor apartment complex in 1982, approximately 400 drums and 6,000 yards of contaminated soil were removed for disposal. Additional suspected buried drums were identified in the western portion of the property during a ground-penetrating radar survey performed in 1986. A preliminary assessment (PA) performed on the site in August 1986, by NUS/FIT determined that surface water, soil, and sediment were potentially

impacted. The SSI was performed by NUS/FIT in 1990, and detected elevated concentrations of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/PCBs, and metals in 10 soil samples collected. Weston found additional rusted empty drums on the Site near the Woonasquatucket River in October 1995, while performing a Site Inspection Prioritization (SIP) investigation of the property.

Weston collected nine sediment samples as part of the SIP, including three from the river and six from the wetland area. Analytical results indicated the presence of elevated concentrations of VOCs, SVOCs, and metals at concentrations greater to or equal to three times the reference sample concentrations. No pesticides or PCBs were detected in these samples.

Subsequent discovery of dioxin in fish tissue samples, and the OEME sediment and water quality investigation is discussed elsewhere in this section. In response to these findings, Weston initiated an ESI of the Centredale Manor Site under the direction of EPA. The ESI was initiated in June 1998, to address the presence of dioxins/furans and hexachloroxanthene (HCX) contamination on the Site, the extent of contamination in areas of potential human exposure, and potential source areas located upstream of the Site. This was the first investigation to analyze for the presence of dioxins and HCX on the Centredale Manor Site.

On September 5, 1998, START personnel collected five soil samples from the Centredale Manor Property, one soil sample from the Brook Village property, 35 sediment samples from the Woonasquatucket River, and four sediment samples from the former drainage canal. The soil and sediment samples were analyzed for dioxins, HCX, SVOCs, pesticides/PCBs, and total organic carbon (TOC).

Analysis of these samples indicated that SVOCs, pesticides, PCBs (Aroclor 1254), dioxins and HCX were detected at concentrations exceeding reference values in various sediment samples collected along the Woonasquatucket River downstream of the Centredale Manor property.

Pesticides, PCBs, dioxins, and HCX were detected at concentrations exceeding reference values in the drainage channel and downstream sediment samples.

Dioxin concentrations were highest near the Centredale Manor property and attenuated to less than one ppb at downstream locations. The highest concentration of dioxins was identified

along the drainage channel adjacent to the Centredale Manor property. The maximum dioxin concentration detected in the Woonasquatucket River was found in a sediment sample collected from Allendale Pond (10.1 ppb). Dioxin concentrations detected in sediment samples collected upstream from the Centredale Manor Site were significantly lower than those collected adjacent to and downstream of the Site.

The greatest number and highest concentration of SVOCs were detected in the sample collected farthest downstream, whereas elevated concentrations of PCBs were detected only in samples collected from Allendale Pond. Pesticide compounds, PCBs, and various dioxin compounds were detected at concentrations exceeding three times the reference values in sediment samples collected along the Woonasquatucket River upstream of the Centredale Manor property. Seventeen of the SVOCs were detected at the highest concentrations in sample SD-37, which was collected approximately 1.8 miles upstream of the Centredale Manor property. The highest PCB concentration (7,800 ppb) was detected in one sample collected upstream of the Centredale Manor Site.

Geophysical Surveys

Two geophysical surveys were conducted in April 1999 and in July 1999 at the Centredale Manor and Brook Village properties to follow up those conducted in 1986. These were performed to determine if there were indications of buried objects that may be contributing to the on-site contamination. These are summarized in the Final Report for Centredale Manor, prepared by Lockheed Martin (September 13, 1999). The first survey found a number of locations that were of potential concern, and follow up investigations discounted many of these locations, as being related to underground utilities (fire hydrants, electrical lines and road boxes, etc). the GPR and EM data indicated that others were mixed metallic fill and / or construction debris.

The report states that thirteen significant undetermined EM anomalies were identified. The GPR signature characteristics indicated that these features could consist of metallic fill or construction debris. These are located primarily in two groups: One group of five anomalies is present in the north end of what is now Cap Area 2, which is an area where drum storage and waste disposal is evident on historic air photos. Another group of four anomalies is present at the south end of the south parking lot and Cap Area 1, correlated with an area where evidence

of solid waste is noted on historic air photos (refer to Section 5.2.2.1). Two of these anomalies located in the south parking lot for Centredale Manor were reported to have the highest potential for containing buried bulk metallic materials. Three anomalies are located across the southern portion of Cap Area 2 and the South parking lot, and one is located east of Brook Village, at the former location of a series of vertical tanks observed on air photos taken between 1965 and 1962. However this single anomaly in the north of the source area is very likely to be a foundation for these tanks or for buildings or the raceway structure, which was also present in this area.

GPR cross sectional profiles collected in the Brook Village parking areas indicated a sequence of stratified materials that may suggest presence of alluvial deposits from a paleochannel.

Emergency Response Actions

During the course of 1999, the IT Group (IT) provided support for EPA emergency response actions at the site. During these actions, an extensive investigation was performed on surface and soils at the source area. In addition, residential and sediment samples were collected downstream of the source area for dioxins and other contaminants.

Surface and limited subsurface soil samples were collected from the source area using hand augers and direct push sampling techniques. Surface soil samples were collected to determine immediate risk to public health and the environment. Data from the surface soil samples were used to identify areas where contaminants were present at unacceptable concentrations. These areas were subsequently covered with a temporary cap system to prevent contact and reduce potential for downstream erosion of contaminated sediments and soils.

Subsurface soil samples were also collected at a subset of the surface soil locations. At most locations, concentrations of contaminants decreased with depth, but due to limitations of the sampling approach, the vertical extent of fill or of contamination was not reached. The subsurface data reported by IT (March 16, 2000) show concentrations of PCBs in excess of 1000 mg/kg and concentrations of dioxins above 10 ug/kg in subsurface soils. In addition, VOCs, SVOCs and metals were found above the Rhode Island Department of Environmental Management (RIDEM) standards for residential soil.

The following VOCs exceeded the RIDEM residential soil standards in subsurface soils (collected below two feet below ground surface).

- benzene,
- 1,2 dichloroethene,
- chlorobenzene,
- tetrachloroethene,
- trichloroethene,
- toluene, and
- xylene (total).

VOCs were detected at high concentrations in subsurface soils in the north east corner of Cap Area 2 (CMS-417), and in the northern most of two borings installed in the north parking lot for Centredale Manor (CMS-419) (Figure 5-2). Slightly elevated concentrations of VOCs were detected in two borings (CMS-405 and -408) installed in the southeast corner of the south parking lot for Centredale Manor. Traces of VOCs were detected in surface soils collected at CMS -060, located on the east bank of the Woonasquatucket river at the south parking lot for Brook Village. These are all locations where historical air photos show previous storage or disposal activities, and/or locations of geophysical anomalies described elsewhere in this section.

The following SVOCs exceeded the RIDEM residential soil standards in subsurface soils (collected below 2 feet below ground surface): benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k) fluoranthene, benzo(ghi)perylene, chrysene, dibenzo(a,h) anthracene, indeno(1,2,3-cd)pyrene, napthalene, and bis(2-ethylhexyl)phthalate. Low concentrations (below 10 ug/kg) of these SVOCs were detected in surface and subsurface soils across the source area. Elevated concentrations of phthalates and naphthalene between 80 and 460 ug/kg were found in surface soils at stations CMS-417 and 405, that also showed high concentrations of VOCs.

Elevated concentrations of arsenic, beryllium, lead and thallium were found in surface and subsurface soils across the site. Most notable were lead concentrations exceeding 1000 mg/kg

in subsurface soils at CMS-405 and 237 (co-located with a set of geophysical anomalies in the south parking lot of Centredale Manor) and at CMS 419 (former location of drum storage).

Elevated concentrations of PCBs (mostly Aroclor 1254) were found in surface and subsurface soils across the source area. PCB concentrations greater than 100 mg/kg were found in subsurface soils in two specific locations: One is the northern section of what is now Cap Area 1, co-located with a series of geophysical anomalies, and the second is the east side of the north parking area for Centredale Manor, immediately south of what is believed to be the location of the former drum recycling facility (refer to Section 5.2.2.1).

Dioxins, including 2,3,7,8-TCDD, were found in surface soil and sediment of what is now Cap Area 1, in the pond, and in wetlands downstream of the Source area. To a lesser extent, TCDD was also detected in surface soils of Cap Area 2. Dioxins were detected at location CMS-060, situated on the east bank of the Woonasquatucket river at the south parking lot for Brook Village, and immediately to the northeast.

<u>USGS Water-To Vapor Diffusion Study</u>

In September 1999, the USGS installed water-to vapor VOC diffusion samplers in the bottom sediments of the Woonasquatucket River and Raceway that bound the site. In addition, samplers were also placed in some of the canals that intersect the wetlands to the south of the source area.

Samples were analyzed on site for VOCs in accordance with the USEPA Region I standard air screening method (USEPA, 1998). Samples were analyzed for the target compounds benzene, toluene, ethylbenzene, xylenes, chlorobenzene, tetrachloroethene, 1,1,1 trichloroethane and trichloroethene, and reported values in parts per billion by volume.

This study found relatively high concentrations of TCE and PCE (maximums of 182,000 ppbv and 1,390,000 ppbv respectively) in samplers installed in the Woonasquatucket River channel adjacent to the two southern most parking areas for Brook Village. Relatively low concentrations (10-100 ppbv) of these compounds were detected in almost all samplers installed in the Woonasquatucket river sediments, with the exception of those installed upstream of the Brook Village building. Most of the samplers installed in the raceway showed no

contaminants detected, although notable concentrations of PCE and TCE were detected in samplers installed adjacent to the Centredale Manor building, and in those installed near the terminus of Redfern Street. TCE and PCE were also detected at concentrations exceeding 1000 ppbv in the so-called cross channel that bounds the southern edge of Cap Area 1. Similar results were reported for samplers installed in the sediments of downstream portions of the Woonasquatucket River and the Lower Mill Raceway, which together bound a small island-like formation south of Cap Area 1. Other target compounds were not detected in nearly all the samplers installed.

Water flow during the period of collection was variable with two separate high flow periods September 10 and again on September 16-17. It is not known what effect, if any this flow regime had on the testing conducted.

The water to vapor diffusion findings seem to indicate a widespread presence of TCE and PCE in the subsurface sediments. These sediment VOCs are possibly interchanging with the waters of the Woonasquatucket River. The relative concentrations reported by USGS indicate a possible discharge area near the two southernmost parking areas for Brook Village, and a more diffuse presence of these contaminants south of the source area.

Woonasquatucket River Sediment Investigation

In October 1999, TtNUS conducted an investigation of the sediment in the Woonasquatucket River from the Centredale Manor property south to the Lymansville Dam. Samples were collected for SVOCs, PCBs, pesticides, metals and dioxins. HCX was also identified in the samples from this data set and reported as a tentatively identified compound from the dioxin analysis. Data collected as a part of previous investigations were used to develop a comprehensive database to evaluate extent of contamination in the river system. Because the data for this investigation is pertinent to the river system, and does not contribute to the source area investigation, the data collected is not detailed in this QAPP. The findings indicated that dioxins and PCBs are present in the river and pond sediments. Concentrations of these contaminants appeared to be higher in depositional areas, and decreased with distance from the source area. Highest concentrations of dioxin were found in the sediments immediately south of the source area in the Allendale Pond and associated wetlands.

5.2.2.3 Previous Geologic Investigations

The geology of the underlying materials at the source area has undergone three separate limited evaluations. Geotechnical borings were installed by Allstate Drilling (Allstate) in 1975 and American Drilling and Boring Co. Inc. (American) in 1976 apparently within the footprint of the Brook Village building at the north end of the source area to support the design and construction of that building. Geotechnical borings and test pits were performed in 1981 by Guild Drilling Co. Inc. (Guild) and Allstate, and 1982 by GZA Consultants (GZA) apparently within the footprint of the Centredale Manor Building to support the design and construction of that building. Finally, In March 1999, Goldman Environmental Consultants (GEC) installed borings finished as monitoring wells in the Brook Village parking areas to investigate possible releases from a UST on the south side of the Brook Village building.

Boring logs from these installations were all reviewed by TtNUS in order to help develop an understanding of the geologic conditions of the source area.

Brook Village Area

The Brook Village geotechnical borings (Allstate and American) were evaluated with those installed by GEC. The findings of each group were evaluated with the consideration that each set of borings were installed for different purposes and used different drilling techniques. Allstate installed five shallow geotechnical borings for building footings in 1975 to between 11.5 feet and 16 feet below ground surface using drive and wash techniques. American Drilling and Boring installed six borings in 1976 within the same area to depths between 36 feet and 60.4 feet bgs also using drive and wash techniques. In 1999, GEC installed seven borings in the Brook Village parking areas with hollow stem augers to between 11 and 15 feet bgs.

The logs provided by Allstate show fill to approximately four feet bgs, peat and silt to 6 feet bgs, and a mixture of sand, gravel and silt to approximately 12 feet below ground surface. Some of those logs provided by American drilling show fill in the upper four feet of material, and a mix of sand and gravel with silt to varying depths. In some of these logs more sand was encountered at depths between 15 and 30 feet or deeper: one boring log indicates presence of sand and gravel mix to a depth of 60 feet. Rock was cored in one boring between 45.5 feet and 50.5 feet. This was the only attempt made to confirm bedrock. Refusal is identified two other of the six borings at

46 feet below ground surface and 60.4 feet bgs. The remaining three logs from borings installed by American show boring completion between 31.5 and 36.5 feet bgs. Boring logs provided by GEC also indicate fill present to approximately three to six feet bgs, and identify sand, silt and gravel between the fill and depths between 7 and 14 feet below ground surface. Below 14 feet, they identify till.

Reviewing the information recorded on the GEC logs, it is unclear how till was defined. Although the blow counts were relatively higher in this material, a presence of gravel may have repelled the split barrel samplers. Blow counts are similar in the boring logs provided by American, although these do not identify the material drilled through as till.

Centredale Manor Area

A package of geotechnical borings and test pits (Guild, Allstate, and GZA) were installed in 1981 and 1982 to evaluate the subsurface conditions and to support design of the Centredale Manor building. This information was reviewed to develop a better understanding of the geology of the source area. A fragment of a report by GZA (January 20, 1982) with Responsiveness Documents (GZA, April 14, 1999) provides an evaluation of these boring logs. Figures accompanying this information did not show locations of most of the borings or test pits, however, it is presumed that the investigations were performed within the existing footprint of the Centredale Manor building. The following information is taken from that report:

Fill

Overlying the entire site is a loose to very dense, predominately granular fill consisting of a mixture of sand, gravel silt, and trash. Occasional pieces of wood and metal were all encountered. Fill thickness appears to vary from 2 to about 6 feet and averaged about 4 feet. Penetration test "N" values range from 8 to greater than 50 blows per foot.

Organic Silt

Based on the test pit explorations, the fill is believed to be underlain by a layer of black organic silt. This deposit is described as varying from a peat to a fine sand, some silt and is about 1 to 2 feet in thickness.

Gravel/Sand

The test pit information and the test boring data indicate that the organic deposit is underlain by a layer of granular material ranging from a gravel, some sand with cobbles to a sand, some gravel, trace nonplastic fines. "N" values ranged from 11 to 45 blows per foot indicating a medium to dense consistency. The thickness of the layer ranged from 6.5 to 14.5 feet -- placing the bottom of the layer at depths of 10 to 21 feet.

Fine Sand/Silt

Underlying the sandy gravel is a very loose to loose material varying from a fine sand, some silt to a silt and sand. The borings indicate that this deposit occurs as a continuous layer between 4 to 12 feet in thickness. Standard Penetration Resistance values ranged from 3 to 11 blows per foot."

Sand/Gravel

Underlying the fine silt/sand strata is a medium-dense to dense, stratified, fine to coarse sand, little to some fine gravel with trace silt. In two of the borings, layers of fine sand/silt were encountered below 45 feet. The thickness of these strata is undetermined, since the borings were terminated in this material. Refusal was encountered in borings B-3 and B-4 at depths of about 21 to 26 feet, respectively. Based on other boring data and on the fact that cobbles were observed in the upper gravel/sand unit, refusal was not interpreted as a conclusive indication of bedrock.

Groundwater Condition

At the time of the exploration, groundwater was encountered in all of the borings at depths ranging from 1 to 4.5 feet, which correspond to elevations between 92 and 94 (no datum provided). These measurements agree with surveyed water elevations in the adjacent river and marshes (elevation 93.8) shown on a topographic plan prepared by Capoto and Wick Ltd. dated October 1981.

This assessment does not include observations noted in the test pit logs of chemical and oil odors. Such odors were reported in all strata to a depth of five feet in one test pit. In a second test pit, a sweet chemical odor was noted in the organic silt stratum between 1-3.25 feet, and an oil odor was noted in the sandy gravel stratum, found between 3.25 feet and the bottom of the test pit.

5.2.3 Problem Definition

The source area is defined for the purposes of this investigation to be inclusive of tax lots 14-200 and 14-250 in the City of North providence, as well as a portion of tax lot 12-560. Lots 14-200 and 14-250 are identified by the historical records to have housed the former Metro Atlantic Chemical facility and New England Container Drum recycling facility. The air photo survey shows most of the filling and land clearing to have occurred on these lots. In addition, some ground disturbance and fill activities appear to have occurred on the north end of Lot 12-560, which abuts lot 14-250. The current location of Cap Area 1 covers portions of both lots 12-560 and 14-250 (Figure 5-1).

A conceptual model has been developed for the source area based on the physical attributes and historical records and investigations performed to date as described in the previous section. This model is presented as figure 5-2. This figure shows eight areas of concern as described below:

<u>Area 1, Northern Portion of Cap Area 2</u>

This area shows large amounts of drums and solid waste storage in air photos evaluated as described in Section 5.2.2.1. Additionally, large geophysical anomalies were found in this area indicating presence of fill still in the ground. Subsurface soil samples collected in 1999 in this area show high concentrations of metals and VOCs, and surface soil samples showed elevated concentrations of dioxins in the surface soils prior to cap construction. This area is currently capped and fenced.

Additional investigation efforts are required for this area to determine thickness of fill, the extent of contamination in soil that could be liberated by groundwater, and the extent of groundwater contamination. In addition, evaluation of soil types throughout the contaminated zones, and determination of groundwater flow direction under various river stages will be necessary to support a conceptual model of groundwater flow and contaminant flow paths through this portion of the source area. This is particularly necessary to determine if contaminants from this area are flowing north to Area 4, where high concentrations of VOCs were detected in water to vapor samplers in 1999.

Area 2 - Centredale Manor South Parking Lot

This area shows continued waste disposal on air photos taken from the 1950s to 1970. A roadway is evident in those photos allowing vehicular access to this area, and waste is evident in a strip along the east bank of the Woonasquatucket River. This waste is co-located with geophysical anomalies identified in 1999 as most likely to contain metallic debris. In addition, subsurface soils collected from this area in 1999 were found to contain elevated concentrations of VOCs, SVOCs, and metals.

Additional investigation efforts are required for this area to determine thickness of fill, the extent of soil contamination that could be liberated by groundwater, and extent of groundwater contamination. In addition, evaluation of soil types throughout the contaminated zones, and determination of groundwater flow direction under different river stages will be necessary to support a conceptual model of groundwater flow and contaminant flow paths through the source area.

Area 3 - Centredale Manor North Parking Lot - This area is shown on air photo interpretations to be the former location of the Drum Recycling facility. This recycling facility first appears on photos taken in 1951. Drainage from this area is believe (from air photo interpretation) to have first been to the west, to an area of stained soils, and then later to the east, and the former raceway. Large quantities of drums appear to be stacked in various locations that are now covered by the Centredale Manor north parking lot and Centredale Manor building. High concentrations of PCBs were found in soils to the southeast of the former drum recycling building in an area of waste disposal and drainage into the raceway.

Additional investigation efforts are required for this area to determine thickness of fill, the extent of soil contamination that could be liberated by groundwater, and the extent of groundwater contamination. In addition, evaluation of soil types throughout the contaminated zones, and determination of groundwater flow direction, will be necessary to support a conceptual model of groundwater flow and contaminant flow paths through the source area.

This is particularly necessary to determine if contaminants from this area are flowing west to Area 4, where high concentrations of VOCs were detected in water to vapor samplers in 1999. In

addition, an understanding of flow to the east and into the former raceway is necessary to determine if this feature is providing a preferential pathway to the river system to the south.

Area 4 - Brook Village South Parking Lots - There are five separate parking areas currently in use by Brook Village. The current location of the southernmost two parking lots is shown in historic air photos as an area of extensively stained soils, possibly from drainage from the former drum recycling facility that was located immediately to the east. While low concentrations of VOCs were detected in subsurface soils collected from this area in 1999 (less than 4 feet bgs), dioxins were detected in the surface and subsurface soils, and high concentrations of VOCs were found in water-to-vapor samplers installed by USGS in 1999.

Additional investigation efforts are required for this area to determine the extent of contamination in soil that could be liberated by groundwater, and the extent of groundwater contamination. Thicknesses of fill are identified in the GEC boring logs described in Section 5.2.2.3. However, determination of groundwater flow direction to this area will be necessary before borings can be scoped to locate and test the source of the apparent discharge at this area.

Area 5 - South Portion of Cap Area 2 - This area shows some waste disposal and drum storage in historic air photos, as well as a small building that was present in the 1970 photo. Three smaller anomalies were also defined in this area through geophysical investigations. Subsurface soil sampling conducted in 1999 showed dioxins present in excess of 1 ppb.

Additional investigation efforts are required for this area to determine the thickness of fill, the extent of contamination in soil that could be liberated by groundwater, and the extent of groundwater contamination. In addition, evaluation of soil types throughout the contaminated zones, and determination of groundwater flow direction, will be necessary to support a conceptual model of groundwater flow and contaminant flow paths through the source area.

Area 6 - Area East of Centredale Manor - This area shows grading scars and waste disposal in air photos taken in 1962 and 1965. The Centredale Manor building appears to have been constructed over this area, however, high concentrations of PCBs were detected in subsurface soils collected on the east side of the Centredale Manor building, indicating continued presence of contaminants.

Additional investigation efforts required for this area to determine thickness of fill, extent of soil contamination that could be liberated by groundwater, and extent of groundwater contamination. In addition, evaluation of soil types throughout the contaminated zones, and determination of groundwater flow direction during different river stages, will be necessary to support a conceptual model of groundwater flow and contaminant flow paths through the source area.

Area 7 - Former Mill Raceway - The raceway is shown on historical aerial photos carrying little water, and may have formed a drainage canal for surface runoff from the source area and the residential neighborhoods to the east. Currently it appears to have been filled, although it still carries some surface water runoff. The presence of the mill buildings so close to the raceway and the drum recycling operation indicates possible disposal of chemical wastes into this channel, and possible filling with contaminated materials prior to, or after the fire destroying the complex in the 1970s.

Additional investigation efforts are required for this area to determine nature and thickness of fill, extent of soil contamination that could be liberated by groundwater, and extent of groundwater contamination. In addition, evaluation of soil types and determination of groundwater flow direction will be necessary to determine if this feature could represent a preferential flow path.

Area 8 - Possible Paleochannel and Gravely Deposits - Geophysical investigations tentatively identified possible alluvial deposits of a paleochannel under the Brook Village parking area. These deposits were not confirmed conclusively by the evaluation of the boring logs from this area, however, these logs indicate the presence of layers of more loose and more dense sands and gravels with varying amounts of silts that could support this finding. Such layers could provide preferential pathways for water and thus contaminant flow with groundwater. Such a presence in the north portions of the source area suggest that this channel could be found as a former meandering watercourse north to south through the source area, or could travel to the east or west under the existing raceway or river course.

Investigation of this feature to determine its presence and course will be required to support the conceptual model of groundwater flow through the source area and to help identify possible contaminant flow paths. This will be conducted to the extent possible through evaluation of data from borings and wells to be installed as part of the investigations of the other seven areas of concern identified elsewhere in this section.

In addition to those defined above, borings and wells will be installed into bedrock west, east and south of the source area. These borings will be used to find the overall extent of the channel (if present), and identify downstream contaminant concentrations in groundwater.

Finally, it will be determined through the completion of the conceptual groundwater model for the site if contaminants are being discharged to the waters of the Woonasquatucket River. To complete the conceptual groundwater model, water table mapping is required for the source area and surrounding areas. In addition, vertical gradient between bedrock and overburden will need to be determined through cluster wells installed in those formations.

Table 5-1
Project Kickoff Meeting Attendance Sheet
Quality Assurance Project Plan
Centredale Manor Restoration Project Site
North Providence, Rhode Island

EPA Regulation Program: RCRA FIFRA TSCA **CERCLA** DW CWA CAA **(underline one)**	**Site Name:** Centredale Manor Restoration Project
	Site Location: North Providence, Rhode Island
Program: RAC	**CERCLA Site/Spill Identifier No.:**
Project Date(s) of Sampling: TBD	**Operable Unit:** Not Applicable
Project Manager: Stephen Parker	**CERCLIS Site Number/Code:**
	Phase: ERA SA/SI Pre-RI **RI** **FS** RD RA post-RA **(underline one)**
	Other phase: NA
Date of Meeting: 7/13/2000	
Meeting Location: U.S. EPA's Boston, Massachusetts Office	

Name	Role	Signature
Kathleen Hunt, EPA	Contract Officer	
Heidi Horahan, EPA	Program Manager	
Anna Krasko, EPA	EPA-WAM	
Richard Willey, EPA	Hydrogeologist	
Sarah Levinson, EPA	Human Health Risk Assessment	
Cornell Rosiu, EPA	Ecological Risk Assessment	
Stephen Parker, TtNUS	Project Manager	
Arnold Ostrofsky, TtNUS	Deputy Program Manager	

Meeting Purpose: Define scope of work and content of QAPP.

Comments and Action Items:Tetra Tech NUS to submit QAPP. Also see Appendix E for Meeting notes

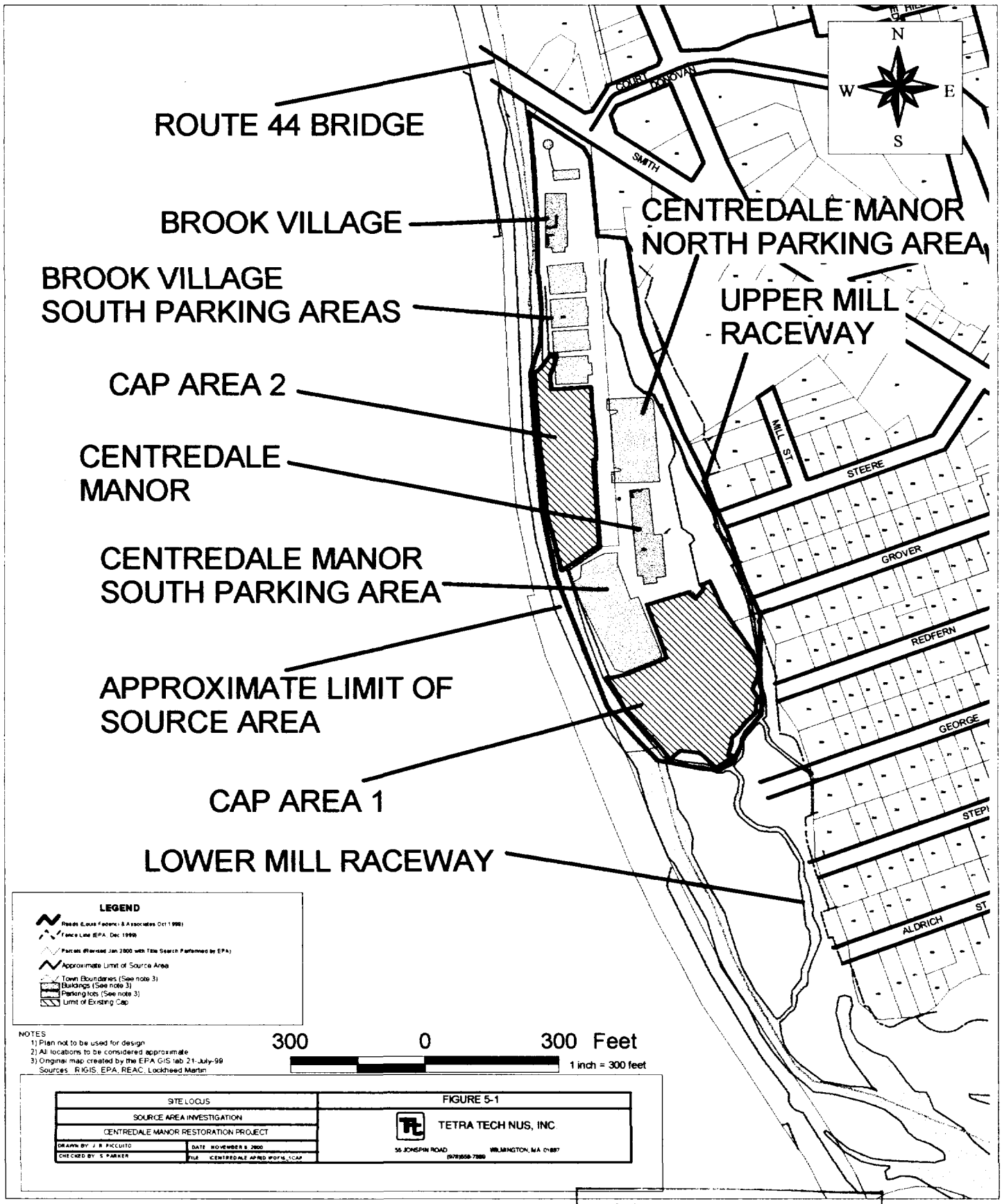
Table 5-2
First Technical Meeting Attendance Sheet
Quality Assurance Project Plan
Centredale Manor Restoration Project Site
North Providence, Rhode Island

EPA Regulation Program: RCRA FIFRA TSCA **CERCLA** DW CWA CAA **(underline one)**	**Site Name:** Centredale Manor Restoration Project Site
	Site Location: North Providence, Rhode Island
Program (Brownfields, NPDES, etc.): RAC	**CERCLA Site/Spill Identifier No.:**
Project Date(s) of Sampling: TBD	**Operable Unit:** Not Applicable
Project Manager: Steve Parker	**CERCLIS Site Number/Code:**
	Phase: ERA SA/SI Pre-RI **RI** (phase I, etc.) **FS** RD RA post-RA **(underline one)**
	Other phase: NA
Date of Meeting: 7/27/2000	
Meeting Location: Tetra Tech NUS, Wilmington, Massachusetts Office	

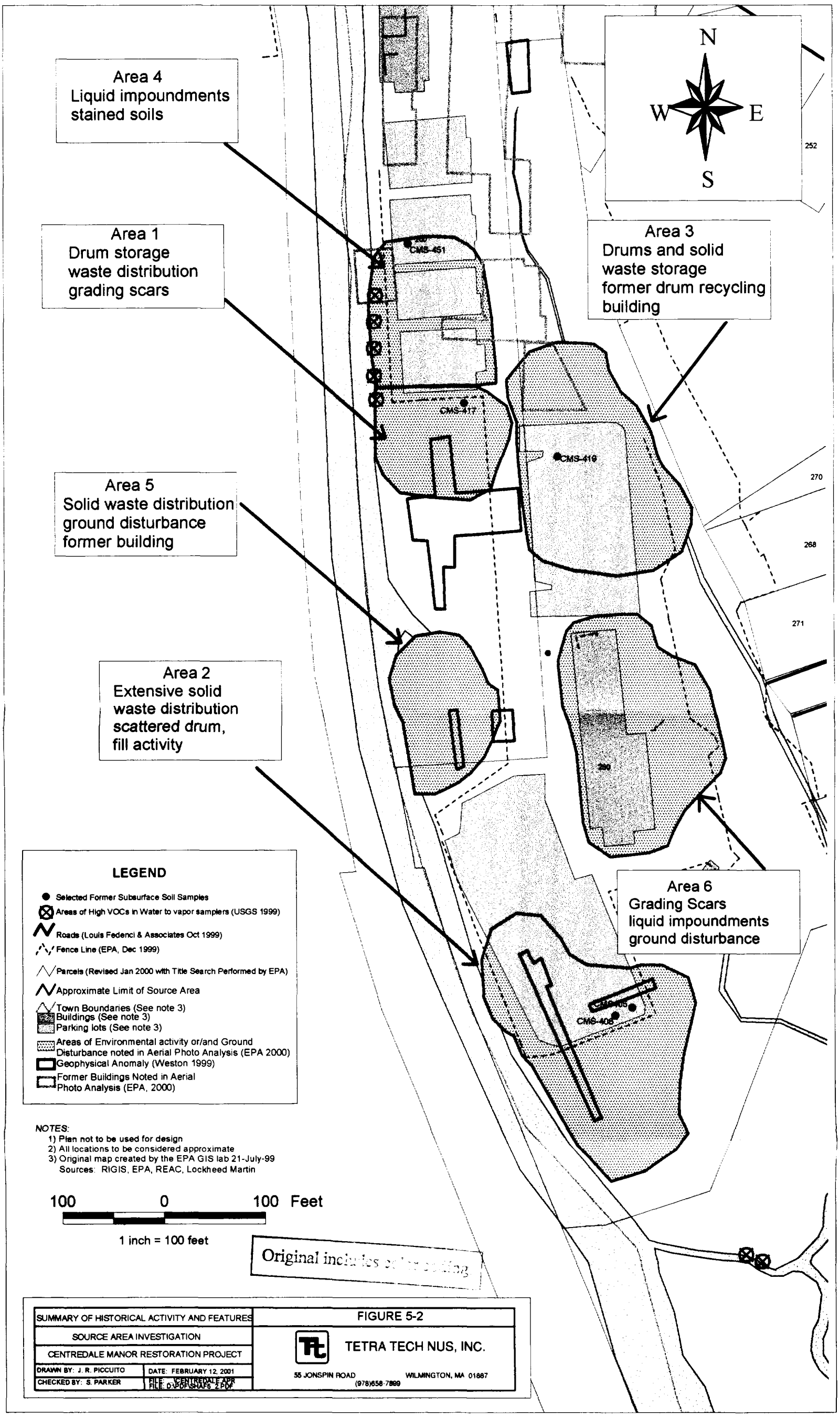
Name	Role	Signature
Steve Parker, TtNUS	Project Manager	
Lucy Guzman, TtNUS	QA Officer/Lead Chemist	
Mike Healy, TtNUS	Lead Hydrologist	
Dick Willey, EPA	Lead Hydrologist	
Anna Krasko EPA	Work Assignment Manager	
Cornell Rosiu EPA	Ecological Risk	
Andy Belliveau EPA	QA Oversight	

Meeting Purpose: Discuss scope of work and QAPP preparation.

Comments and Action Items: TtNUS to prepare and submit QAPP, upon EPA funding of work assignment. See Appendix E for meeting notes



Original Included in Binding


N
W
E
S
Area 4
Liquid impoundments
stained soils
Area 1
Drum storage
waste distribution
grading scars
Area 3
Drums and solid
waste storage
former drum recycling
building
Area 5
Solid waste distribution
ground disturbance
former building
Area 2
Extensive solid
waste distribution
scattered drum,
fill activity
Area 6
Grading Scars
liquid impoundments
ground disturbance
CMS-451
CMS-417
CMS-419
CMS-405
CMS-406
252
270
268
271
LEGEND
Selected Former Subsurface Soil Samples
Areas of High VOCs in Water to vapor samplers (USGS 1999)
Roads (Louis Fedenci & Associates Oct 1999)
Fence Line (EPA, Dec 1999)
Parcels (Revised Jan 2000 with Title Search Performed by EPA)
Approximate Limit of Source Area
Town Boundaries (See note 3)
Buildings (See note 3)
Parking lots (See note 3)
Areas of Environmental activity or/and Ground Disturbance noted in Aerial Photo Analysis (EPA 2000)
Geophysical Anomaly (Weston 1999)
Former Buildings Noted in Aerial Photo Analysis (EPA, 2000)
NOTES:
1) Plan not to be used for design
2) All locations to be considered approximate
3) Original map created by the EPA GIS lab 21-July-99
Sources: RIGIS, EPA, REAC, Lockheed Martin
100 0 100 Feet
1 inch = 100 feet
Original includes other buildings
SUMMARY OF HISTORICAL ACTIVITY AND FEATURES
SOURCE AREA INVESTIGATION
CENTREDALE MANOR RESTORATION PROJECT
DRAWN BY: J. R. PICCUITO
DATE: FEBRUARY 12, 2001
CHECKED BY: S. PARKER
FILE: \CENTREDALE APR
FILE: D:\PDF\SHAF5_2.PDF
FIGURE 5-2
TETRA TECH NUS, INC.
55 JONSPIN ROAD
WILMINGTON, MA 01887
(978)658-7899

6.0 PROJECT DESCRIPTION AND SCHEDULE

This section of the QAPP provides a general overview of the sampling activities and other data collection activities that will be performed as part of the Centredale Manor Restoration Project Source Area Investigation, and how they will be performed based upon regulatory action limits and data needs. These activities are summarized below. Specific details for individual project activities will be discussed in later sections of the QAPP.

6.1 Project Overview (Outcome of Project Scoping Activities)

The project planning phase determines the project quality objectives, i.e., the type, quantity, and quality of data needed to ensure project data can be used for its intended purpose to answer specific environmental questions and support environmental decisions.

The review of existing data presented in Section 5 of this QAPP resulted in identification of various data gaps. To complete the source area investigation as described in Sections 5.0 and 5.1, data is needed to determine thickness of fill, the extent of soil contamination that could be released by groundwater, and the extent of groundwater contamination. In addition, evaluation of soil types throughout the saturated overburden, and determination of groundwater flow direction (horizontally and vertically) will be necessary to support a conceptual model of groundwater flow and identification of possible contaminant flow paths through the source area and into potential resource areas.

These data needs will be met through a series of investigative efforts that will include, but may not be limited to installation of piezometers and groundwater level monitoring activities, surface and borehole geophysical investigations, and installation and sampling of soil borings and groundwater monitoring wells. Installations will be designed to target each of the eight areas identified in Section 5.2.3, and used in conjunction with each other such that the groundwater flow for the entire source area can be evaluated to predict direction and outputs.

As a separate unrelated item, data will also be collected as part of this source area investigation to support a determination of whether residents within the Centredale Manor building are being

exposed to site contaminants. These data needs will be met through collection of air and wipe samples from various areas within this building.

Since one objective of this source area investigation is to support preparation of a human health risk assessment, all soil and groundwater sampling data must be of adequate quality to meet the objectives for risk assessment purposes, in accordance with EPA Region I guidelines. Specific exposure scenarios and final site-related contaminants of concern (COCs) have not been identified at this point in the remedial process, however it is anticipated that the data to be collected may be used to support these decisions in the future.

This information included in this section describes the general approach to data collection and the use of each group of data.

6.2 Contaminants of Concern

Available chemical data for the source area properties (Centredale Manor and Brook Village) is summarized in Section 5.2.2.2. Based on available historical disposal information for these two properties, the estimated contaminants of concern (COCs) may include VOCs, SVOCs, PCBs, dioxins, and metals. However, available data is limited to the surface and, to a lesser extent, the subsurface soils, to a depth of 8 feet below ground surface. No groundwater data is available and limited geological soil information has been collected (Section 5.2.2.3). Because high concentrations of some contaminants have been found in surface and subsurface soils, the sampling described in this QAPP will be performed to evaluate the extent of such contamination in soils and groundwater, to evaluate possible off-site migration of COCs.

In addition, because high concentrations of some contaminants have been found in surface soils near the Centredale Manor building, sampling will be conducted to measure the VOCs, PCBs, and dioxins in indoor air, and the PCBs, and dioxins in dust collected within that building.

The media to be sampled as part of this investigation include soil, groundwater, non-aqueous phase liquid (NAPL) (if found), indoor air, and indoor settled dust (wipe samples). Tables 6-1 through 6-21 describes project action limits, project quantitation limits and laboratory method and quantitation limits. The action limits are identified for site contaminants in different media to

be sampled. These action limits have been chosen as the lowest achievable regulatory criteria published for each contaminant pertinent to the media. Sources for the action limits are presented in footnotes to Tables 6-1 through 6-21, as appropriate. The analytical methods and reporting limits have been selected for these contaminants and media to assure these action limits can be met.

Hexachloroxanthene (HCX) will be analyzed and reported as a tentatively identified compounds during the dioxins/furans analysis for all the matrices described in this QAPP.

Tables for each media to be sampled with the respective analytical laboratory programs are summarized below:

Table	Media	COCs	Analytical Laboratory
6-1	Soil	low/medium concentration VOCs	DAS (2)
6-2		low/medium concentration SVOCs	CLP(1)
6-3		low/medium concentration pesticides/PCBs	CLP
6-4		low/medium concentration metals	CLP
6-5		low/medium concentration dioxins	DAS
6-6	Groundwater	low/medium concentration VOCs	CLP
6-7		low/medium concentration SVOCs	CLP
6-8		low/medium concentration pesticides/PCBs	CLP
6-9		low/medium concentration metals	CLP
6-10		low/medium concentration dioxins	DAS
6-11		Alkalinity, sulfides, and TOC	DAS
6-12	NAPL	medium concentration VOCs	CLP
6-13		low/medium concentration SVOCs	CLP
6-14		low/medium concentration pesticide/PCBs	CLP
6-15		low/medium concentration metals	CLP
6-16		low/medium concentration dioxins	DAS
6-17	Air	low/medium concentration VOCs	DAS
6-18		low concentration pesticides/PCBs	DAS
6-19		low concentration dioxins	DAS
6-20	Wipes	low concentration PCBs	DAS
6-21		low concentration dioxins	DAS

(1) EPA Contract Laboratory Program

(2) TtNUS subcontracted laboratory under the Delivery of Analytical Services (DAS) work assignment

6.3 Sampling and Field Data Collection Tasks

This section presents an overview of the sampling and field data collection tasks that will be conducted during the Centredale Manor Restoration Project source area field investigation. The media to be sampled under this investigation, as summarized in the sections below, include soil, groundwater, NAPL (if present), air, and settled dust (wipe) samples. The number of samples for each media, including quality control samples, is summarized in Table 6-22. As summarized in the sections that follow, a phased approach of sampling and investigation will be implemented at the site (Phase 1 and Phase 2).

Several data collection activities to be conducted as part of this investigation which do not involve the actual collection of environmental media samples (e.g. geophysical investigations, piezometer installations and water table measurements, hydraulic conductivity tests) are also included in the summary below.

6.3.1 Subsurface Investigations (Borings, Wells, Piezometers, and Geophysical Investigations)

To support the determination of the nature and extent of contamination present at the site and preparation of the baseline human health risk assessment, a variety of subsurface investigation activities and associated data collection events will be implemented. These activities include the advancement of borings and soil sample collection, monitoring well installations (overburden and bedrock), piezometer and surface water gauge installations and measurements, geophysical surveys, and hydraulic conductivity testing, as discussed in the sections that follow.

Soil borings will be advanced and subsurface soil sampling will be conducted, to include sampling and chemical analysis of subsurface soils at three properties that constitute the source area:

- Brook Village Properties, North Providence Plat 14, Lot 200,
- Centredale Manor Property, North Providence Plat 14, Lot 250, and
- Allendale Mill and Allendale Mill Associates, north end of North Providence Plat 12, Lot 560

In addition, data will be collected from borings and/or wells to be installed on properties surrounding the source area, including, but not necessarily limited to:

- North Providence Plat 14, Lot 511, (possible post office development area)
- Johnston Plat 38, Lot 245, Narragansett Electric Co.
- Town of North Providence, on Steere, Grover, and Redfern Streets.

These properties are shown in relation to the source area in Figure 6-1.

Also, as part of the initial (Phase 1) drilling activities, direct push technique (DPT) piezometers and surface water gauges will be installed for the purpose of obtaining groundwater table and surface water level measurements to better define the configuration of the groundwater table across the site (no samples will be collected from these installations).

Possible boring, well, piezometer, and surface water gauge locations are presented in Figures 6-1 (Phase 1) and 6-3 (Phase 2). Exact boring and well locations will be determined as described below and in Section 8. In addition, these locations may be supplemented as described in Sections 8 and 9 of this QAPP.

Subsurface soil samples will be collected from the soil borings in order to investigate the presence of VOCs, SVOCs, pesticides/PCBs, metals, and dioxins at these locations for the purposes stated above. See Section 8 for a detailed description of the soil sampling rationale.

6.3.1.1 Phase 1 Soil Borings, Soil Sampling and Monitoring Well Installations

The Phase 1 soil sampling will include the advancement of soil borings and soil sample collection from shallow soil borings to be advanced: (1) in the Centredale Raceway, and (2) in or near several potential contaminant source areas as identified through evaluation of historical air photos and through interpreted geophysical ground anomalies, as discussed below.

Phase 1 - Soil Borings and Monitoring Wells in the Centredale Raceway

Five soil borings will be installed in the Centredale raceway. The exact locations will be determined in the field using the historic air photos and landmarks, such that the borings are installed as closely as possible to the former centerline of this watercourse. These borings will be installed to determine the thickness of fill (if present) in the former raceway and to provide data for evaluation of the nature and extent of soil contamination in the former raceway. The soils will be classified using the Unified Soil Classification System (USCS). The description of geologic materials will assist in evaluating the presence of potential confining layers and/or preferential pathways for groundwater transport. This information may also be used to support a conceptual design for the restoration of the raceway as a drainage channel.

The raceway borings may be located as depicted on Figure 6-1 to collect continuous subsurface soil samples as deep as the limit of natural soils (bottom of fill), which is anticipated to be approximately 8 feet below ground surface. These samples will be collected using a 3-inch diameter split barrel sampling tool from 1-foot intervals beginning at 1-foot below ground surface.

The borings will be continued beyond the depth of fill to a minimum of 20 feet below ground surface (bgs) to characterize the upper unconsolidated overburden. Borings may be continued beyond 20 feet bgs as determined by the supervising geologist, based on conditions encountered as described in Sections 8.2.1 and 9.1.1 of this QAPP. Soils will undergo jar headspace screening for total volatile organics compounds (VOCs). Headspace screening results for VOCs in soils will be used to identify zones of highest potential for contamination. This data, in conjunction with the soil characterization and visual observations of staining or other evidence of potential contamination will be used to determine the vertical position of well screens, as described further in Section 8.

Samples of fill/soils will be collected and analyzed for the following parameters: VOC screening using jar headspace, and laboratory analysis for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins.

An estimated three shallow groundwater monitoring wells may be installed in selected raceway borings to provide data for evaluation of groundwater flow directions and contaminant presence in groundwater in the raceway vicinity. Wells will be installed to screen areas within the overburden suspected to carry contaminants within the groundwater. The screened interval depths and lengths will be determined by the supervising geologist based on the soil classification and headspace VOC screening results. Because it is anticipated that the water table in the raceway is above ground, wells will not likely be screened to cross the water table. In general, the portion of the saturated zone that has the highest likelihood of contamination will be screened, based on headspace screening and visual observations. The rationale for selection of screen lengths and depths is described in Section 8.

If multiple vertical zones of potential contaminants are identified in a single boring, multiple wells may be installed at that location. In addition, if soil conditions vary between borings, and field observations indicate different contaminant layers are being encountered in borings not originally designated for well installations, such borings may also be completed as monitoring wells.

Phase 1 - Source Area Shallow Borings and Monitoring Wells

Four shallow borings will be installed in the source area as shown on Figure 6-1. The exact locations of these borings will be determined in the field, to be located adjacent to or within areas of ground disturbance shown on the historic air photos and adjacent to (but not within) geophysical anomalies identified by studies described in Section 5.2.2.2. These borings will be installed to determine the thickness of fill (if present) and to provide data to evaluate the nature and extent of soil contamination (soils generally at and above the water table). The soils will be classified using the USCS. The description of geologic materials will assist in evaluating the presence of potential confining layers and/or preferential pathways for groundwater transport.

During installation of the source area borings, continuous samples of subsurface soil will be collected to the bottom of fill, which is presumed to be approximately 8 feet below ground surface. These samples will be collected at 1-foot intervals beginning at a point immediately below the cap materials or parking lot bedding materials, as described in Section 9.1.1.

The borings will be continued beyond the depth of fill to a minimum of 20 feet bgs to characterize the upper unconsolidated overburden. Borings may be continued beyond 20 feet bgs as determined by the supervising geologist, based on conditions encountered as described in Sections 8.2 and 9.1 of this QAPP. Soils will be screened using the jar headspace technique for total VOCs. Screening results will be used to identify zones of highest potential for contamination within each boring. This data, in conjunction with the soil characterization and visual observation of staining or other evidence of potential contamination will be used to determine the vertical position of well screens, as described in Section 8.

Samples of soil presumed to be fill or identified as fill will be analyzed for the following parameters: VOC screening using jar headspace, and laboratory analysis for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins.

The four shallow source area borings will be finished as monitoring wells in order to identify contaminants within what is anticipated to be the areas of highest probability of contamination, based on review of historic information (Section 5.2.2). The wells will be installed in the targeted source areas to screen the vertical horizons that are suspected to carry contaminants within the groundwater. The well screen intervals (depth and length) will be determined by the supervising geologist based on soil classification, visual observations of contaminant horizons and headspace VOC screening results. In general, the portion of the saturated zone that has the highest likelihood of contamination will be selected for the screened interval. The rationale for selection of screen length and elevation is described in Section 8.2. If multiple separate zones of suspected contamination are found in a single boring, additional wells may be installed within close proximity to evaluate contamination from each of these depth intervals.

6.3.1.2 Phase 1 - DPT Piezometers, Surface Water Gauges, and Long-Term Water Table Measurements

Phase 1 activities will include the advancement of shallow water table piezometers using the direct push technique (DPT), to establish locations for the measurement of groundwater table elevations across the site. Using DPT methods, an estimated 20 small diameter (1-inch) piezometers with screened lengths of 5 feet will be installed in the source area. Approximate piezometer locations are indicated in Figure 6-1. The piezometers will be advanced and

screened in the shallow water table aquifer, strictly for the purpose of providing locations for groundwater table elevation measurements. This data will be used to better define the groundwater table configuration at the site. These installations will not be used for soil or groundwater sample collection purposes.

Following piezometer installation, recording electronic transducers will be installed at selected piezometer and/or shallow (water table) monitoring well locations for the purpose of long-term groundwater level monitoring at the site. Three surface water gauges will also be installed in the Woonasquatucket River and in the Centredale raceway (approximate proposed locations indicated in Figure 6-1). Water table elevation measurements from these installations and from an existing USGS gauging station in the Woonasquatucket River will provide data on the water table configuration at the site. Phase 1 activities will include one 4-week event of water table elevation monitoring to be conducted near or during the high water table season (spring). A second long-term (6-week) groundwater elevation monitoring event will be conducted near or during the low water table season (summer), as summarized in Section 6.3.1.6.

6.3.1.3 Phase 1 - Geophysical Surveys

As part of Phase 1 activities, surface geophysical surveys will be implemented in the site vicinity, including Seismic Refraction, Ground Penetrating Radar (GPR) and 2-D Resistivity Imaging. These surveys will provide data to support characterization of overburden materials, data on characterization of overburden, depth of fill, depth to bedrock and the general bedrock surface configuration, as discussed below. These data will also be used to assist in refining the positioning of monitoring wells to be installed during Phase 2 activities, and to provide needed information to refine the site conceptual model.

The GPR and 2-D Resistivity will be conducted to provide information on depth of fill, the configuration of natural organic materials, buried channel deposits, and potential aquitards. The Seismic Refraction survey will provide information on depths to bedrock and the configuration of a potential bedrock valley in the area that may influence contaminant transport at and near the site.

Following completion and evaluation of the initial surface geophysical work described above, and other Phase 1 data, additional geophysical work may be conducted in the site vicinity. This work would use Square Array Azimuthal Resistivity to provide data for estimating bedrock fracture orientation in the area. The data would be used to assist in refining proposed Phase 2 bedrock monitoring well locations and would provide information to support the site conceptual model of likely groundwater flow direction(s) in bedrock.

Figure 6-2 presents proposed locations of geophysical investigations. Additional information on the proposed geophysical surveys is presented in Section 9. (Environmental sampling and chemical analysis will not be conducted under this task.)

6.3.1.4 Phase 2 - Soil Borings, Soil Sampling and Monitoring Well Installations

The Phase 2 subsurface investigations will include the advancement of overburden soil borings and drilling and installation of overburden and bedrock monitoring wells, as well as borehole geophysical activities, as summarized below.

Phase 2 – "Perimeter Area" Monitoring Wells and Borehole Geophysics

Four clusters of two to three monitoring wells per cluster (one bedrock well, plus one to two overburden wells, depending on saturated thickness of the overburden) will be installed in areas perimeter to the source area. It is anticipated that two well clusters will be located to the west and southwest of the source area (opposite side of the Woonasquatucket River) and two well clusters will be located to the east of the source area (opposite side of the raceway). Potential proposed locations are indicated in Figure 6-3, however, actual locations of these wells may be revised based on an evaluation of Phase 1 data, including geophysical survey results.

These borings/wells are to be advanced to provide information to confirm depths to bedrock, and to provide water level measurement points for evaluating vertical and horizontal groundwater gradients in these areas adjacent to the source area, in bedrock and in shallow and deep overburden. These wells will also be used for groundwater sampling purposes, to provide data on groundwater quality in these perimeter areas of the source area.

Soil samples collected during the advancement of these borings will be evaluated in the field using VOC headspace screening techniques, and will be described using the USCS soil classification system (soil samples will not be collected from these locations for laboratory chemical analysis). This information, to be collected from the initial (deepest) boring at each cluster location, will be used to select the screened intervals of the overburden wells.

Bedrock will be cored at each location to an estimated depth of 30 feet below the top of rock. One "open hole" bedrock groundwater monitoring well will be installed at each well cluster, following the collection of field data, including packer tests to be conducted during drilling, and other field data such as visual observations of fractures and weathering in the rock core, drilling rates, and loss or gain of water during bedrock drilling.

Borehole geophysics will also be conducted within each bedrock hole. The objectives of the borehole geophysical activities are to determine the orientation of linear features in the boreholes, to determine the zones that produce water under static and stressed conditions, and to measure natural gamma radiation. Borehole geophysics activities may generate heat pulse flow meter logs, caliper logs, natural gamma logs, and borehole acoustic televiewer logs for each bedrock borehole.

Phase 2 – "Southern (Downgradient) Area" Monitoring Wells and Borehole Geophysics

Two clusters of two to three monitoring wells per cluster (one bedrock well, plus one to two overburden wells, depending on saturated thickness of the overburden) will be installed in areas south (and likely downgradient) of the source area. It is anticipated that these well clusters will be located south of the source area near locations of previously detected VOCs (in vapor diffusion sampling conducted by USGS). Potential proposed locations are shown in Figure 6-3, however, actual locations of these wells may be revised following the evaluation of Phase 1 data.

These borings/wells are to be advanced to provide information on extent of contamination in soils and groundwater, to confirm depths to bedrock, and to provide water level measurement points for evaluating vertical and horizontal groundwater gradients in these areas south of the

source area, within bedrock and in shallow and deep overburden. These wells will also be used for groundwater sampling purposes, to provide data on groundwater quality in these areas.

Continuous soil samples collected during the advancement of the initial (deepest) boring at each cluster will be evaluated in the field using VOC headspace screening techniques, and will be described using the USCS soil classification system. This information, as well as total saturated thickness and predicted vertical gradients (from Phase 1) will be used to determine the well screen locations and to determine the number of wells per cluster (assuming up to two wells per cluster).

Soil samples for laboratory chemical analysis will also be collected from the initial (deepest) boring at each cluster, however, laboratory samples will be collected only to an estimated depth of approximately 8 feet below ground surface. Laboratory analysis of these soils is to evaluate potential source-area-related contaminants that may be present in shallow soils in this area due to depositional events from previous flooding or overland flows. Continuous soil samples will be collected from 1-foot intervals using a 3-inch diameter split barrel sampling tool, to an estimated depth of 8-feet, and will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins, in addition to VOC headspace field screening. Soils below 8-feet will be collected for VOC headspace screening and visual identification (USCS) only, as stated above.

Bedrock will be cored at each location to an estimated depth of 30 feet below the top of rock. One "open hole" bedrock groundwater monitoring well is anticipated at each well cluster, following the collection of field data, including packer tests to be conducted during drilling, and other field data such as visual observations of fractures and weathering in the rock core, drilling rates, and loss or gain of water during bedrock drilling.

As in the "perimeter area wells" discussed above, borehole geophysics will also be conducted within each bedrock hole in the "southern area". The objectives of the borehole geophysical activities are to determine the orientation of linear features in the boreholes, to determine the zones that produce water under static and stressed conditions, and to measure natural gamma radiation. Borehole geophysics activities may generate heat pulse flow meter logs, caliper logs, natural gamma logs, and borehole acoustic televiewer logs for each bedrock borehole.

Phase 2 – "Discharge Area" Soil Borings and Monitoring Wells

An estimated four clusters of up to two monitoring wells per cluster (one deep overburden and one shallow overburden well, depending on saturated thickness of the overburden) will be installed in areas estimated to be potential "discharge areas" of groundwater contaminants originating in the source area, and potentially discharging through groundwater to the Woonasquatucket River and/or to the raceway. These borings/wells are to be advanced to provide information on groundwater contaminants from the source area that are potentially discharging to the River and/or raceway from shallow and/or deep overburden, and to provide additional data to evaluate the nature and extent of soil contamination (soils generally at and above the water table).

It is anticipated that these well clusters will be located between (downgradient of) potential "hot spots" within the source area and the River and/or raceway, in order to evaluate contaminants which may be discharging to these surface water bodies via groundwater in shallow and/or deep overburden. It is anticipated that the "discharge area" borings may be advanced to the top of bedrock, to provide data on the entire saturated thickness within the overburden at each location. Based on available data at the writing of this QAPP, the deep overburden wells may be advanced to approximately 45 to 60 feet, the estimated depth to bedrock. Specific depths, locations, and numbers of wells per cluster for the "discharge area" borings/wells will be selected following the evaluation of Phase 1 results, including geophysical survey results, groundwater flow direction data, vertical gradients, and soil and groundwater analytical results. One or more "discharge area" wells may be co-located with one or more existing shallow source area wells that were installed during Phase 1, if appropriate (a deep overburden well could be co-located with an existing Phase 1 shallow overburden well, if appropriate, based on the evaluation of Phase 1 data).

Continuous soil samples collected during the advancement of the initial (deepest) boring at each cluster will be evaluated in the field using VOC headspace screening techniques, and will be described using the USCS soil classification system. This information, as well as total saturated thickness and predicted vertical gradients (from Phase 1) will be used to determine the well screen locations and to determine the number of wells per cluster (assuming up to two wells per cluster).

Soil samples for laboratory chemical analysis will also be collected from the initial (deepest) boring at each cluster, however, laboratory samples will be collected only to the bottom of fill materials (estimated to be approximately 8 feet below ground surface). Continuous soil samples will be collected from 1-foot intervals using a 3-inch diameter split barrel sampling tool, to an estimated depth of 8-feet (estimated bottom of fill), and will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins, in addition to VOC headspace field screening. Soils below the identified fill materials will be collected for VOC headspace screening and visual identification (USCS) only, as stated above.

6.3.1.5 Phase 2 – Hydraulic Conductivity Tests

Hydraulic conductivity tests will be performed at each newly installed overburden monitoring well (including Phase 1 and Phase 2 wells) to provide data to evaluate groundwater flow conditions in the water-bearing zones of each well. It is anticipated that the data generated from these tests will be used to define the water-yielding characteristics of each formation, to develop groundwater velocity values, and to estimate the rate of groundwater movement across and away from the study area.

Constant discharge hydraulic conductivity tests will be performed where possible (at well locations of sufficient hydraulic conductivity, as determined during well development activities). These tests will be performed by pumping at a given rate and measuring drawdown in the well until steady-state drawdown occurs, or a maximum of 15 minutes, as further detailed in Section 9.

Slug tests may be used in place of pump tests at wells screened in materials of lower hydraulic conductivity. Slug tests will be performed by inserting or withdrawing a solid slug from the well, inducing a nearly instantaneous change in water level within the well. The rate of recovery of the water level to static conditions will be measured.

It is noted that hydraulic conductivity estimates in bedrock wells will be based on packer tests to be conducted during bedrock drilling activities (Section 6.3.1.4).

6.3.1.6 Phase 2 – Long-Term Groundwater/Surface Water Level Measurements

Phase 2 activities will include one 6-week event of groundwater and surface water elevation monitoring to be conducted near or during the low water table season (summer). As in the Phase 1 long-term water level monitoring event (Section 6.3.1.2), recording electronic transducers will be installed at selected piezometer and monitoring well locations for the purpose of long-term groundwater level monitoring at the site. The three surface water gauges installed during Phase 1 activities in the Woonasquatucket River and in the Centredale raceway (approximate proposed locations indicated in Figure 6-1) will also be monitored. Groundwater and surface water elevation measurements from these installations and from an existing USGS gauging station in the Woonasquatucket River will provide data on the water table configuration, on shallow and deep hydraulic heads at the site, and vertical gradients between shallow and deep aquifers (overburden and bedrock) within the study area over the selected 8-week time period (to be conducted near/during the low water table season).

Since this Phase 2 monitoring event will be implemented after the installation of several bedrock and deep overburden monitoring wells, selected bedrock and deep overburden installations will also be instrumented with recording electronic transducers, in addition to the water table wells/piezometers measured during the Phase 1 event. Specific wells/piezometers to be instrumented and measured during the 8-week event will be selected following evaluation of Phase 1 data.

6.3.2 Groundwater Sampling

Two events of groundwater sampling and analysis (Phase 1 and Phase 2) will be conducted from the newly installed monitoring wells within the study area. The groundwater analytical data is needed:

- To support an evaluation of the nature and extent of source-area-related contamination;
- To evaluate the impact of contaminated groundwater discharge to surface waters (Woonasquatucket River and the raceway) in the vicinity of the source area and in downgradient areas.

During both the Phase 1 and Phase 2 events, groundwater samples will be collected using low-flow sampling methods, and will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals (total and dissolved), dioxins, alkalinity, sulfides, and total organic carbon (TOC). These analytes for groundwater samples were selected based on the type of contaminants that have been historically detected in the source area or in the adjacent Woonasquatucket River, and/or based on contaminants typically associated with the previous industries that were active at the source area, based on historical records (refer to details in Section 5).

It is noted that groundwater in the vicinity of the study area is classified as "GB" (not used for drinking water purposes), therefore, the human health risk assessment to be conducted is not anticipated to evaluate a "drinking water exposure scenario"; however, it is anticipated that the groundwater data will be used in the human health risk assessment for other possible exposure scenarios (to be determined). The groundwater data may be compared to RIDEM Upper Concentration Limits (UCLs) for "GB" groundwater, and to RIDEM Ambient Water Quality Criteria and Guidelines (Freshwater Chronic Criteria), assuming a 1000:1 dilution in groundwater to river discharge.

During Phase 1 and Phase 2 of the subsurface investigations, as described in Sections 6.3.1.1 and 6.3.1.4, groundwater monitoring wells are to be installed in areas estimated to be upgradient and downgradient of the source area. Further details on well location rationale are provided in Section 8. Proposed groundwater sampling locations are presented in Figures 6-1 and 6-3, however, it is noted that some well locations may be revised based on an evaluation of Phase 1 data. Each groundwater sampling event is summarized below.

6.3.2.1 Phase 1 Groundwater Sampling

The Phase 1 groundwater sampling event will be conducted after completion of Phase 1 drilling activities, and will include all monitoring wells installed during Phase 1 (seven shallow overburden wells). Groundwater samples will be collected from each monitoring well using low-flow sampling methods, and will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals (total and dissolved), dioxins, alkalinity, sulfides, and TOC. Additional information on groundwater sampling design and groundwater sampling procedures is provided in Sections 8 and 9, respectively.

6.3.2.2 Phase 2 Groundwater Sampling

The Phase 2 groundwater sampling event will be conducted after completion of Phase 2 drilling activities, and will include all monitoring wells installed during Phase 1 (seven shallow overburden wells), and all monitoring wells installed during Phase 2 (an estimated maximum of 26 wells, including shallow overburden, deep overburden, and bedrock wells), for a total estimated maximum of 33 wells during the Phase 2 sampling event. Groundwater samples will be collected from each monitoring well using low-flow sampling methods, and will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals (total and dissolved), dioxins, alkalinity, sulfides, and TOC. Additional information on groundwater sampling design and groundwater sampling procedures is provided in Sections 8 and 9, respectively.

6.3.3 NAPL Sampling

Shallow monitoring wells will be installed in the source area borings as discussed in Section 6.3.1 in order to evaluate the presence of possibly high concentrations of contaminants. Based on the anomalies identified by geophysical surveys performed in this area in 1999, it is possible that some of the borings may be advanced into areas where NAPL is present. Therefore, an allowance is made within this work scope to collect samples of this material during either the soil sampling efforts (during soil boring/well installation activities) or the groundwater sampling effort, or both, depending on the conditions found during sampling.

NAPLs may be captured with split barrel samplers (in emulsion with soil), with bailers (in groundwater monitoring wells) or through low-flow groundwater sample collection, if recoverable quantities are present. If recoverable amounts of NAPL are captured at any time during the fieldwork, this material will be collected for laboratory analysis of VOCs, SVOCs, pesticides/PCBs, total metals, and dioxins, as available volume allows.

It is anticipated that NAPLs could be present in any of the borings and wells to be installed as described in this QAPP. An allowance of up to 15 NAPL samples is included in this work scope to accommodate this potential finding during soil or groundwater sampling.

6.3.4 Air Sampling

To evaluate the potential presence of site-related contaminants inside the Centredale Manor building, an air sampling investigation will be conducted. Air samples will be collected from five separate locations within the Centredale Manor, including the ground floor, common spaces, and enclosed living spaces, and will be analyzed for VOCs, PCBs, and dioxins. Air sample collection methods are described in Section 9.

6.3.5 Wipe Sampling

To further evaluate the potential presence of site-related contaminants in the Centredale Manor building, wipe samples will be collected from horizontal surfaces in that building, where contaminants possibly present in dust may have settled. Samples will be collected in five separate locations of the Centredale Manor, including the ground floor, common spaces, and enclosed living spaces, and will be analyzed for PCBs and dioxins. Samples will be collected by wiping designated surface areas to capture dust and other particulates that may contain contaminants. Wipe sample collection methods are described in Section 9.

6.4 Analytical Tasks and Services

All analytical tasks, with the exception of headspace VOC screening, will be performed at off-site fixed laboratories. The groundwater sample analyses for VOCs, SVOCs, pesticides/PCBs, and metals, and the soil sample analyses for SVOCs, pesticides/PCBs, and metals will be conducted by laboratories to be assigned by EPA through the Contract Laboratory Program (CLP). The soil sample analyses for VOCs, and all sample analyses for dioxin will be conducted by laboratories to be selected under the Delivery of Analytical Services (DAS) Work Assignment. In addition, all analyses for the air, wipe, and NAPL samples to be collected will be conducted by a DAS laboratory.

The analytical services are summarized in Table 6-23. The data generated by the CLP and DAS laboratories will be reviewed and validated by TtNUS, with the exception of dioxin data, which will be validated by EPA. Sections 18 and 19 discuss data verification and validation.

The QA Officer will perform quality assurance audits. The audits will review the major activities conducted for the Centredale Manor Restoration Project to confirm compliance with this QAPP. Corrective actions will be taken after non-compliances if activities are not being performed in accordance with this QAPP. Data usability will be assessed as outlined in Section 20.

All project documentation will be organized and filed at TtNUS as described in Section 15.0.

6.5 Project Schedule

An anticipated project schedule is attached as Table 6-24. This schedule presents anticipated start and finish dates, assuming availability of prerequisite data from other tasks and investigations. Revisions to the anticipated schedule may be required due to findings of the ongoing investigations, and due to weather conditions encountered during field tasks. If an event causes an impact to the schedule, the TtNUS Project Manager will notify the EPA WAM.

The initial portion of Phase 1 (drilling of raceway and source area borings/wells and soil sampling) began in December 2000, under the QAPP Revision 0 and Revision 1. Phase 1 activities also include installation of DPT piezometers, surface water gauges, groundwater sampling and analysis activities (February 2001), and Phase 1 surface geophysical surveys. Surface geophysics, long-term water table measurements and land survey activities will complete Phase I (April 2001).

Phase 2 is scheduled to begin in May 2001. Phase 2 activities include installation of borings and wells in the perimeter areas, southern (downgradient) area, and discharge area. Downhole geophysics will also be conducted to evaluate bedrock fractures. Following completion of Phase 2 drilling and well installations, hydraulic conductivity tests will be conducted from new wells, and a second event (summer/low water table season) of long-term groundwater/surface water level measurements will be conducted. A Phase 2 event of groundwater sample collection and analysis will also be conducted, to include all wells installed during Phase 1 and Phase 2. Air sampling and wipe sampling will be conducted in May or June 2001.

Prior to field mobilization for each phase and task, all participating field team members will review the QAPP, the HASP and all applicable SOPs. In addition, a field orientation meeting

will be held with the Project Manager, the Lead Chemist, and the Health and Safety Manager prior to initiating the sampling events to familiarize field team members with the scope of the field activities.

Project team personnel are trained in the specific procedures to be followed during the execution of the work, including but not limited to project QA/QC requirements, sampling procedures, chain- of-custody procedures, document control, testing and inspection methods, calibration methods, and in particular, the general provisions of this QAPP and its supporting procedures and guidelines.

Table 6-1
Soil – Volatile Contaminants of Concern and Other Target Analytes
Volatile Organic Compounds Method 5035/OLM04.2, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs(2) (µg/kg)	Method QLs (µg/kg)	MDLs(2) (µg/kg)	QLs (µg/kg)
Dichlorodifluoromethane	75-71-8	NA	600	54.6	600	54.6	600
Chloromethane	74-87-3	NA	600	72.0	600	72.0	600
Bromomethane	74-83-9	NA	600	108	600	108	600
Vinyl Chloride	75-01-4	NA	600	60.0	600	60.0	600
Chloroethane	75-00-3	NA	600	46.8	600	46.8	600
Methylene Chloride	75-09-2	NA	600	174.0	600	174.0	600
Acetone	67-64-1	NA	600	168.0	600	168.0	600
Methyl Acetate	79-20-9	NA	600	-	600	-	600
Carbon Disulfide	75-15-0	NA	600	48.0	600	48.0	600
Trichlorofluoromethane	75-69-4	NA	600	59.4	600	59.4	600
1,1-Dichloroethene	75-35-4	NA	600	60.0	600	60.0	600
1,1,2-Trichloro-1,2,2-trifluoro-ethane	76-13-1	NA	600	-	600	-	600
1,1- Dichloroethane	75-34-3	NA	600	49.2	600	49.2	600
Methyl tert-Butyl Ether	1634-04-4	NA	600	25.8	600	25.8	600
cis-1,2- Dichloroethene	156-59-2	NA	600	39.0	600	39.0	600
trans-1,2- Dichloroethene	156-60-5	NA	600	54.6	600	54.6	600
Chloroform	67-66-3	NA	600	50.4	600	50.4	600
*1,2- Dichloroethane	107-06-2	900	600	19.8	600	19.8	600
2-Butanone	78-93-3	NA	600	264.0	600	264.0	600
1,1,1-Trichloroethane	71-55-6	NA	600	58.2	600	58.2	600
Bromochloromethane	74-97-5	NA	600	50.4	600	50.4	600
Cyclohexane	110-82-7	NA	600	-	600	-	600
Carbon Tetrachloride	56-23-5	NA	600	26.4	600	26.4	600
Bromodichloromethane	75-27-4	NA	600	27.0	600	27.0	600
Methylcyclohexane	108-87-2	NA	600	-	600	-	600
1,2-Dichloropropane	78-87-5	NA	600	42.6	600	42.6	600
cis-1,3- Dichloropropene	10061-01-5	NA	600	22.8	600	22.8	600
*Trichloroethene	79-01-6	13,000	600	24.6	600	24.6	600
Dibromochloromethane	124-48-1	NA	600	16.8	600	16.8	600
1,1,2- Trichloroethane	79-00-5	NA	600	18.0	600	18.0	600
*Benzene	71-43-2	2,500	600	30.0	600	30.0	600
trans-1,3-Dichloropropene	10061-02-6	NA	600	39.6	600	39.6	600
Isopropylbenzene	98-82-8	NA	600	28.8	600	28.8	600
Bromoform	75-25-2	NA	600	40.8	600	40.8	600
4-Methyl-2-Pentanone	108-10-1	NA	600	432.0	600	432.0	600
2-Hexanone	591-78-6	NA	600	84.0	600	84.0	600
*Tetrachlorethene	127-18-4	12,000	600	27.6	600	27.6	600
1,1,2,2- Tetrachlorethane	79-34-5	NA	600	138.0	600	138.0	600
Ethylene Dibromide	106-93-4	NA	600	41.4	600	41.4	600
Toluene	108-88-3	NA	600	43.2	600	43.2	600
1,2-Dibromoethane	106-93-4	NA	600	41.4	600	41.4	600
*Chlorobenzene	108-90-7	210,000	600	28.2	600	28.2	600
*Ethylbenzene	100-41-4	71,000	600	27.0	600	27.0	600
Styrene	100-42-5	NA	600	40.2	600	40.2	600
*Total Xylenes	1330-20-7	110,000	600	78.0	600	78.0	600
1,3-Dichlorobenzene	541-73-1	NA	600	25.8	600	25.8	600
1,4- Dichlorobenzene	106-46-7	NA	600	27.6	600	27.6	600
1,2- Dichlorobenzene	95-50-1	NA	600	21.0	600	21.0	600
1,2-Dibromo-3-chloropropane	96-12-8	NA	600	72.0	600	72.0	600
1,2,4-Trichlorobenzene	120-82-1	NA	600	33.0	600	33.0	600

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites. Direct Exposure Criteria for Residential Use Soils.
(2) MDLs from Katahdin Analytical Services for Medium Level VOC soil samples

Table 6-2
Soil – Semivolatile Contaminants of Conern and Other Target Analytes
Semivolatile Organic Compounds CLP Method OLM04.2
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit[1] (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2]	Method QLs (µg/kg)	MDLs[2]	QLs (µg/kg)
Benzaldehyde	100-52-7	NA	330		330		330
Phenol	108-95-2	NA	330		330		330
Bis-(2-Chloroethyl) ether	111-44-4	NA	330		330		330
2-Chlorophenol	95-57-8	NA	330		330		330
2-Methylphenol	95-48-7	NA	330		330		330
2,2-oxybis(1-Chloropropane)	108-60-1	NA	330		330		330
Acetophenone	98-86-2	NA	330		330		330
4-Methylphenol	106-44-5	NA	330		330		330
N-Nitroso-di-n propylamine	621-64-7	NA	330		330		330
Hexachloroethane	67-72-1	NA	330		330		330
Nitrobenzene	98-95-3	NA	330		330		330
Isophorone	78-59-1	NA	330		330		330
2-Nitrophenol	88-75-5	NA	330		330		330
2,4-Dimethylphenol	105-67-9	NA	330		330		330
Bis(2-Chloroethoxy) methane	111-91-1	NA	330		330		330
2,4-Dichlorophenol	120-83-2	NA	330		330		330
Naphthalene	91-20-3	NA	330		330		330
4-Chloroaniline	106-47-8	NA	330		330		330
Hexachlorobutadiene	87-68-3	NA	330		330		330
Caprolactam	105-60-2	NA	330		330		330
4-Chloro-3-methylphenol	59-50-7	NA	330		330		330
2-Methylnaphthalene	91-57-6	NA	330		330		330
Hexachlorocyclopentadiene	77-47-4	NA	330		330		330
2,4,6-Trichlorophenol	88-06-2	NA	330		330		330
2,4,5-Trichlorophenol	95-95-4	NA	830		830		830
1,1'-Biphenyl	92-52-4	NA	330		330		330
2-Chloronaphthalene	91-58-7	NA	330		330		330
2-Nitroaniline	88-74-4	NA	830		830		830
Dimethylphthalate	131-11-3	NA	330		330		330
2,6-Dinitrotoluene	606-20-2	NA	330		330		330
Acenaphthylene	208-96-8	NA	330		330		330
3-Nitroaniline	99-09-2	NA	830		830		830
Acenaphthene	83-32-9	NA	330		330		330
2,4-Dinitrophenol	51-28-5	NA	830		830		830
4-Nitrophenol	100-02-7	NA	830		830		830
Dibenzofuran	132-64-9	NA	330		330		330
2,4-Dinitrotoluene	121-14-2	NA	330		330		330
Diethylphthalate	84-66-2	NA	330		330		330
Fluorene	86-73-7	NA	330		330		330
4-Chlorophenyl-phenyl ether	7005-72-3	NA	330		330		330
4-Nitroaniline	100-01-6	NA	830		830		830
4,6-Dinitro-2-methylphenol	534-52-1	NA	830		830		830
N-Nitroso diphenylamine	86-30-6	NA	330		330		330
4-Bromophenyl-phenylether	101-55-3	NA	330		330		330

Table 6-2 (cont.)
Soil - SVOC Target Analytes
Semi-Volatile Organic Compounds CLP Method OLM04.2
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Analytes	CAS Number	Project Action Limit(1) (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs(2)	Method QLs (µg/kg)	MDLs(2)	QLs (µg/kg)
Hexachlorobenzene	118-74-1	NA	330		330		330
Atrazine	1912-24-9	NA	330		330		330
Pentachlorophenol	87-86-5	NA	830		830		830
Phenanthrene	85-01-8	NA	330		330		330
Anthracene	120-12-7	NA	330		330		330
Carbazole	86-74-8	NA	330		330		330
Di-n-butylphthalate	84-74-2	NA	330		330		330
Fluoranthene	206-44-0	NA	330		330		330
Pyrene	129-00-0	NA	330		330		330
Butylbenzylphthalate	85-68-7	NA	330		330		330
3,3'-Dichlorobenzidine	91-94-1	NA	330		330		330
*Benzo (a) anthracene	56-55-3	900	330		330		330
*Chrysene	218-01-9	400	330		330		330
*bis(2-Ethylhexyl) phthalate	117-81-7	46,000	330		330		330
Di-n-octylphthalate	117-84-0	NA	330		330		330
*Benzo (b) fluoroanthene	205-99-2	900	330		330		330
Benzo (k) fluoroanthene	207-08-9	NA	330		330		330
*Benzo (a) pyrene	50-32-8	600(3)	330		330		330
Indeno (1,2,3-cd)-pyrene	193-39-5	NA	330		330		330
Dibenzo (a,h)-anthracene	53-70-3	NA	330		330		330
*Benzo (g,h,i) perylene	191-24-2	800	330		330		330

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites, Direct Exposure Criteria for Residential Use Soils
(2) MDL for CLP laboratory not available
(3) Region IX PRGs for Residential Soils

Table 6-3
Soil – Pesticides/PCB Contaminants of Concern and Other Target Analytes
Pesticide/PCB CLP Method OLM04.2
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit(1) (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs(2)	Method QLs (µg/kg)	MDLs(2)	QLs (µg/kg)
alpha-BHC	319-84-6	NA	1.7		1.7		1.7
beta-BHC	319-85-7	NA	1.7		1.7		1.7
delta-BHC	319-86-8	NA	1.7		1.7		1.7
gamma-BHC	58-89-9	NA	1.7		1.7		1.7
Heptachlor	76-44-8	NA	1.7		1.7		1.7
Aldrin	309-00-2	NA	1.7		1.7		1.7
Heptachlor epoxide	1024-57-3	NA	1.7		1.7		1.7
Endosulfan I	959-98-8	NA	1.7		1.7		1.7
*Dieldrin	60-57-1	40	3.3		3.3		3.3
4,4'-DDE	72-55-9	NA	3.3		3.3		3.3
Endrin	72-20-8	NA	3.3		3.3		3.3
Endosulfan II	33213-65-9	NA	3.3		3.3		3.3
4,4'-DDD	72-54-8	NA	3.3		3.3		3.3
Endosulfan sulfate	1031-07-8	NA	3.3		3.3		3.3
4,4'-DDT	50-29-3	NA	3.3		3.3		3.3
Methoxychlor	72-43-5	NA	17		17		17
Endrin ketone	53494-70-5	NA	3.3		3.3		3.3
Endrin aldehyde	7421-93-4	NA	3.3		3.3		3.3
alpha-Chlordane	5103-71-9	NA	1.7		1.7		1.7
gamma-Chlordane	5103-74-2	NA	1.7		1.7		1.7
Toxaphene	8001-35-2	NA	170		170		170
*Aroclor-1016	12674-11-2	10,000	33		33		33
*Aroclor-1221	11104-28-2	10,000	67		67		67
*Aroclor-1232	11141-16-5	10,000	33		33		33
*Aroclor-1242	53469-21-9	10,000	33		33		33
*Aroclor-1248	12672-29-6	10,000	33		33		33
*Aroclor-1254	11097-69-1	10,000	33		33		33
*Aroclor-1260	11096-82-5	10,000	33		33		33

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites, Direct Exposure Criteria for Residential Use Soils
(2) MDL not available for CLP laboratory

Table 6-4
Soil – Total Metals Contaminants of Concern and Other Target Analytes
Metals CLP Method ILM04.1
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (1) (mg/kg)	Project Quantitation (3) Limit (mg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs(2)	Method QLs (mg/kg)	MDLs(2)	QLs (mg/kg)
Aluminum	7429-90-5	NA	1.5 – 7.4		40		40
Antimony	7440-36-0	NA	0.3 – 1.0		12		12
*Arsenic	7440-38-2	1.7	0.3 – 1.1		2		2
Barium	7440-39-3	NA	0.02 – 0.2		40		40
*Beryllium	7440-41-7	0.4	0.02 – 0.2		1		1
Cadmium	7440-43-9	NA	0.04 – 0.2		1		1
Calcium	7440-70-2	NA	0.5 – 4.0		1000		1000
Chromium	7440-47-3	NA	0.06 – 0.4		2		2
Cobalt	7440-48-4	NA	0.06 – 0.4		10		10
Copper	7440-50-8	NA	0.12 – 1.2		5		5
Iron	7439-89-6	NA	2.2 – 6.4		20		20
*Lead	7439-92-1	150	0.12 – 0.52		0.6		0.6
Magnesium	7439-95-4	NA	0.54 – 40		1000		1000
Manganese	7439-96-5	NA	0.02 – 0.2		3		3
Mercury	7439-97-6	NA	0.02 – 0.2		0.1		0.1
Nickel	7440-02-0	NA	0.08 – 0.4		8		8
Potassium	7440-09-7	NA	5.2 – 10		1000		1000
Selenium	7782-49-2	NA	0.34 – 1.0		1		1
Silver	7440-22-4	NA	0.04 – 0.6		2		2
Sodium	7440-23-5	NA	1.3 – 80		1000		1000
*Thallium	7440-28-0	5.5	0.5 – 1.6		2		2
Vanadium	7440-62-2	NA	0.06 – 0.4		10		10
Zinc	7440-66-6	NA	0.1 – 0.7		4		4

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites, Direct Exposure Criteria for Residential Use Soils
(2) MDL not available for CLP laboratory
(3) Range of typical IDLs from current CLP laboratories

Table 6-5
Soil – Dioxin Contaminants of Concern and Other Target Analytes
Dioxin EPA SW-846 Method 8290
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit(1) (ng/kg)	Project Quantitation Limit (ng/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs(2) (ng/kg)	Method QLs (ng/kg)	MDLs(2) (ng/kg)	QLs (ng/kg)
1,2,3,4,6,7,8-HpCDD	35822-39-4	NA	2.5	2.40	2.5	2.40	2.5
1,2,3,4,6,7,8-HpCDF	67562-39-4	NA	2.5	1.20	2.5	1.20	2.5
1,2,3,4,7,8,9-HpCDF	55673-89-7	NA	2.5	4.0	2.5	4.0	2.5
1,2,3,4,7,8-HxCDD	39227-28-6	NA	2.5	1.00	2.5	1.00	2.5
1,2,3,4,7,8-HxCDF	70648-26-9	NA	2.5	1.90	2.5	1.90	2.5
1,2,3,6,7,8-HxCDD	57653-85-7	NA	2.5	1.00	2.5	1.00	2.5
1,2,3,6,7,8-HxCDF	57117-44-9	NA	2.5	1.40	2.5	1.40	2.5
1,2,3,7,8,9-HxCDD	19408-74-3	NA	2.5	2.50	2.5	2.50	2.5
1,2,3,7,8,9-HxCDF	72918-21-9	NA	2.5	4.30	2.5	4.30	2.5
1,2,3,7,8-PeCDD	40321-76-4	NA	2.5	1.20	2.5	1.20	2.5
1,2,3,7,8-PeCDF	57117-41-6	NA	2.5	1.30	2.5	1.30	2.5
HCX	--	NA	2.5	--	2.5	--	2.5
2,3,4,6,7,8-HxCDF	60851-34-5	NA	2.5	1.90	2.5	1.90	2.5
2,3,4,7,8-PeCDF	57115-31-4	NA	1.0	1.50	1.0	1.50	1.0
*2,3,7,8-TCDD	1746-01-6	1000	1.0	0.78	1.0	0.78	1.0
2,3,7,8-TCDF	51207-31-9	NA	1.0	0.49	1.0	0.49	1.0
OCDD	3268-87-9	NA	5.0	0.70	5.0	0.70	5.0
OCDF	39001-02-0	NA	5.0	3.80	5.0	3.80	5.0
Total HpCDD	--	NA	2.5		2.5		2.5
Total HpCDF	--	NA	2.5		2.5		2.5
Total HxCDD	--	NA	2.5		2.5		2.5
Total HxCDF	--	NA	2.5		2.5		2.5
Total PeCDD	--	NA	2.5		2.5		2.5
Total PeCDF	--	NA	2.5		2.5		2.5
Total TCDD	--	NA	1.0		1.0		1.0
Total TCDF	--	NA	1.0		1.0		1.0

Notes:
NA Not applicable
* Site contaminant
(1) Site specific criterion for this contaminant
(2) MDLs from Triangle Labs

Table 6-6
Groundwater – Volatile Contaminants of Concern and Other Target Analytes
Volatile Organic Compounds CLP Method OLM04.2
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (µg/L)	Project Quantitation Limit (µg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs[3]	Method QLs (µg/L)	MDLs[3]	QLs (µg/L)
Dichlorodifluoromethane	75-71-8	NA	10		10		10
Chloromethane	74-87-3	NA	10		10		10
Bromomethane	74-83-9	NA	10		10		10
Vinyl Chloride	75-01-4	NA	10		10		10
Chloroethane	75-00-3	NA	10		10		10
Methylene Chloride	75-09-2	NA	10		10		10
Acetone	67-64-1	NA	10		10		10
Methyl Acetate	79-20-9	NA	10		10		10
Carbon Disulfide	75-15-0	NA	10		10		10
Trichlorofluoromethane	75-69-4	NA	10		10		10
1,1-Dichloroethene	75-35-4	NA	10		10		10
1,1,2-Trichloro-1,2,2-trifluoro-ethane	76-13-1	NA	10		10		10
1,1- Dichloroethane	75-34-3	NA	10		10		10
Methyl tert-Butyl Ether	1634-04-4	NA	10		10		10
cis-1,2- Dichloroethene	156-59-2	NA	10		10		10
trans-1,2- Dichloroethene	156-60-5	NA	10		10		10
Chloroform	67-66-3	NA	10		10		10
*1,2- Dichloroethane	107-06-2	670[1]	10		10		10
2-Butanone	78-93-3	NA	10		10		10
1,1,1-Trichloroethane	71-55-6	NA	10		10		10
Bromochloromethane	74-97-5	NA	10		10		10
Cyclohexane	110-82-7	NA	10		10		10
Carbon Tetrachloride	56-23-5	NA	10		10		10
Bromodichloromethane	75-27-4	NA	10		10		10
Methylcyclohexane	108-87-2	NA	10		10		10
1,2-Dichloropropane	78-87-5	NA	10		10		10
cis-1,3- Dichloropropene	10061-01-5	NA	10		10		10
*Trichloroethene	79-01-6	87[1]	10		10		10
Dibromochloromethane	124-48-1	NA	10		10		10
1,1,2- Trichloroethane	79-00-5	NA	10		10		10
*Benzene	71-43-2	18[1]	10		10		10
Trans-1,3-Dichloropropene	10061-02-6	NA	10		10		10
Isopropylbenzene	98-82-8	NA	10		10		10
Bromoform	75-25-2	NA	10		10		10
4-Methyl-2-Pentanone	108-10-1	NA	10		10		10
2-Hexanone	591-78-6	NA	10		10		10
*Tetrachlorethene	127-18-4	5,300[2]	10		10		10
1,1,2,2- Tetrachlorethane	79-34-5	NA	10		10		10
Ethylene Dibromide	106-93-4	NA	10		10		10
Toluene	108-88-3	NA	10		10		10
1,2-Dibromoethane	106-93-4	NA	10		10		10
*Chlorobenzene	108-90-7	56[1]	10		10		10
*Ethylbenzene	100-41-4	16[1]	10		10		10
Styrene	100-42-5	NA	10		10		10
*Total Xylenes	1330-20-7	NA	10		10		10
1,3-Dichlorobenzene	541-73-1	NA	10		10		10
1,4- Dichlorobenzene	106-46-7	NA	10		10		10
1,2- Dichlorobenzene	95-50-1	NA	10		10		10
1,2-Dibromo-3-chloropropane	96-12-8	NA	10		10		10
1,2,4-Trichlorobenzene	120-82-1	NA	10		10		10

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Sites, Upper Concentration Limit for GB Groundwater
(2) Rhode Island Ambient Water Quality Criteria and Guidelines, Freshwater Chronic Criteria, assuming a 1000:1 dilutiion in groundwater to river discharge
(3) MDL not available for CLP laboratories

Table 6-7
Groundwater – Semivolatile Contaminants of Concern and Other Target Analytes
Semivolatile Organic Compounds CLP Method OLM04.2
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (µg/L)	Project Quantitation Limit (µg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs[4]	Method QLs (µg/L)	MDLs[4]	QLs (µg/L)
Benzaldehyde	100-52-7	NA	10		10		10
Phenol	108-95-2	NA	10		10		10
Bis-(2-Chloroethyl) ether	111-44-4	NA	10		10		10
2-Chlorophenol	95-57-8	NA	10		10		10
2-Methylphenol	95-48-7	NA	10		10		10
2,2-oxybis(1-Chloropropane)	108-60-1	NA	10		10		10
Acetophenone	98-86-2	NA	10		10		10
4-Methylphenol	106-44-5	NA	10		10		10
N-Nitroso-di-n propylamine	621-64-7	NA	10		10		10
Hexachloroethane	67-72-1	NA	10		10		10
Nitrobenzene	98-95-3	NA	10		10		10
Isophorone	78-59-1	NA	10		10		10
2-Nitrophenol	88-75-5	NA	10		10		10
2,4-Dimethylphenol	105-67-9	NA	10		10		10
Bis(2-Chloroethoxy) methane	111-91-1	NA	10		10		10
2,4-Dichlorophenol	120-83-2	NA	10		10		10
Naphthalene	91-20-3	NA	10		10		10
4-Chloroaniline	106-47-8	NA	10		10		10
Hexachlorobutadiene	87-68-3	NA	10		10		10
Caprolactam	105-60-2	NA	10		10		10
4-Chloro-3-methylphenol	59-50-7	NA	10		10		10
2-Methylnaphthalene	91-57-6	NA	10		10		10
Hexachlorocyclopentadiene	77-47-4	NA	10		10		10
2,4,6-Trichlorophenol	88-06-2	NA	10		10		10
2,4,5-Trichlorophenol	95-95-4	NA	25		25		25
1,1'-Biphenyl	92-52-4	NA	10		10		10
2-Chloronaphthalene	91-58-7	NA	10		10		10
2-Nitroaniline	88-74-4	NA	25		25		25
Dimethylphthalate	131-11-3	NA	10		10		10
2,6-Dinitrotoluene	606-20-2	NA	10		10		10
Acenaphthylene	208-96-8	NA	10		10		10
3-Nitroaniline	99-09-2	NA	25		25		25
Acenaphthene	83-32-9	NA	10		10		10
2,4-Dinitrophenol	51-28-5	NA	25		25		25
4-Nitrophenol	100-02-7	NA	25		25		25
Dibenzofuran	132-64-9	NA	10		10		10
2,4-Dinitrotoluene	121-14-2	NA	10		10		10
Diethylphthalate	84-66-2	NA	10		10		10
Fluorene	86-73-7	NA	10		10		10
4-Chlorophenyl-phenyl ether	7005-72-3	NA	10		10		10
4-Nitroaniline	100-01-6	NA	25		25		25
4,6-Dinitro-2-methylphenol	534-52-1	NA	25		25		25
N-Nitroso diphenylamine	86-30-6	NA	10		10		10
4-Bromophenyl-phenylether	101-55-3	NA	10		10		10

Table 6-7 (cont.)
Groundwater – Semivolatile Contaminants of Concern and Other Target Analytes
Semi-Volatile Organic Compounds CLP Method OLM04.2
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Analytes	CAS Number	Project Action Limit (µg/L)	Project Quantitation Limit (µg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs[4]	Method QLs (µg/L)	MDLs[4]	QLs (µg/L)
Hexachlorobenzene	118-74-1	NA	10		10		10
Atrazine	1912-24-9	NA	10		10		10
Pentachlorophenol	87-86-5	NA	25		25		25
Phenanthrene	85-01-8	NA	10		10		10
Anthracene	120-12-7	NA	10		10		10
Carbazole	86-74-8	NA	10		10		10
Di-n-butylphthalate	84-74-2	NA	10		10		10
Fluoranthene	206-44-0	NA	10		10		10
Pyrene	129-00-0	NA	10		10		10
Butylbenzylphthalate	85-68-7	NA	10		10		10
3,3'-Dichlorobenzidine	91-94-1	NA	10		10		10
*Benzo (a) anthracene	56-55-3	27[1]	10		10		10
*Chrysene	218-01-9	14[2]	10		10		10
*bis(2-Ethylhexyl) phthalate	117-81-7	12,000[3]	10		10		10
Di-n-octylphthalate	117-84-0	NA	10		10		10
*Benzo (b) fluoroanthene	205-99-2	14[2]	10		10		10
Benzo (k) fluoroanthene	207-08-9	NA	10		10		10
*Benzo (a) pyrene	50-32-8	14[1]	10		10		10
Indeno (1,2,3-cd)-pyrene	193-39-5	NA	10		10		10
Dibenzo (a,h)-anthracene	53-70-3	NA	10		10		10
*Benzo (g,h,i) perylene	191-24-2	14[2]	10		10		10

Notes:
NA Not applicable
* Site contaminant
(1) Oak Ridge National Laboratory, Summary of Conventional Benchmarks for Priority Contaminants in Fresh Water (1996)
(2) Oak Ridge National Laboratory, Summary of Conventional Benchmarks for Priority Contaminants in Fresh Water 1996, Surrage Value for Similar Compounds (PAHs use value for benzo(a)pyrene); assumes a 1000:1 dilution in groundwater to river discharge
(3) Rhode Island DEM Ambient Water Quality Criteria and Guideline, Freshwater Chronic Criteria; assumes a 1000:1 dilution in groundwater to river discharge
(4) MDL for CLP laboratory not available

Table 6-8
Groundwater - Pesticide/PCB Contaminants of Concern and Other Target Analytes
Pesticide/PCB CLP Method OLM04.2
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (µg/L)	Project Quantitation Limit (µg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs[3]	Method QLs (µg/L)	MDLs[3]	QLs (µg/L)
alpha-BHC	319-84-6	NA	0.05		0.05		0.05
beta-BHC	319-85-7	NA	0.05		0.05		0.05
delta-BHC	319-86-8	NA	0.05		0.05		0.05
gamma-BHC	58-89-9	NA	0.05		0.05		0.05
Heptachlor	76-44-8	NA	0.05		0.05		0.05
Aldrin	309-00-2	NA	0.05		0.05		0.05
Heptachlor epoxide	1024-57-3	NA	0.05		0.05		0.05
Endosulfan I	959-98-8	NA	0.05		0.05		0.05
*Dieldrin	60-57-1	1.9[1]	0.10		0.10		0.10
*4,4'-DDE	72-55-9	11[2]	0.10		0.10		0.10
Endrin	72-20-8	NA	0.10		0.10		0.10
Endosulfan II	33213-65-9	NA	0.10		0.10		0.10
4,4'-DDD	72-54-8	NA	0.10		0.10		0.10
Endosulfan sulfate	1031-07-8	NA	0.10		0.10		0.10
4,4'-DDT	50-29-3	NA	0.10		0.10		0.10
Methoxychlor	72-43-5	NA	0.50		0.50		0.50
Endrin ketone	53494-70-5	NA	0.10		0.10		0.10
Endrin aldehyde	7421-93-4	NA	0.10		0.10		0.10
alpha-Chlordane	5103-71-9	NA	0.05		0.05		0.05
gamma-Chlordane	5103-74-2	NA	0.05		0.05		0.05
Toxaphene	8001-35-2	NA	5.0		5.0		5.0
Aroclor-1016	12674-11-2	NA	1.0		1.0		1.0
Aroclor-1221	11104-28-2	NA	2.0		2.0		2.0
Aroclor-1232	11141-16-5	NA	1.0		1.0		1.0
Aroclor-1242	53469-21-9	NA	1.0		1.0		1.0
Aroclor-1248	12672-29-6	NA	1.0		1.0		1.0
Aroclor-1254	11097-69-1	NA	1.0		1.0		1.0
Aroclor-1260	11096-82-5	NA	1.0		1.0		1.0

Notes:
* Site contaminant
NA Not applicable
(1) Rhode Island DEM Ambient Water Quality Criteria and Guideline, Freshwater Chronic Criteria; assumes a 1000:1 dilution in groundwater to river discharge
(2) Oak Ridge National Laboratory, Summary of Conventional Benchmarks for Priority in Fresh Water, 1996, surrogate value for similar compound (PAHs use value for benzo(a)pyrene); assumes a 1000:1 dilution in groundwater to river discharge
(3) MDL not available for CLP laboratories

Table 6-9
Groundwater – Total and Dissolved Metals Contaminants of Concern and Other Target Analytes
Metals CLP Method ILM04.1
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (µg/L)	Project Quantitation Limit (µg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs(3)	Method QLs (µg/L)	MDLs(3)	QLs (µg/L)
Aluminum	7429-90-5	NA	200		200		200
Antimony	7440-36-0	NA	60		60		60
*Arsenic	7440-38-2	150(1)	10		10		10
Barium	7440-39-3	NA	200		200		200
*Beryllium	7440-41-7	170(2)	5		5		5
Cadmium	7440-43-9	NA	5		5		5
Calcium	7440-70-2	NA	5000		5000		5000
Chromium	7440-47-3	NA	10		10		10
Cobalt	7440-48-4	NA	50		50		50
Copper	7440-50-8	NA	25		25		25
Iron	7439-89-6	NA	100		100		100
*Lead	7439-92-1	1180(2)	3		3		3
Magnesium	7439-95-4	NA	5000		5000		5000
Manganese	7439-96-5	NA	15		15		15
Mercury	7439-97-6	NA	0.2		0.2		0.2
Nickel	7440-02-0	NA	40		40		40
Potassium	7440-09-7	NA	5000		5000		5000
Selenium	7782-49-2	NA	5		5		5
Silver	7440-22-4	NA	10		10		10
Sodium	7440-23-5	NA	5000		5000		5000
*Thallium	7440-28-0	1,000(2)	10		10		10
Vanadium	7440-62-2	NA	50		50		50
Zinc	7440-66-6	NA	20		20		20

Notes:
NA Not applicable
* Site contaminant
(1) Federal Recommended Water Quality Criteria for Priority Toxic Pollutants, Freshwater CCC
(2) Rhode Island DEM Ambient Water Quality Criteria and Guideline, Freshwater Chronic Criteria; assumes 1000:1 dilution in groundwater to river discharge
(3) MDL not available for CLP laboratories

Table 6-10
Groundwater – Dioxins Contaminants of Concern and Other Target Analytes
Dioxin EPA SW-846 Method 8290
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (pg/L)	Project Quantitation Limit (pg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2] (pg/L)	Method QLs (pg/L)	MDLs[2] (pg/L)	QLs (pg/L)
1,2,3,4,6,7,8-HpCDD	35822-39-4	NA	25	11.3	25	11.3	25
1,2,3,4,6,7,8-HpCDF	67562-39-4	NA	25	12.4	25	12.4	25
1,2,3,4,7,8,9-HpCDF	55673-89-7	NA	25	16.3	25	16.3	25
1,2,3,4,7,8-HxCDD	39227-28-6	NA	25	13.6	25	13.6	25
1,2,3,4,7,8-HxCDF	70648-26-9	NA	25	10.4	25	10.4	25
1,2,3,6,7,8-HxCDD	56753-85-7	NA	25	10.9	25	10.9	25
1,2,3,6,7,8-HxCDF	57117-44-9	NA	25	10.7	25	10.7	25
1,2,3,7,8,9-HxCDD	19408-74-3	NA	25	17.4	25	17.4	25
1,2,3,7,8,9-HxCDF	72918-21-9	NA	25	14.2	25	14.2	25
1,2,3,7,8-PeCDD	40321-76-4	NA	10	10.1	10	10.1	10
1,2,3,7,8-PeCDF	57117-41-6	NA	10	11.7	10	11.7	10
HCX	--	NA	25	--	25	--	25
2,3,4,6,7,8-HxCDF	60851-34-5	NA	25	14.5	25	14.5	25
2,3,4,7,8-PeCDF	57115-31-4	NA	10	27.9	10	27.9	10
*2,3,7,8-TCDD	1746-01-6	1,000,000[1]	10	3.0	10	3.0	10
2,3,7,8-TCDF	51207-31-9	NA	10	3.1	10	3.1	10
OCDD	3268-87-9	NA	50	25.8	50	25.8	50
OCDF	39001-02-0	NA	50	17.9	50	17.9	50
Total HpCDD	--	NA	25		25		25
Total HpCDF	--	NA	25		25		25
Total HxCDD	--	NA	25		25		25
Total HxCDF	--	NA	25		25		25
Total PeCDD	--	NA	10		10		10
Total PeCDF	--	NA	10		10		10
Total TCDD	--	NA	10		10		10
Total TCDF	--	NA	10		10		10

Notes:
NA Not applicable
* Site contaminant
(1) Site specific criterion for this contaminant
(2) MDLs from Triangle Labs

Table 6-11
Groundwater – Alkalinity, Sulfide, and TOC Analysis[1]
Alkalinity EPA Method 310.1, Sulfide EPA Method 376.1, and
TOC EPA Method 415.1
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit	Project Quantitation Limit (mg/L)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2] (mg/L)	Method QLs (mg/L)	MDLs[2] (mg/L)	QLs (mg/L)
Alkalinity	E14506	NA	5.0	0.47	5.0	0.47	5.0
Sulfide	18496258	NA	1.0	0.14	1.0	0.14	1.0
Total Organic Carbon	7440440	NA	1.0	0.05	1.0	0.05	1.0

Notes:
NA Not applicable
(1) No COC established for this parameter
(2) MDLs from Katahdin Analytical Services

Table 6-12
NAPL – Volatile Contaminants of Concern and Other Target Analytes
Volatile Organic Compounds CLP Method OLM04.2, Modified
Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit[1] (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2] (µg/kg)	Method QLs (µg/kg)	MDLs[2] (µg/kg)	QLs (µg/kg)
Dichlorodifluoromethane	75-71-8	NA	1200	230	1200	230	1200
Chloromethane	74-87-3	NA	1200	300	1200	300	1200
Bromomethane	74-83-9	NA	1200	450	1200	450	1200
Vinyl Chloride	75-01-4	NA	1200	250	1200	250	1200
Chloroethane	75-00-3	NA	1200	200	1200	200	1200
Methylene Chloride	75-09-2	NA	1200	730	1200	730	1200
Acetone	67-64-1	NA	1200	700	1200	700	1200
Methyl Acetate	79-20-9	NA	1200	-	1200	-	1200
Carbon Disulfide	75-15-0	NA	1200	200	1200	200	1200
Trichlorofluoromethane	75-69-4	NA	1200	250	1200	250	1200
1,1-Dichloroethene	75-35-4	NA	1200	250	1200	250	1200
1,1,2-Trichloro-1,2,2-trifluoro-ethane	76-13-1	NA	1200	-	1200	-	1200
1,1- Dichloroethane	75-34-3	NA	1200	205	1200	205	1200
Methyl tert-Butyl Ether	1634-04-4	NA	1200	110	1200	110	1200
cis-1,2- Dichloroethene	156-59-2	NA	1200	160	1200	160	1200
trans-1,2- Dichloroethene	156-60-5	NA	1200	230	1200	230	1200
Chloroform	67-66-3	NA	600	210	600	210	600
*1,2- Dichloroethane	107-06-2	900	600	80	600	80	600
2-Butanone	78-93-3	NA	1200	1100	1200	1100	1200
1,1,1-Trichloroethane	71-55-6	NA	1200	240	1200	240	1200
Bromochloromethane	74-97-5	NA	1200	210	1200	210	1200
Cyclohexane	110-82-7	NA	1200	-	1200	-	1200
Carbon Tetrachloride	56-23-5	NA	1200	110	1200	110	1200
Bromodichloromethane	75-27-4	NA	1200	110	1200	110	1200
Methylcyclohexane	108-87-2	NA	1200	-	1200	-	1200
1,2-Dichloropropane	78-87-5	NA	1200	180	1200	180	1200
cis-1,3- Dichloropropene	10061-01-5	NA	1200	100	1200	100	1200
*Trichloroethene	79-01-6	13,000	1200	100	1200	100	1200
Dibromochloromethane	124-48-1	NA	1200	70	1200	70	1200
1,1,2- Trichloroethane	79-00-5	NA	1200	100	1200	100	1200
*Benzene	71-43-2	2,500	1200	130	1200	130	1200
trans-1,3-Dichloropropene	10061-02-6	NA	1200	170	1200	170	1200
Isopropylbenzene	98-82-8	NA	1200	120	1200	120	1200
Bromoform	75-25-2	NA	1200	170	1200	170	1200
4-Methyl-2-Pentanone	108-10-1	NA	1200	1800	1200	1800	1200
2-Hexanone	591-78-6	NA	1200	350	1200	350	1200
*Tetrachlorethene	127-18-4	12,000	1200	120	1200	120	1200
1,1,2,2- Tetrachlorethane	79-34-5	NA	1200	580	1200	580	1200
Ethylene Dibromide	106-93-4	NA	1200	170	1200	170	1200
Toluene	108-88-3	NA	1200	180	1200	180	1200
1,2-Dibromoethane	106-93-4	NA	1200	170	1200	170	1200
*Chlorobenzene	108-90-7	210,000	1200	120	1200	120	1200
*Ethylbenzene	100-41-4	71,000	1200	110	1200	110	1200
Styrene	100-42-5	NA	1200	170	1200	170	1200
*Total Xylenes	1330-20-7	110,000	1200	330	1200	330	1200
1,3-Dichlorobenzene	541-73-1	NA	1200	110	1200	110	1200
1,4- Dichlorobenzene	106-46-7	NA	1200	120	1200	120	1200
1,2- Dichlorobenzene	95-50-1	NA	1200	90	1200	90	1200
1,2-Dibromo-3-chloropropane	96-12-8	NA	1200	300	1200	300	1200
1,2,4-Trichlorobenzene	120-82-1	NA	1200	140	1200	140	1200

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites, Direct Exposure Criteria for Residential Use Soils
(2) MDLs from Katahdin Analytical Services for medium level VOC analysis

Table 6-13
NAPL – Semivolatile Contaminants of Concern and Other Target Analytes
Semi-Volatile Organic Compounds CLP Method OLM04.2, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit[1] (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2] (µg/kg)	Method QLs (µg/kg)	MDLs[2] (µg/kg)	QLs (µg/kg)
Benzaldehyde	100-52-7	NA	330	-	330	-	330
Phenol	108-95-2	NA	330	34	330	34	330
Bis-(2-Chloroethyl) ether	111-44-4	NA	330	24	330	24	330
2-Chlorophenol	95-57-8	NA	330	42	330	42	330
2-Methylphenol	95-48-7	NA	330	40	330	40	330
2,2-oxybis(1-Chloropropane)	108-60-1	NA	330	18	330	18	330
Acetophenone	98-86-2	NA	330	-	330	-	330
4-Methylphenol	106-44-5	NA	330	40	330	40	330
N-Nitroso-di-n propylamine	621-64-7	NA	330	21	330	21	330
Hexachloroethane	67-72-1	NA	330	22	330	22	330
Nitrobenzene	98-95-3	NA	330	23	330	23	330
Isophorone	78-59-1	NA	330	18	330	18	330
2-Nitrophenol	88-75-5	NA	330	37	330	37	330
2,4-Dimethylphenol	105-67-9	NA	330	31	330	31	330
Bis(2-Chloroethoxy) methane	111-91-1	NA	330	19	330	19	330
2,4-Dichlorophenol	120-83-2	NA	330	37	330	37	330
Naphthalene	91-20-3	NA	330	21	330	21	330
4-Chloroaniline	106-47-8	NA	330	17	330	17	330
Hexachlorobutadiene	87-68-3	NA	330	29	330	29	330
Caprolactam	105-60-2	NA	330	-	330	-	330
4-Chloro-3-methylphenol	59-50-7	NA	330	37	330	37	330
2-Methylnaphthalene	91-57-6	NA	330	19	330	19	330
Hexachlorocyclopentadiene	77-47-4	NA	330	14	330	14	330
2,4,6-Trichlorophenol	88-06-2	NA	330	30	330	30	330
2,4,5-Trichlorophenol	95-95-4	NA	830	33	830	33	830
1,1'-Biphenyl	92-52-4	NA	330	-	330	-	330
2-Chloronaphthalene	91-58-7	NA	330	15	330	15	330
2-Nitroaniline	88-74-4	NA	830	16	830	16	830
Dimethylphthalate	131-11-3	NA	330	15	330	15	330
2,6-Dinitrotoluene	606-20-2	NA	330	24	330	24	330
Acenaphthylene	208-96-8	NA	330	21	330	21	330
3-Nitroaniline	99-09-2	NA	830	63	830	63	830
Acenaphthene	83-32-9	NA	330	18	330	18	330
2,4-Dinitrophenol	51-28-5	NA	830	230	830	230	830
4-Nitrophenol	100-02-7	NA	830	21	830	21	830
Dibenzofuran	132-64-9	NA	330	20	330	20	330
2,4-Dinitrotoluene	121-14-2	NA	330	20	330	20	330
Diethylphthalate	84-66-2	NA	330	17	330	17	330
Fluorene	86-73-7	NA	330	20	330	20	330
4-Chlorophenyl-phenyl ether	7005-72-3	NA	330	20	330	20	330
4-Nitroaniline	100-01-6	NA	830	74	830	74	830
4,6-Dinitro-2-methylphenol	534-52-1	NA	830	150	830	150	830
N-Nitroso diphenylamine	86-30-6	NA	330	8.3	330	8.3	330
4-Bromophenyl-phenylether	101-55-3	NA	330	23	330	23	330

Table 6-13 (cont.)
NAPL – Semivolatile Contaminants of Concern and Other Target Analytes
Semi-Volatile Organic Compounds CLP Method OLM04.2, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Analytes	CAS Number	Project Action Limit[1] (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2] (µg/kg)	Method QLs (µg/kg)	MDLs[2] (µg/kg)	QLs (µg/kg)
Hexachlorobenzene	118-74-1	NA	330	23	330	23	330
Atrazine	1912-24-9	NA	330	-	330	-	330
Pentachlorophenol	87-86-5	NA	830	120	830	120	830
Phenanthrene	85-01-8	NA	330	19	330	19	330
Anthracene	120-12-7	NA	330	19	330	19	330
Carbazole	86-74-8	NA	330	20	330	20	330
Di-n-butylphthalate	84-74-2	NA	330	26	330	26	330
Fluoranthene	206-44-0	NA	330	19	330	19	330
Pyrene	129-00-0	NA	330	28	330	28	330
Butylbenzylphthalate	85-68-7	NA	330	24	330	24	330
3,3'-Dichlorobenzidine	91-94-1	NA	330	62	330	62	330
*Benzo (a) anthracene	56-55-3	900	330	17	330	17	330
*Chrysene	218-01-9	400	330	18	330	18	330
*bis(2-Ethylhexyl) phthalate	117-81-7	46,000	330	24	330	24	330
Di-n-octylphthalate	117-84-0	NA	330	16	330	16	330
*Benzo (b) fluoroanthene	205-99-2	900	330	26	330	26	330
Benzo (k) fluoroanthene	207-08-9	NA	330	21	330	21	330
*Benzo (a) pyrene	50-32-8	600 [3]	330	17	330	17	330
Indeno (1,2,3-cd)-pyrene	193-39-5	NA	330	18	330	18	330
Dibenzo (a,h)-anthracene	53-70-3	NA	330	18	330	18	330
*Benzo (g,h,il) perylene	191-24-2	800	330	20	330	20	330

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites, Direct Exposure Criteria for Residential Use Soils
(2) MDLs from Katahdin Analytical Services
(3) Region IX PRGs for Residential soils

Table 6-14
NAPL - Pesticide/PCB Contaminants of Concern and Other Target Analytes
Pesticide/PCB CLP Method OLM04.2, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit[1] (µg/kg)	Project Quantitation Limit (µg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2] (µg/kg)	Method QLs (µg/kg)	MDLs[2] (µg/kg)	QLs (µg/kg)
alpha-BHC	319-84-6	NA	1.7	0.34	1.7	0.34	1.7
beta-BHC	319-85-7	NA	1.7	0.51	1.7	0.51	1.7
delta-BHC	319-86-8	NA	1.7	0.38	1.7	0.38	1.7
gamma-BHC	58-89-9	NA	1.7	0.37	1.7	0.37	1.7
Heptachlor	76-44-8	NA	1.7	0.66	1.7	0.66	1.7
Aldrin	309-00-2	NA	1.7	0.56	1.7	0.56	1.7
Heptachlor epoxide	1024-57-3	NA	1.7	0.56	1.7	0.56	1.7
Endosulfan I	959-98-8	NA	1.7	0.55	1.7	0.55	1.7
*Dieldrin	60-57-1	40	3.3	0.49	3.3	0.49	3.3
4,4'-DDE	72-55-9	NA	3.3	0.45	3.3	0.45	3.3
Endrin	72-20-8	NA	3.3	0.56	3.3	0.56	3.3
Endosulfan II	33213-65-9	NA	3.3	0.57	3.3	0.57	3.3
4,4'-DDD	72-54-8	NA	3.3	0.45	3.3	0.45	3.3
Endosulfan sulfate	1031-07-8	NA	3.3	0.72	3.3	0.72	3.3
4,4'-DDT	50-29-3	NA	3.3	0.46	3.3	0.46	3.3
Methoxychlor	72-43-5	NA	17	0.58	17	0.58	17
Endrin ketone	53494-70-5	NA	3.3	0.54	3.3	0.54	3.3
Endrin aldehyde	7421-93-4	NA	3.3	0.53	3.3	0.53	3.3
alpha-Chlordane	5103-71-9	NA	1.7	0.57	1.7	0.57	1.7
gamma-Chlordane	5103-74-2	NA	1.7	0.55	1.7	0.55	1.7
Toxaphene	8001-35-2	NA	170	8.78	170	8.78	170
*Aroclor-1016	12674-11-2	10,000	33	2.60	33	2.60	33
*Aroclor-1221	11104-28-2	10,000	67	5.80	67	5.80	67
*Aroclor-1232	11141-16-5	10,000	33	6.10	33	6.10	33
*Aroclor-1242	53469-21-9	10,000	33	7.40	33	7.40	33
*Aroclor-1248	12672-29-6	10,000	33	3.00	33	3.00	33
*Aroclor-1254	11097-69-1	10,000	33	7.10	33	7.10	33
*Aroclor-1260	11096-82-5	10,000	33	2.60	33	2.60	33

Notes:
NA Not applicable
* Site Contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites. Direct Exposure Criteria for Residential Use Soils.
(2) MDLs from Katahdin Analytical Services

Table 6-15
NAPL – Total Metals Contaminants of Concern and Other Target Analytes[1]
Metals CLP Method ILM04.1, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit[1] (mg/kg)	Project Quantitation Limit (mg/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2] (mg/kg)	Method QLs (mg/kg)	MDLs[2] (mg/kg)	QLs (mg/kg)
Aluminum	7429-90-5	NA	2.68	2.68	40	2.68	2.68
Antimony	7440-36-0	NA	0.21	0.21	12	0.21	0.21
*Arsenic	7440-38-2	1.7	0.14	0.14	2	0.14	0.14
Barium	7440-39-3	NA	0.38	0.38	40	0.38	0.38
*Beryllium	7440-41-7	0.4	0.005	0.005	1	0.005	0.005
Cadmium	7440-43-9	NA	0.02	0.02	1	0.02	0.02
Calcium	7440-70-2	NA	0.29	0.29	1000	0.29	0.29
Chromium	7440-47-3	NA	0.07	0.07	2	0.07	0.07
Cobalt	7440-48-4	NA	0.06	0.06	10	0.06	0.06
Copper	7440-50-8	NA	0.05	0.05	5	0.05	0.05
Iron	7439-89-6	NA	2.18	2.18	20	2.18	2.18
*Lead	7439-92-1	150	0.10	0.10	0.6	0.10	0.10
Magnesium	7439-95-4	NA	0.59	0.59	1000	0.59	0.59
Manganese	7439-96-5	NA	0.02	0.02	3	0.02	0.02
Mercury	7439-97-6	NA	0.004	0.004	0.1	0.004	0.004
Nickel	7440-02-0	NA	0.07	0.07	8	0.07	0.07
Potassium	7440-09-7	NA	43.2	43.2	1000	43.2	43.2
Selenium	7782-49-2	NA	0.21	0.21	1	0.21	0.21
Silver	7440-22-4	NA	0.11	0.11	2	0.11	0.11
Sodium	7440-23-5	NA	3.00	3.00	1000	3.00	3.00
*Thallium	7440-28-0	5.5	0.36	0.36	2	0.36	0.36
Vanadium	7440-62-2	NA	0.07	0.07	10	0.07	0.07
Zinc	7440-66-6	NA	0.12	0.12	4	0.12	0.12

Notes:
NA Not applicable
* Site contaminant
(1) Rhode Island DEM Rules and Regulations for Hazardous Waste Release Sites, Direct Exposure Criteria for Residential Use Soils
(2) MDLs from Katahdin Analytical Services

Table 6-16
NAPL – Dioxin Contaminants of Concern and Other Target Analytes
Dioxin EPA SW-846 Method 8290, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit(1) (ng/kg)	Project Quantitation Limit (ng/kg)	Analytical Method		Achievable Laboratory Limits	
				MDLs(2) (ng/kg)	Method QLs (ng/kg)	MDLs(2) (ng/kg)	QLs (ng/kg)
1,2,3,4,6,7,8-HpCDD	35822-39-4	NA	12.5	2.40	12.5	2.40	12.5
1,2,3,4,6,7,8-HpCDF	67562-39-4	NA	12.5	1.20	12.5	1.20	12.5
1,2,3,4,7,8,9-HpCDF	55673-89-7	NA	12.5	4.00	12.5	4.00	12.5
1,2,3,4,7,8-HxCDD	39227-28-6	NA	12.5	1.00	12.5	1.00	12.5
1,2,3,4,7,8-HxCDF	70648-26-9	NA	12.5	1.90	12.5	1.90	12.5
1,2,3,6,7,8-HxCDD	56753-85-7	NA	12.5	1.00	12.5	1.00	12.5
1,2,3,6,7,8-HxCDF	57117-44-9	NA	12.5	1.40	12.5	1.40	12.5
1,2,3,7,8,9-HxCDD	19408-74-3	NA	12.5	2.50	12.5	2.50	12.5
1,2,3,7,8,9-HxCDF	72918-21-9	NA	12.5	4.30	12.5	4.30	12.5
1,2,3,7,8-PeCDD	40321-76-4	NA	5.0	1.20	5.0	1.20	5.0
1,2,3,7,8-PeCDF	57117-41-6	NA	5.0	1.30	5.0	1.30	5.0
HCX	--	NA	12.5	--	12.5		12.5
2,3,4,6,7,8-HxCDF	60851-34-5	NA	12.5	1.90	12.5	1.90	12.5
2,3,4,7,8-PeCDF	57115-31-4	NA	5.0	1.50	5.0	1.50	5.0
*2,3,7,8-TCDD	1746-01-6	1000	5.0	0.78	5.0	0.78	5.0
2,3,7,8-TCDF	51207-31-9	NA	5.0	0.49	5.0	0.49	5.0
OCDD	3268-87-9	NA	25.0	0.70	25.0	0.70	25.0
OCDF	39001-02-0	NA	25.0	3.80	25.0	3.80	25.0
Total HpCDD	--	NA	12.5		12.5		12.5
Total HpCDF	--	NA	12.5		12.5		12.5
Total HxCDD	--	NA	12.5		12.5		12.5
Total HxCDF	--	NA	12.5		12.5		12.5
Total PeCDD	--	NA	5.0		5.0		5.0
Total PeCDF	--	NA	5.0		5.0		5.0
Total TCDD	--	NA	5.0		5.0		5.0
Total TCDF	--	NA	5.0		5.0		5.0

Notes:
NA Not applicable
* Site contaminant
(1) Site specific criterion for this contaminant
(2) MDLs from Triangle Labs

Table 6-17
Air - VOC Contaminants of Concern and Other Target Analytes
Volatile Organic Compounds Method TO-15/SIM
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit(1) (ppbv)	Project Quantitation Limit (2) (ppbv)	Analytical Method		Achievable Laboratory Limits	
				MDLs	Method QLs (2) (ppbv)	MDLs	QLs (2) (ppbv)
Vinyl Chloride	75-01-4	NA	0.01		0.01		0.01
Chloroethane	75-00-3	NA	0.22		0.22		0.22
1,1-Dichloroethene	75-35-4	NA	0.22		0.22		0.22
Methylene Chloride	75-09-2	NA	0.22		0.22		0.22
1,1-Dichloroethane	75-34-3	NA	0.22		0.22		0.22
cis-1,2-Dichloroethene	156-59-2	NA	0.22		0.22		0.22
Chloroform	67-66-3	NA	0.22		0.22		0.22
1,1,1-Trichloroethane	71-55-6	NA	0.22		0.22		0.22
Carbon Tetrachloride	56-23-5	NA	0.22		0.22		0.22
*Benzene	71-43-2	0.08	0.05		0.05		0.05
*1,2-Dichloroethane	107-06-2	0.23	0.02		0.02		0.02
*Trichloroethene	79-01-6	0.20	0.02		0.02		0.02
1,2-Dichloropropane	78-87-5	NA	0.22		0.22		0.22
Toluene	108-88-3	NA	0.22		0.22		0.22
1,1,2-Trichloroethane	79-00-5	NA	0.22		0.22		0.22
*Tetrachloroethene	127-18-4	0.48	0.02		0.02		0.02
*Chlorobenzene	108-90-7	1.41	0.22		0.22		0.22
*Ethylbenzene (NC)	100-41-4	25.0	0.02		0.02		0.02
*m-, p-Xylene (NC)	108-38-3/106-42-3	16.6	0.02		0.02		0.02
*o-Xylene (NC)	95-47-6	16.6	0.04		0.04		0.04
Styrene	100-42-5	NA	0.02		0.02		0.02

Notes:
NA Not applicable
* Site contaminant
(1) Project action limits are calculated from Region IX PRGs in Ambient air converted to ppb volatiles assuming 1 atm, 68°F.
(2) Quantitation limits from Air Toxics, Ltd.
(NC) Project action limits converted to correspond to HI of 1

Table 6-18
Air – PCB Contaminants of Concern and Other Target Analytes
PCB Method TO-10
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit (ug/m ^{3}) (1)	Project Quantitation Limit (2) (ug/m ^{3})	Analytical Method		Achievable Laboratory Limits	
				MDLs	Method QLs (2) (ug)	MDLs	QLs (2) (ug)
*Aroclor-1016	12674-11-2	0.34	0.13		0.13		0.13
*Aroclor-1242	53469-21-9	0.34	0.13		0.13		0.13
*Aroclor-1248	12672-29-6	0.34	0.13		0.13		0.13
*Aroclor-1254	11097-69-1	0.34	0.13		0.13		0.13
*Aroclor-1260	11096-82-5	0.34	0.13		0.13		0.13

Notes:

* Site contaminant
(1) Risk-based criterion, presuming 24-hour inhalation and dermal exposure under residential scenario presumes sample volume of 10 m^3
(2) Quantitation Limits from Air Toxics, L.L.C.

Table 6-19
Air – Dioxins Contaminants of Concern and Other Target Analytes
Dioxin EPA SW-846 Method TO-9/8290A
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit(1) (pg/m^3)	Project Quantitation(2) Limit (pg/m^3)	Analytical Method		Achievable Laboratory Limits	
				MDLs	Method QLs (ng)	MDLs	QLs(2) (ng)
1,2,3,4,6,7,8-HpCDD	35822-39-4	NA	17.3		17.3		17.3
1,2,3,4,6,7,8-HpCDF	67562-39-4	NA	17.3		17.3		17.3
1,2,3,4,7,8,9-HpCDF	55673-89-7	NA	17.3		17.3		17.3
1,2,3,4,7,8-HxCDD	39227-28-6	NA	17.3		17.3		17.3
1,2,3,4,7,8-HxCDF	70648-26-9	NA	17.3		17.3		17.3
1,2,3,6,7,8-HxCDD	56753-85-7	NA	17.3		17.3		17.3
1,2,3,6,7,8-HxCDF	57117-44-9	NA	17.3		17.3		17.3
1,2,3,7,8,9-HxCDD	19408-74-3	NA	17.3		17.3		17.3
1,2,3,7,8,9-HxCDF	72918-21-9	NA	17.3		17.3		17.3
1,2,3,7,8-PeCDD	40321-76-4	NA	17.3		17.3		17.3
1,2,3,7,8-PeCDF	57117-41-6	NA	17.3		17.3		17.3
HCX		NA	17.3		17.3		17.3
2,3,4,6,7,8-HxCDF	60851-34-5	NA	17.3		17.3		17.3
2,3,4,7,8-PeCDF	57115-31-4	NA	17.3		17.3		17.3
*2,3,7,8-TCDD	1746-01-6	4.5	3.47		3.47		3.47
2,3,7,8-TCDF	51207-31-9	NA	3.47		3.47		3.47
OCDD	3268-87-9	NA	34.7		34.7		34.7
OCDF	39001-02-0	NA	34.7		34.7		34.7

Notes:
NA Not applicable
* Site contaminant
(1) Region IX PRG ambient air criterion, presuming 24-hour inhalation and dermal exposure under residential scenario, presumes sample volume of 14.4 m^3
(2) Quantitation Limits from Triangle Labs

Table 6-20
Wipes – PCB Contaminants of Concern and Other Target Analytes
Pesticide/PCB Method OLM04.2, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit(1) (ug/cm^2)	Project Quantitation Limit (ug/cm^2)	Analytical Method		Achievable Laboratory Limits	
				MDLs(2) (ug/kg)	Method QLs (ug/kg)	MDLs(2) (ug/kg)	QLs (ug/kg)
*Aroclor-1016	12674-11-2	0.012	0.00013		0.00013		0.00013
*Aroclor-1221	11104-28-2	0.000425	0.00013		0.00013		0.00013
*Aroclor-1232	11141-16-5	0.000425	0.00013		0.00013		0.00013
*Aroclor-1242	53469-21-9	0.000425	0.00013		0.00013		0.00013
*Aroclor-1248	12672-29-6	0.000425	0.00013		0.00013		0.00013
*Aroclor-1254	11097-69-1	0.000425	0.00013		0.00013		0.00013
*Aroclor-1260	11096-82-5	0.000425	0.00013		0.00013		0.00013

Notes:
* Site contamination
(1) Risk-based criterion, presuming 24-hour inhalation and dermal exposure under residential scenario
(2) QLs from Katahdin Analytical Services

Table 6-21
Wipes – Dioxins Contamination of Concern and Other Target Analytes
Dioxin EPA SW-846 Method 8290, Modified
Low/Medium Concentration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Analytes	CAS Number	Project Action Limit[1] (pg/cm^2)	Project Quantitation Limit (pg/cm^2)	Analytical Method		Achievable Laboratory Limits	
				MDLs[2]	Method QLs (ng)	MDLs[2]	QLs (ng)
1,2,3,4,6,7,8-HpCDD	35822-39-4	NA	0.025		0.025		0.025
1,2,3,4,6,7,8-HpCDF	67562-39-4	NA	0.025		0.025		0.025
1,2,3,4,7,8,9-HpCDF	55673-89-7	NA	0.025		0.025		0.025
1,2,3,4,7,8-HxCDD	39227-28-6	NA	0.025		0.025		0.025
1,2,3,4,7,8-HxCDF	70648-26-9	NA	0.025		0.025		0.025
1,2,3,6,7,8-HxCDD	56753-85-7	NA	0.025		0.025		0.025
1,2,3,6,7,8-HxCDF	57117-44-9	NA	0.025		0.025		0.025
1,2,3,7,8,9-HxCDD	19408-74-3	NA	0.025		0.025		0.025
1,2,3,7,8,9-HxCDF	72918-21-9	NA	0.025		0.025		0.025
1,2,3,7,8-PeCDD	40321-76-4	NA	0.025		0.025		0.025
1,2,3,7,8-PeCDF	57117-41-6	NA	0.025		0.025		0.025
HCX	--	NA	0.025		0.025		0.025
2,3,4,6,7,8-HxCDF	60851-34-5	NA	0.025		0.025		0.025
2,3,4,7,8-PeCDF	57115-31-4	NA	0.025		0.025		0.025
*2,3,7,8-TCDD	1746-01-6	0.025	0.005		0.005		0.005
2,3,7,8-TCDF	51207-31-9	NA	0.005		0.005		0.005
OCDD	3268-87-9	NA	0.05		0.05		0.05
OCDF	39001-02-0	NA	0.05		0.05		0.05

Notes:
NA Not applicable
* Site Contaminants
(1) Risk-based criterion presuming 24-hour inhalation and dermal exposure under residential scenario, presumes use of 100g sample media wiped across 100 x 100 cm sample area.
(2) QLs from Triangle Labs

Table 6-22
Field and Quality Control Sample Summary
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/ Matrix	Analytical Parameter	Conc. Level	Analytical Method/ SOP Reference[1]	No. of Samples	No. of Field Duplicate Pairs	No. of Trip Blanks	No. of Equip. Blanks	No. of PE Samples	Total No. of Samples to Lab	Organic No. of MS	Organic No. of MSD	Inorganic No. of Duplicates	Inorganic No. of MS
Soil Sampling Phase I – Raceway													
Soil	Volatiles	Medium	L1	63	7	7	7	4	88	5	5	-	-
Soil	Semivolatiles	Low/ Medium	L2	63	7	-	7	4	81	5	5	-	-
Soil	Pesticides/ PCBs	Low/ Medium	L3	63	7	-	7	4	81	5	5	-	-
Soil	Total Metals	Low/ Medium	L4	63	7	-	7	4	81	-	-	5	5
Soil	Dioxins	Low/ Medium	L5	63	7	-	7	8	85	5	5	-	-
Soil Sampling Phase 1 – Source Area													
Soil	Volatiles	Medium	L1	28	3	3	3	2	39	2	2	-	-
Soil	Semivolatiles	Low/ Medium	L2	28	3	-	3	2	36	2	2	-	-
Soil	Pesticides/ PCBs	Low/ Medium	L3	28	3	-	3	2	36	2	2	-	-
Soil	Total Metals	Low/ Medium	L4	28	3	-	3	2	36	-	-	2	2
Soil	Dioxins	Low/ Medium	L5	28	3	-	3	4	38	2	2	-	-
Soil Sampling Phase 2 – Southern (downgradient) Area													
Soil	Volatiles	Medium	L1	14	2	2	2	1	21	2	2	-	-
Soil	Semivolatiles	Low/ Medium	L2	14	2	-	2	1	19	1	1	-	-
Soil	Pesticides/ PCBs	Low/ Medium	L3	14	2	-	2	1	19	1	1	-	-
Soil	Total Metals	Low/ Medium	L4	14	2	-	2	1	19	-	-	1	1
Soil	Dioxins	Low/ Medium	L5	14	2	-	2	2	20	1	1	-	-

Table 6-22 (cont'd)
Field and Quality Control Sample Summary
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 4

Medium/ Matrix	Analytical Parameter	Conc. Level	Analytical Method/ SOP Reference[1]	No. of Samples	No. of Field Duplicate Pairs	No. of Trip Blanks	No. of Equip. Blanks	No. of PE Samples	Total No. of Samples to Lab	Organic No. of MS	Organic No. of MSD	Inorganic No. of Duplicates	Inorganic No. of MS
Soil Sampling Phase 2 – Discharge Area													
Soil	Volatiles	Medium	L1	28	3	3	3	2	39	2	2	-	-
Soil	Semivolatiles	Low/ Medium	L2	28	3	-	3	2	36	2	2	-	-
Soil	Pesticides/ PCBs	Low/ Medium	L3	28	3	-	3	2	36	2	2	-	-
Soil	Total Metals	Low/ Medium	L4	28	3	-	3	2	36	-	-	2	2
Soil	Dioxin	Low/ Medium	L5	28	3	-	3	4	38	2	2	-	-
Groundwater Sampling Phase 1													
GW	Volatiles	Low/ Medium	L6	7	1	1	1	1	11	1	1	-	-
GW	Semivolatiles	Low/ Medium	L7	7	1	-	1	1	10	1	1	-	-
GW	Pesticides/ PCBs	Low/ Medium	L8	7	1	-	1	1	10	1	1	-	-
GW	Total Metals	Low/ Medium	L9	7	1	-	1	1	10	-	-	1	1
GW	Dissolved Metals	Low/ Medium	L10	7	1	-	1	1	10	-	-	1	1
GW	Dioxin	Low/ Medium	L11	7	1	-	1	2	11	1	1	-	-
GW	Alkalinity	Low/ Medium	L12	7	1	-	-	-	8	-	-	-	-

Table 6-22 (cont'd)
Field and Quality Control Sample Summary
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 3 of 4

Medium/ Matrix	Analytical Parameter	Conc. Level	Analytical Method/ SOP Reference[1]	No. of Samples	No. of Field Duplicate Pairs	No. of Trip Blanks	No. of Equip. Blanks	No. of PE Samples	Total No. of Samples to Lab	Organic No. of MS	Organic No. of MSD	Inorganic No. of Duplicates	Inorganic No. of MS
GW	Sulfide	Low/ Medium	L13	7	1	-	-	-	8	-	-	-	-
GW	TOC	Low/ Medium	L14	7	1	-	-	-	8	-	-	-	-
Groundwater Sampling Phase 2													
GW	Volatiles	Low/ Medium	L6	33	4	4	4	2	47	3	3	-	-
GW	Semivolatiles	Low/ Medium	L7	33	4	-	4	2	43	3	3	-	-
GW	Pesticides/ PCBs	Low/ Medium	L8	33	4	-	4	2	43	3	3	-	-
GW	Total Metals	Low/ Medium	L9	33	4	-	4	2	43	-	-	3	3
GW	Dissolved Metals	Low/ Medium	L10	33	4	-	4	2	43	-	-	3	3
GW	Dioxin	Low/ Medium	L11	33	4	-	4	4	45	3	3	-	-
GW	Alkalinity	Low/ Medium	L12	33	4	-	-	-	37	-	-	-	-
GW	Sulfide	Low/ Medium	L13	33	4	-	-	-	37	-	-	-	-
GW	TOC	Low/ Medium	L14	33	4	-	-	-	37	-	-	-	-

Table 6-22 (cont'd)
Field and Quality Control Sample Summary
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 4 of 4

Medium/ Matrix	Analytical Parameter	Conc. Level	Analytical Method/ SOP Reference[1]	No. of Samples	No. of Field Duplicate Pairs	No. of Trip Blanks	No. of Equip. Blanks	No. of PE Samples	Total No. of Samples to Lab	Organic No. of MS	Organic No. of MSD	Inorganic No. of Duplicates	Inorganic No. of MS
NAPL Sampling													
Phase 2 (if available)													
NAPL	Volatiles	Medium	L15	15	2	2	2	1	22	1	1	-	-
NAPL	Semivolatiles	Low/ Medium	L16	15	2	-	2	1	20	1	1	-	-
NAPL	Pesticides/ PCBs	Low/ Medium	L17	15	2	-	2	1	20	1	1	-	-
NAPL	Total Metals	Low/ Medium	L18	15	2	-	2	1	20	-	-	1	1
NAPL	Dioxins	Low/ Medium	L19	15	2	-	2	6	21	1	1	-	-
Air Sampling													
CM Building													
Air	Volatiles	Low	L20	5	1	-	-	1	8	-	-	-	-
Air	PCBs	Low/ Medium	L21	5	1	-	1	1	8	-	-	-	-
Air	Dioxins	Low/ Medium	L22	5	1	-	1	2	9	-	-	-	-
Wipe Sampling													
CM Building													
Wipe	PCBs	Low/ Medium	L23	5	1	-	1	1	8	-	-	-	-
Wipe	Dioxins	Low/ Medium	L24	5	1	-	1	2	9	-	-	-	-

Notes:
(1) – Refer to Table 12-1 for Method/SOP References
NAPL – Non-Aqueous Phase Liquid

Table 6-23
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Soil Sampling Phase 1 –Raceway						
Soil	Volatiles	Medium	L1	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
Soil	Semivolatiles	Low/ Medium	L2	21	TBD – CLP Laboratory	NA
Soil	Pesticides/ PCBs	Low/ Medium	L3	21	TBD – CLP Laboratory	NA
Soil	Total Metals	Low/ Medium	L4	21	TBD – CLP Laboratory	NA
Soil	Dioxins	Low/ Medium	L5	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA
Soil Sampling Phase 1 - Source Area						
Soil	Volatiles	Medium	L1	35	Katahdin Analytical Services 340 County Road No. 5 P.O. Box 720 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA

Table 6-23 (cont.)
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 8

Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Soil Sampling Phase 2 – Source Area						
Soil	Volatiles	Medium	L1	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
Soil	Semivolatiles	Low/ Medium	L2	21	TBD – CLP Laboratory	NA
Soil	Pesticides/ PCBs	Low/ Medium	L3	21	TBD – CLP Laboratory	NA
Soil	Total Metals	Low/ Medium	L4	21	TBD – CLP Laboratory	NA
Soil	Dioxins	Low/ Medium	L5	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA
Soil Sampling Phase 2 – Discharge Area						
Soil	Volatiles	Medium	L1	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
Soil	Semivolatiles	Low/ Medium	L2	21	TBD – CLP Laboratory	NA

Table 6-23 (cont.)
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 3 of 8

Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Soil	Total Metals	Low/ Medium	L4	21	TBD - CLP Laboratory	NA
Soil	Dioxins	Low/ Medium	L5	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA
Groundwater Sampling Phase 1						
GW	Volatiles	Low/ Medium	L6	21	TBD – CLP Laboratory	NA
GW	Semivolatiles	Low/ Medium	L7	21	TBD – CLP Laboratory	NA
GW	Pesticides/ PCBs	Low/ Medium	L8	21	TBD – CLP Laboratory	NA
GW	Total Metals	Low/ Medium	L9	21	TBD – CLP Laboratory	NA

Table 6-23 (cont.)
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 4 of 8

Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
GW	Dissolved Metals	Low/ Medium	L10	21	TBD – CLP Laboratory	NA
GW	Dioxins	Low/ Medium	L11	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA
GW	Alkalinity	Low/ Medium	L12	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
GW	Total Sulfide	Low/ Medium	L13	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 ~~Andrea Colby~~ (207)874-2400	NA
GW	TOC	Low/ Medium	L14	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
Groundwater Sampling Phase 2						
GW	Volatiles	Low/ Medium	L6	21	TBD – CLP Laboratories	NA

Table 6-23 (cont.)
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 5 of 8

Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
GW	Semivolatiles	Low/ Medium	L7	21	TBD – CLP Laboratories	NA
GW	Pesticides/ PCBs	Low/ Medium	L8	21	TBD – CLP Laboratories	NA
GW	Total Metals	Low/ Medium	L9	21	TBD – CLP Laboratories	NA
GW	Dissolved Metals	Low/ Medium	L10	21	TBD – CLP Laboratories	NA
GW	Dioxins	Low/ Medium	L11	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA
GW	Alkalinity	Low/ Medium	L12	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
GW	Total Sulfide	Low/ Medium	L13	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA

Table 6-23 (cont.)
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 6 of 8

Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
GW	TOC	Low/ Medium	L14	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
NAPL Sampling Phase 2 (if available)						
NAPL	Volatiles	Medium	L15	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
NAPL	Semivolatiles	Low/ Medium	L16	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
NAPL	Pesticides/ PCBs	Low/ Medium	L17	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA
NAPL	Total Metals	Low/ Medium	L18	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA

Table 6-23 (cont.)
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 7 of 8

Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
NAPL	Dioxins	Low/ Medium	L19	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA
Air Sampling						
Air	Volatiles	Low/ Medium	L20	35	Air Toxics, Ltd. 180-B Blue Ravine Rd. Folsom, CA 95630 Robin Walla (800) 985-5955	NA
Air	PCBs	Low/ Medium	21	35	Air Toxics, Ltd. 180-B Blue Ravine Rd. Folsom, CA 95630 Robin Walla (800) 985-5955	NA
Air	Dioxins	Low/ Medium	L22	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA
Wipe Sampling						
Wipe	Pesticides/ PCBs	Low/ Medium	L23	35	Katahdin Analytical Services 340 County Road No. 5 Westbrooke, ME 04098 Andrea Colby (207)874-2400	NA

Table 6-23 (cont.)
Analytical Services
Quality Assurance and Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 8 of 8

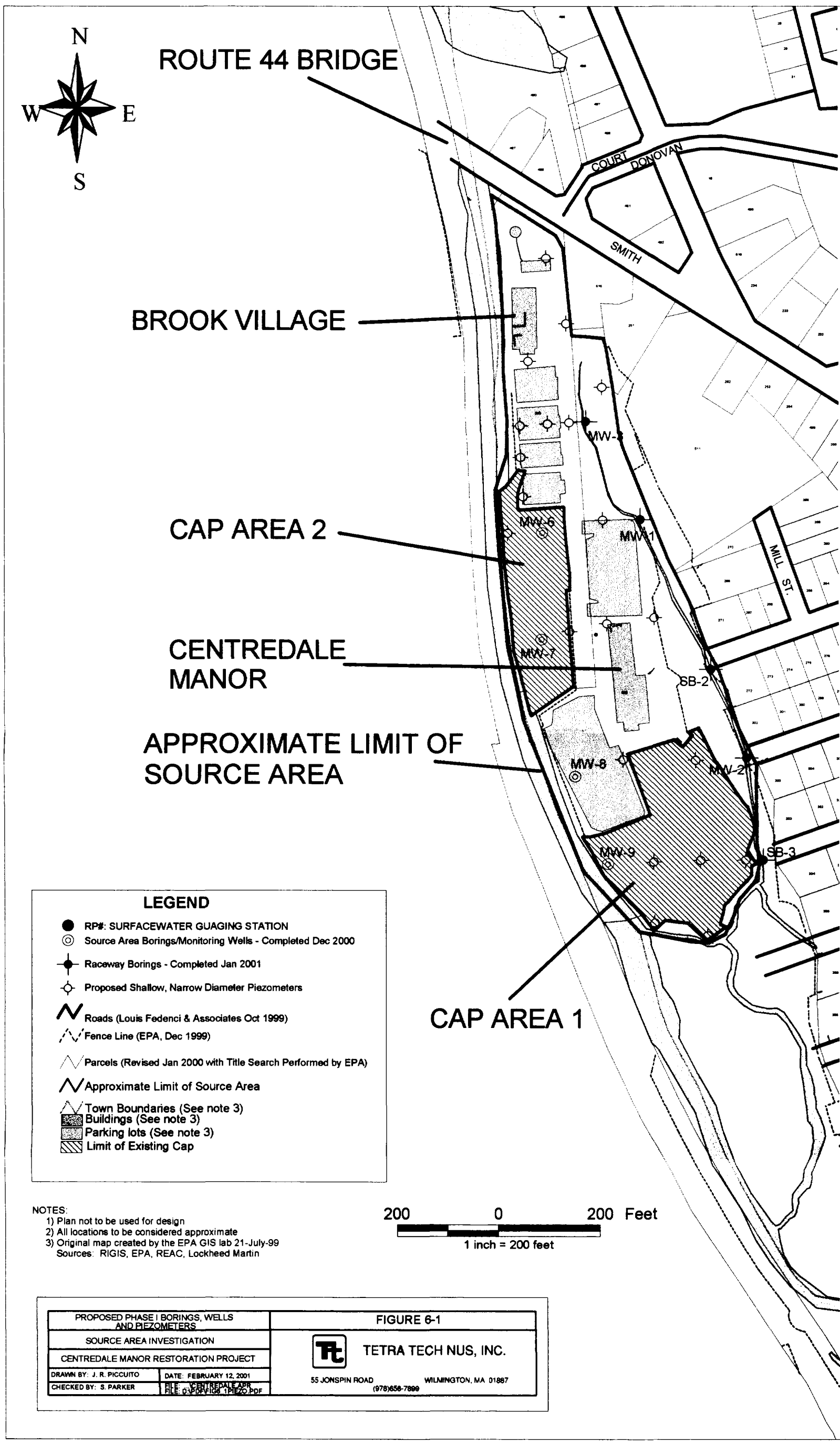
Medium/ Matrix	Analytical Parameter	Concentration Level	Analytical Method/SOP[1]	Data Package Turnaround Time	Laboratory/Organization (Name and Address: Contact Person and Telephone Number)	Backup Laboratory/Organization (Name and Address: Contact Person and Telephone Number)
Wipe	Dioxins	Low/ Medium	L24	35	Triangle Labs 801 Capitola Drive Durham, NC 27713 Mary McDonald (919) 544-5729	NA

Notes:

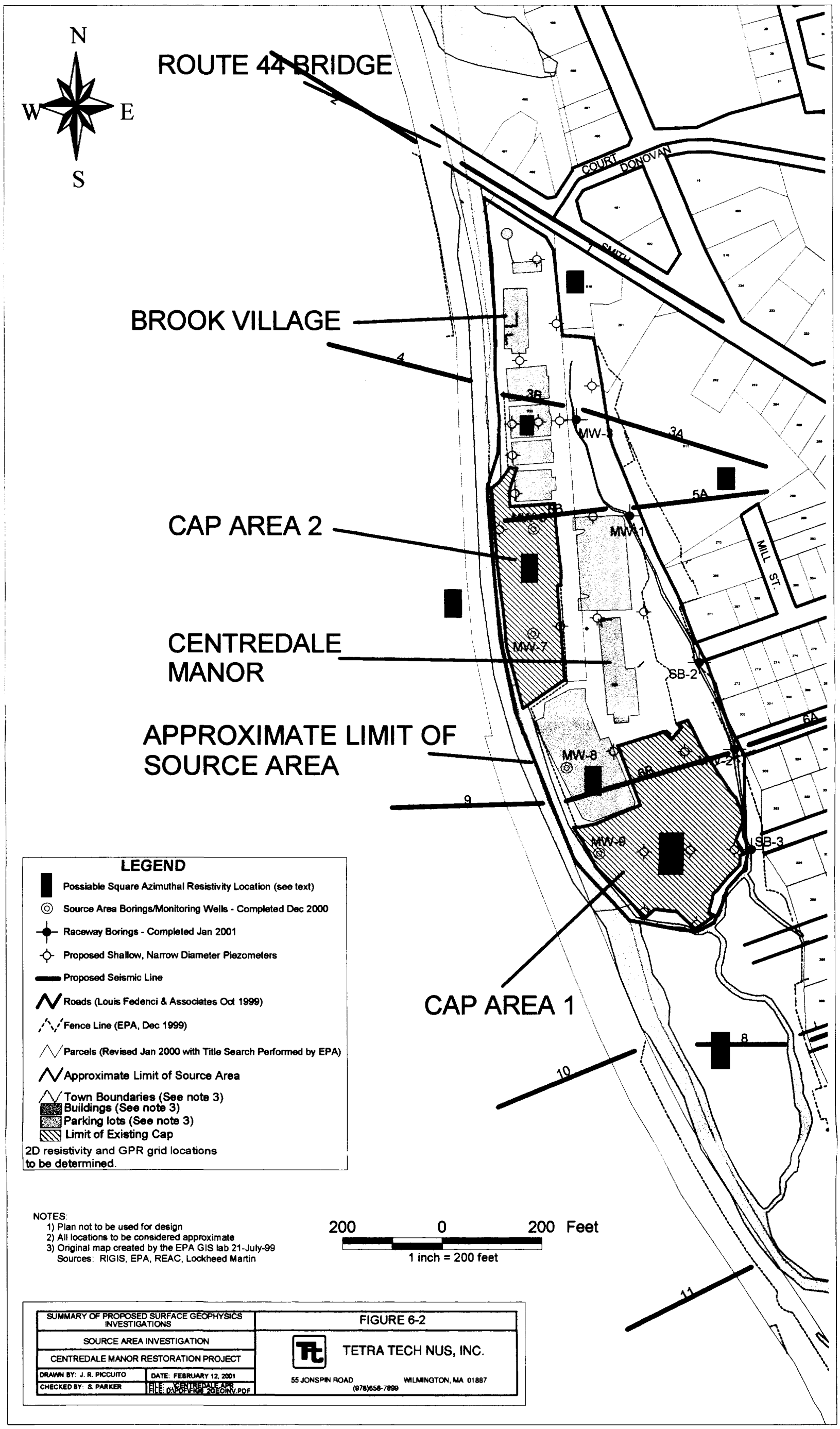
TBD – To be determined
NAPL – Non-Aqueous Phase Liquid
(1) – Refer to Table 12-1 for Method/SOP References

Table 6-24
Project Schedule Timeline
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

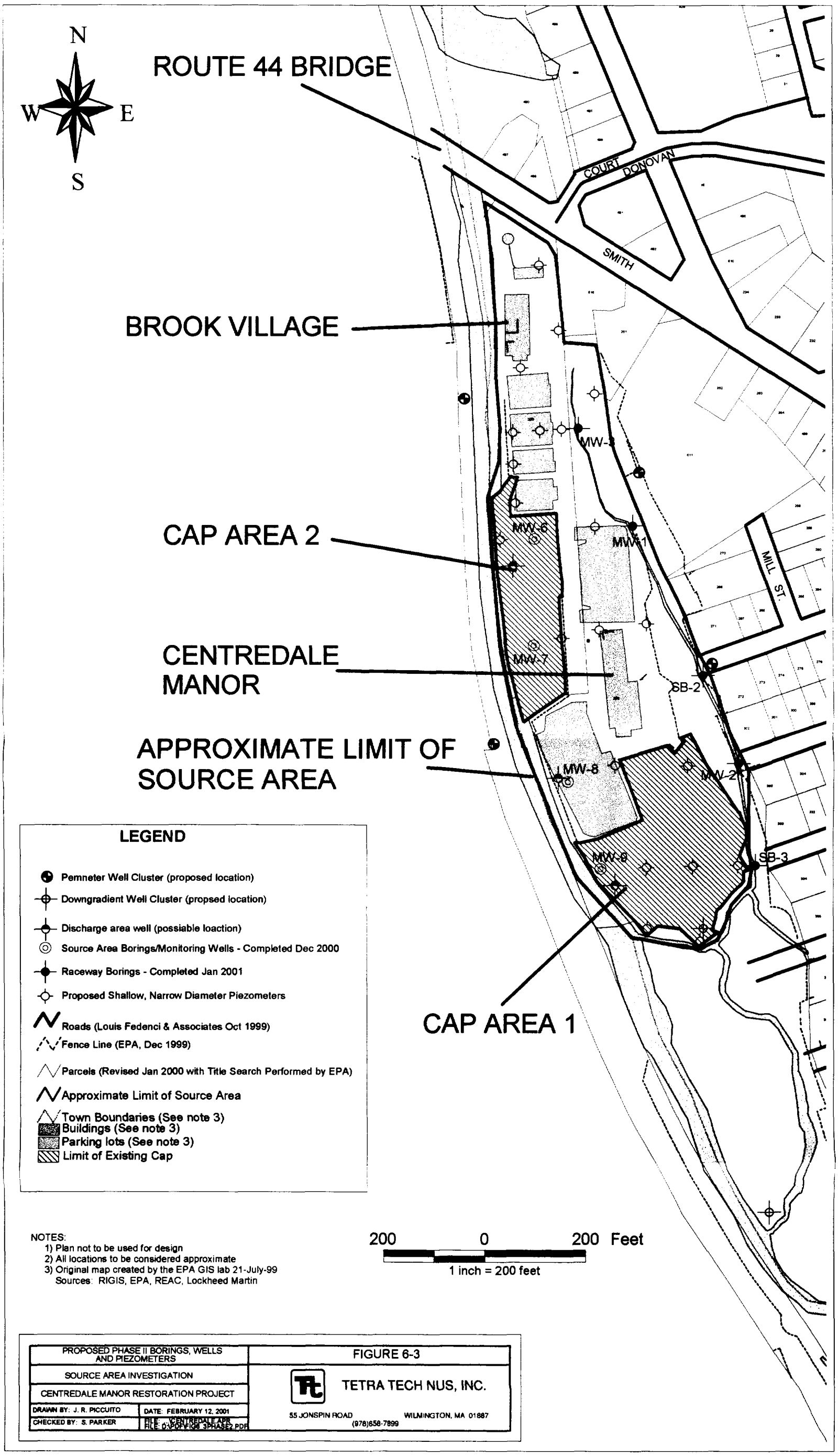
Activities	Anticipated Date of Initiation	Anticipated Date of Completion	Deliverables	Deliverable Due Dates
Phase I Soil Sampling/ Well Installation	November 2000	March 2001	Data Packages from Laboratories	Last Package due April 2001
Phase I Soil Data Validation	January 2001	April 2001	Data Validation Memoranda	Estimated 3 weeks following receipt of final lab data
Phase I Groundwater Sampling	February 2001	February 2001	Data Packages from Laboratories	Last Package due May 2001
Phase I Groundwater Data Validation	March 2001	April 2001	Data Validation Memoranda	Estimated 3 weeks following receipt of final lab data
Phase I Data Validation	March 2001	March 2001	Data Validation Memoranda	Estimated 3 weeks following receipt of final lab data
Surface Geophysics	March 2001	March 2001	Subcontractor Report	April 2001
Phase I Long Term Water Level Monitoring	March 2001	April 2001	Field Data Records	Download April 2001
Phase II Soil Sampling/ Well Installation	May 2001	July 2001	Data Packages from Laboratories	Last Package due July 2001
Data Validation	July 2001	August 2001	Data Validation Memoranda	Estimated 3 weeks following receipt of final lab data
Phase II Groundwater Sampling	July 2001	August 2001	Data Packages from Laboratories	Last Package due August 2001
Data Validation	August 2001	September 2001	Data Validation Memoranda	Estimated 3 weeks following receipt of final lab data
Phase II Long Term Monitoring Water Level	July 2001	September 2001	Field Data Records	Download September 2001
Air Sampling	May 2001	June 2001	Data Packages from Laboratories	Last Package due July 2001
Air Data Validation	August 2001	August 2001	Data Validation Memoranda	Estimated 3 weeks following receipt of final lab data
Wipe Sampling	May 2001	June 2001	Data Packages from Laboratories	Last package due July 2001
Wipe Data Validation	August 2001	August 2001	Data Evaluation Memoranda	Estimated 3 weeks following receipt of final lab data
Data Evaluation and Report Preparation	Ongoing (after initiation of sampling activities	5 weeks following completion of final data validation	Data Evaluation Report (to summarize all sampling events)	4 weeks following completion of final data validation



Original includes color coding.



Original includes color coding.



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7.0 PROJECT QUALITY OBJECTIVES AND MEASUREMENT PERFORMANCE CRITERIA

The following sections detail the project quality objectives and measurement performance criteria that have been developed for the data collection activities currently scoped for the Centredale Manor Restoration Project – Source Area Investigation. Project Quality Objectives (PQOs) are descriptions of the type, quality, and quantity of data needed to answer a specific environmental question. Measurement performance criteria are objective measures that can be used to determine if a PQO has been met.

7.1 Project Quality Objectives

PQOs were developed using a systematic planning process including reviews of the EPA Statement of Work, documents concerning the history of the site, available previous investigations of the site, previous sampling or remedial activities at the site, and in discussions with EPA. As a result of this review, the following PQO's were developed, discussed by sample media in the following sections.

7.1.1 Soil Sampling

The PQOs for the various soil sampling events to be performed under this QAPP are discussed below. It is noted that some soil samples will be collected for VOC headspace screening and soil classification purposes only. However, all soil samples that are to be collected for laboratory analysis (includes soils from raceway, source area, downgradient area, and discharge area, as described below) are, in part, to provide data to support preparation of a baseline human health risk assessment for the site (it is assumed that the current and anticipated future use of the property is residential), and possible remedial activities, if needed.

The study area defined for collection of subsurface soil data to support the human health risk assessment, as defined by EPA, includes:

- Brook Village Properties, North Providence Plat 14, Lot 200
- Centredale Manor Property, North Providence Plat 14, Lot 250

In order to use the data for risk assessment purposes, the soil data must be of the highest quality with the most stringent Measurement Performance Criteria (MPC) for the Data Quality Indicators (DQIs) and analytical QC, as described in Tables 7-1 to 7-5. The sensitivity of the analytical method selected for soil analysis meets the PALs listed in Tables 6-1 through 6-5 for the site contaminants of concern.

Section 6.0 provides additional information on the number of samples to be taken during each event, Section 8.0 discusses the sample design rationale, and Section 9.0 presents soil sampling procedures to be used. The PQOs for individual soil sampling activities/areas are discussed further in the following sections.

7.1.1.1 Phase 1 – Soil Borings/Wells in the Centredale Raceway

Five soil borings will be advanced in the Centredale Raceway in order to characterize the nature of those soils, to evaluate potential contaminants in the subsurface soils, and to provide data for human health risk assessment purposes. Historically, the Centredale Raceway was a stream carrying water from the power source of the former mill, and appears to have filled in naturally over time. Contaminants associated with the source area may have been deposited in sediments settled out from historical flows within the raceway, over the course of the site operations. Currently, the raceway is a low spot or ditch that is prone to carrying storm water runoff from the properties located to the east of the site, resulting in some scouring and eroding of subsurface soils.

Borings will be advanced in the raceway and soil samples collected to determine presence and depth of fill and of source-area-related contaminants. If contaminant concentrations are identified in the subsurface soils that exceed acceptable human health standards, or if contaminants present in the soils are likely to be transported via stormwater washouts and discharged to the Woonasquatucket River, the need for remedial action at the raceway will have to be evaluated.

As described in Section 6, continuous soil samples will be collected through the advancement of drive and wash borings, using 3-inch diameter split barrel samplers to maximize soil sample volume for laboratory analysis. Samples will be collected every 1-foot interval beginning from 1

foot below ground surface. An estimated 35 subsurface soil samples (plus QA/QC samples) may be collected for chemical analysis of contaminant groups identified in Section 6.

In addition, an estimated three shallow overburden monitoring wells are to be installed in selected borings (based on headspace screening results and soil observations) with the objectives of providing sampling locations to assist in evaluating groundwater quality underlying the raceway area, and to provide groundwater elevation measurement points in the raceway area to aid in evaluating the shallow water table configuration.

7.1.1.2 Phase I – Source Area Shallow Soil Borings/Wells

Four soil borings will be advanced in or adjacent to areas previously identified through historical photos or geophysical investigations as possible fill (contaminant source) areas or as areas possibly containing buried debris, in order to identify potentially high concentrations of contaminant in these soils. If contaminant concentrations are identified that exceed acceptable human health standards, or if contaminants present in the soils are likely to be transported via groundwater and discharged to Woonasquatucket River, the need for remedial action in this area will have to be evaluated.

As described in Section 6, continuous samples will be collected through the advancement of drive and wash borings, using 3-inch diameter split barrel samplers to maximize soil sample volume for laboratory analysis. Samples will be collected every 1-foot interval beginning from 1 foot below clean fill placed as a part of the cap construction conducted in 1999, and will continue until one of the following conditions indicate that vertical extent of soil contamination has been reached:

- Field-screening of total VOCs (by soil jar headspace measurements) show a trend of high or moderate concentrations in samples collected from fill decreasing with depth below the limit of that fill to reach non-detected levels within natural soils, indicating that depth of fill has been reached;

- A hydraulic potential confining layer is encountered, based on soil types observed by the site geologist;

- Bedrock is encountered.

An estimated 28 subsurface soil samples (plus QA/QC samples) may be collected for chemical analysis of contaminant groups identified in Section 6.

In addition, shallow overburden monitoring wells are to be installed in each of the four borings (based on headspace screening results and soil observations) with the objectives of providing sampling locations to assist in evaluating groundwater quality in the shallow overburden in the source area, and to provide groundwater elevation measurement points in these areas to aid in evaluating the shallow water table configuration.

7.1.1.3 Phase II – Perimeter Area Borings/Wells

Soil and bedrock borings will be advanced in four locations along the perimeter of the source area, with an estimated two overburden wells (shallow and deep) and one bedrock well installed at each of the four cluster locations. The monitoring wells to be installed in these borings are to accomplish the objectives of evaluating contaminant concentrations in groundwater in these areas, and to evaluate horizontal and vertical hydraulic gradients of groundwater flow between the bedrock, deep overburden and shallow overburden.

As described in Section 6, continuous split-spoon soil samples will be collected from the ground surface to bedrock from the first (deepest) boring of each cluster, through the advancement of drive and wash borings. Samples will be collected using standard penetration tests and a 2-inch OD split barrel sampler. Soils from each 2-foot split-spoon will be collected for field headspace screening of total VOCs and will be classified using the USCS; samples for laboratory analysis are not anticipated from these off-site borings. Headspace screening and soil classification results will be used to determine depths and lengths of overburden well screens. Overburden well screens will be targeted for intervals at or below the water table where headspace screening results indicate the presence of VOCs, or based on visual or olfactory evidence of contamination; if VOCs are not detected, screens will be targeted for

zones likely to be most permeable or possible preferred pathways for groundwater contaminant transport. (No headspace screening is associated with the bedrock drilling activities, which are described in more detail in Section 9.)

7.1.1.4 Phase II – Downgradient (Southern) Area Borings/Monitoring Wells

Soil and bedrock borings will be advanced in two locations anticipated to be downgradient of the source area (near areas of previous detections of VOCs in vapor diffusion sampling), with an estimated two overburden wells (shallow and deep) and one bedrock well installed at each of the two cluster locations. The monitoring wells to be installed in these borings are to provide data to evaluate the downgradient nature and extent of source-area-related groundwater contamination, and to evaluate horizontal and vertical hydraulic gradients of groundwater flow between the bedrock, deep overburden and shallow overburden in these areas. Data from these wells will be used to evaluate if groundwater contaminants in this area may be discharging to the Woonasquatucket River, and the potential need for remedial action. In addition, analytical data from soil samples to be collected from the soil borings advanced in these locations will assist in the evaluation of potential source-area-related soil contamination in downgradient floodplain/depositional areas.

As described in Section 6, continuous soil samples will be collected from the ground surface to the top of bedrock from the first (deepest) boring of each cluster, through the advancement of drive and wash borings, using 3-inch diameter split barrel samplers to maximize soil sample volume for laboratory analysis. Samples will be collected at 1-foot intervals beginning at ground surface to the top of bedrock. Soil samples from each split-spoon will be collected for field headspace screening of total VOCs and will be classified using the USCS. In addition, soil samples for laboratory analysis will be collected from ground surface to an estimated depth of 8 feet below ground surface. The objective of these shallow soil samples for laboratory chemical analysis is to evaluate potential source area-related contaminants possibly resulting from depositional events from previous flooding or overland flows from the source area. This depth is also comparable to the depths from which analytical soil samples are to be collected during the Phase 1 soil sampling event. Also, depositional sediments containing site-related contaminants from flooding events are unlikely to be at depths greater than 8 feet, based on previous sampling results in comparable areas, which found contaminants up to 5 feet below ground surface.

Headspace screening of VOCs and soil classification results will be used to determine depths and lengths of overburden well screens. Overburden well screens will be targeted for intervals at or below the water table where headspace screening results indicate the presence of VOCs, or based on visual or olfactory evidence of contamination; if VOCs are not detected, screens will be targeted for zones likely to be most permeable or possible preferred pathways for groundwater contaminant transport. (No headspace screening is associated with the bedrock drilling activities, which are described in more detail in Section 9.) . An estimated maximum of 16 shallow subsurface soil samples (plus QA/QC samples) are anticipated for collection for chemical analysis of contaminant groups identified in Section 6: eight samples (0 to 8 feet in 1-foot intervals) from each of the 2 cluster locations.

7.1.1.5 Phase II – Discharge Area Borings/Wells

As described in Section 6, an estimated four clusters of up to two monitoring wells per cluster (one deep overburden and one shallow overburden well, depending on saturated thickness of the overburden) will be installed in areas estimated to be potential "discharge areas" of groundwater contaminants originating in the source area, and potentially discharging through groundwater to the Woonasquatucket River and/or to the raceway. These borings/wells are to be advanced to provide information on groundwater contaminants from the source area, or from hotspots within the source area, that are potentially discharging to the River and/or raceway from shallow and/or deep overburden, and to provide additional data to evaluate the nature and extent of soil contamination (soils generally at and above the water table). Data from these wells will be used to evaluate if groundwater contaminants in these areas may be discharging to the Woonasquatucket River, from shallow and/or deep overburden, and the potential need for remedial action. Also, if contaminant concentrations that exceed acceptable human health standards are identified in shallow soils, the need for remedial action in this area will have to be evaluated.

It is anticipated that the "discharge area" borings may be advanced from 1 foot below ground surface to the top of bedrock (up to an estimated 45 to 60 feet) to provide data on the entire saturated thickness within the overburden at each location. One or more "discharge area" wells may be co-located with one or more existing shallow source area wells that were installed

during Phase 1, if appropriate (a deep overburden well could be co-located with an existing Phase 1 shallow overburden well, if appropriate, based on the evaluation of Phase 1 data).

Continuous soil samples will be collected from 1-foot intervals using a 3-inch diameter split barrel sampling tool during the advancement of the initial (deepest) boring at each cluster. Soils will be evaluated in the field using VOC headspace screening techniques, and will be described using the USCS soil classification system. This information, as well as total saturated thickness and predicted vertical gradients (from Phase 1) will be used to determine the well screen locations and to determine the number of wells per cluster (assuming up to two wells per cluster). In addition, continuous soil samples for laboratory chemical analysis will be collected from each 1-foot interval from the initial (deepest) boring at each cluster, up to an estimated depth of 8-feet below ground surface (estimated bottom of fill). An estimated 28 shallow subsurface soil samples (plus QA/QC samples), seven samples (1 per foot, from 1 to 8 feet) from each of the four cluster locations, are anticipated for collection for chemical analysis of contaminant groups identified in Section 6. Soils below the identified fill materials will be collected for VOC headspace screening and visual identification (USCS) only, as stated above.

7.1.2 Groundwater Sampling

The PQOs for groundwater sampling events to be performed under this QAPP are discussed below. Section 6.0 provides additional information on the number of samples to be taken during each event, Section 8.0 discusses the sample design rationale, and Section 9.0 presents groundwater sampling procedures to be used. The PQOs for each of the two planned groundwater sampling events are discussed further in the following sections.

As discussed with EPA, the primary objective of groundwater sampling and analysis is to evaluate the impact of the potential discharge of source-area-related groundwater contamination to the nearby surface water bodies, including the Woonasquatucket River, the raceway, and pond. Groundwater samples will be collected from wells installed in different areas on and near the site, as detailed elsewhere in this section, and from shallow and deep overburden and bedrock wells, to provide data for this purpose.

Since the impact of contaminated groundwater on surface water quality (through groundwater discharge to surface water) is the primary objective, various surface water quality criteria are to

be used, in part, to determine project quality objectives and project action limits (specific project action limits are detailed in Section 7.2). Since groundwater in the area is identified as a GB aquifer (not for drinking water use), the human health risk assessment will likely not evaluate a drinking water scenario, therefore, drinking water standards and human health risk assessment are not data quality drivers for groundwater analyses.

In order to obtain data for evaluation against surface water quality criteria, the groundwater data must be of the highest quality with the most stringent Measurement Performance Criteria (MPC) for the Data Quality Indicators (DQIs) and analytical QC, as described in Tables 7-6 to 7-13. The sensitivity of the analytical methods selected for groundwater analysis meets the PALs listed in Tables 6-6 through 6-11 for the site contaminants of concern.

7.1.2.1 Phase 1 Groundwater Sampling

The Phase 1 groundwater sampling event will include collecting samples from all monitoring wells installed during Phase 1 soil boring activities, as described in Sections 7.1.1.1 and 7.1.1.2. These include:

- Three shallow overburden monitoring wells installed in selected raceway borings to identify contaminant presence in groundwater in the raceway vicinity;

- Four shallow overburden monitoring wells installed in the source area to identify groundwater contaminants within what is anticipated to be the areas of highest probability of contamination, based on review of historic information (Section 5.2.2). The wells will be installed in the targeted source areas to screen the vertical horizons that are suspected to carry contaminants within the groundwater.

7.1.2.2 Phase 2 Groundwater Sampling

The Phase 2 groundwater sampling event will include collecting samples from all monitoring wells installed during both Phase 1 and Phase 2 soil boring activities, as described in Section 7.1.1. These include the shallow overburden monitoring wells described above (Section 7.1.2.1) and the following wells to be installed during Phase 2 drilling activities:

- Four clusters of two to three wells each (one bedrock and up to two overburden wells per cluster), installed on the perimeter of the source area. These will be sampled in order to collect groundwater analytical data to evaluate contaminant concentrations in bedrock, deep overburden and shallow overburden groundwater.

- Two clusters of two to three wells each (one bedrock and up to two overburden wells per cluster), installed downgradient (likely south) of the source area. These will be sampled in order to collect groundwater analytical data to evaluate contaminant concentrations in bedrock, deep overburden and shallow overburden groundwater.

- An estimated four clusters of up to two wells each (one deep overburden and one shallow overburden well, depending on saturated thickness of the overburden) installed in areas estimated to be potential "discharge areas" of groundwater contaminants originating in the source area, and discharging through groundwater to the Woonasquatucket River and/or to the raceway. These wells will provide information on groundwater contaminants from the source area, or from hotspots within the source area, that are potentially discharging to the river and/or raceway from shallow and/or deep overburden.

7.1.3 NAPL Sampling

The PQOs for NAPL sampling to be potentially performed under this QAPP are discussed below. Section 6.0 provides additional information on the number of samples to be taken during each event, Section 8.0 discusses the sample design rationale, and Section 9.0 presents NAPL sampling procedures to be used.

During both Phases 1 and 2, shallow monitoring wells will be installed in the source area in order to identify potential high concentrations of contaminants within the source area. Based on the anomalies found by geophysical surveys performed in this area in 1999, it is possible that some of the borings may be advanced into areas where non-aqueous phase liquid (NAPL) is present. Because of this possibility, an allowance is made to capture samples of this material during either the soil sampling effort (during boring installation) or the groundwater sampling

effort. If NAPLs are found at the site and are potentially discharging to the waters of the Woonasquatucket River, it is important to understand their composition and location to allow possible targeted remedial actions.

The Measurement Performance Criteria (MPC) for the Data Quality Indicators (DQIs) and analytical QC for NAPL samples are described in Tables 7-14 to 7-18. The sensitivity of the analytical methods selected for NAPL analysis meet the PALs listed in Tables 6-12 through 6-16 for the site contaminants of concern.

7.1.4 Air and Wipe Sampling

The PQOs for air and wipe sampling to be performed under this QAPP are discussed below. Section 6.0 provides additional information on the number of samples to be taken during each event, Section 8.0 discusses the sample design rationale, and Section 9.0 presents air and wipe sampling procedures to be used.

To determine if contaminants are present in the Centredale Manor building and to support a baseline risk assessment, an air sampling investigation will be conducted. Air samples will be collected in five separate locations of the Centredale Manor, including the ground floor, common spaces, and enclosed living spaces. Samples will be collected to determine if residents within the building might be exposed to site contaminants.

To determine contaminant presence inside the Centredale Manor building and to support a baseline risk assessment, wipe samples of indoor dust from horizontal surfaces will be collected. Samples will be collected in five separate locations of the Centredale Manor, including the ground floor, common spaces, and enclosed living spaces. Samples will be collected to determine if there is increased risk to the residents of the building from potential site-related airborne contaminants that potentially accumulated in settled dust within the building.

In order to support a baseline risk assessment, the air and wipe data must be of the highest quality within the most stringent Measurement Performance Criteria (MPC) for the Data Quality Indicators (DQIs) and analytical QC as described in Tables 7-19 to 7-23. The sensitivity of the

analytical methods selected for air and wipe sample analysis meet the PALs listed in Tables 6-17 through 6-21 for the site contaminants of concern.

7.2 Project Action Limits

The current action limits for the selected site contaminants of concern (COCs) are specific criteria against which the analytical data will be initially screened to support the preparation of a human health risk assessment (soil), to evaluate potential effects of groundwater discharging to surface water, and to evaluate the presence of contaminants within onsite buildings.

The project action limits for the COCs in soils (except dioxin) are based on the Rhode Island Department of Environmental Management (RIDEM) direct exposure criteria for residential soils. The action limit for dioxin in soils is 1 ug/kg, which has been found to roughly correspond to a cancer risk of less than 1x10-4 under residential risk scenarios (TtNUS 9/00).

The action limits for the COCs in groundwater are based on a number of criteria, including RIDEM ambient water quality criteria and guidelines, federal ambient water quality criteria, and Oak Ridge National Laboratory Conventional Benchmarks for priority in fresh water. Drinking water standards have not been identified as project action limits, because the area is in a GB aquifer, because many site contaminants do not have drinking water criteria assigned, and because the surface water criteria noted above cite target concentrations below those cited for drinking water standards (metals). The action limit of 1 ug/l of dioxin has been selected for this project because exposure to groundwater is not anticipated except on a recreational basis, through incidental ingestion similar to that for soils.

The action limits for air and wipe samples have been developed using published criteria where available, and risk based exposure scenarios. The action limits for volatile organics in air were calculated from Region IX PRGs in ambient air converted to ppbv assuming 1 atm at 68 degrees Fahrenheit. Action limits for PCBs and dioxins in air (suspended dust) and wipe samples (settled dust) have been developed through a target cancer risk of $1x10^{-6}$, presuming a 24-hour residential inhalation and dermal exposure.

The action limits for NAPLs are selected based on Rhode Island Department of Environmental Management direct exposure criteria for residential soils. This selection was made as there are

no criteria for NAPLs, and the presumption is that if they are contacted, they would be done so through an exposure route similar to that for inadvertent ingestion and dermal contact with soil. The action limit for dioxin in soils is 1 ug/kg, which has been found to roughly correspond to a cancer risk of less than 1x10-4 under residential risk scenarios (TtNUS 9/00).

Tables 6-1 through 6-21 provide a list of action limits for this project for the site COCs, based on currently available data.

7.3 Measurement Performance Criteria

The quality assurance objectives for all measurement data include considerations for precision, accuracy, completeness, and comparability (PARCC). To meet these PARCC requirements quality control procedures are implemented in the field during sample collection and in the laboratories during sample analysis. Field and laboratory quality control samples include the analysis of field duplicates and laboratory matrix spike/matrix spike duplicates to assess precision and representativeness; matrix spikes, blanks, and laboratory control samples to assess accuracy; blanks and sampling procedures to assess representativeness; and performance evaluation samples to assess accuracy.

Precision is a measure of the mutual agreement among individual measurements of the same property under the same or similar conditions. Precision is measured using field and laboratory duplicates. Precision is expressed in terms of relative percent difference (RPD) using the following equation:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100$$

where:

C_1 = The larger of the two observed values
C_2 = The smaller of the two observed values

Acceptable levels of precision will vary according to the sample matrix, the specific analytical methods, and the analyte concentration relative to the method detection limit (MDL). Quality

assurance objectives for precision will be met through the use of written field and laboratory procedures (SOPs) and properly calibrated instruments. The goals for measurement performance criteria are summarized in Tables 7-1 to 7-23.

Accuracy/Bias is the degree of agreement of an observed value (sample result) with an accepted reference or true value (standard). The difference is usually expressed as a percentage difference. Accuracy is a measure of the bias of a system. In the field, routine calibration checks are performed to assess the accuracy of field instrumentation measures. The accuracy/bias of laboratory analytical data is measured through the analysis of method blanks, sample matrix spikes, matrix spike duplicates, sample surrogate recoveries, laboratory control samples, and performance evaluation samples.

The percent difference (%D) is calculated by the following equation:

$$\%D = \frac{MeasuredValue}{TrueValue} \times 100$$

The percent recovery (%R) of a known method analyte or surrogate spike is calculated by the following equation:

$$\%R = \frac{Spiked \text{ Sample Conc. - Unspiked Sample Conc.}}{\text{Amount of Spiked added}} x\,100$$

The objective for field measurement accuracy is to achieve and maintain the manufacturer's specifications for field equipment. The objective for laboratory determination accuracy is to maintain a system which can be demonstrated to achieve measurements within accuracy criteria published or statistically derived for the applicable analytical methods for sample or QC elements of similar matrix and analyte concentration. The goals for accuracy for this sampling are summarized in Tables 7-1 to 7-23.

Representativeness expresses the degree to which a sampling design accurately and precisely reflects the environmental conditions of the site. The consistent collection, preservation, and analysis of samples according to standardized procedures will control representativeness.

Representativeness can be assessed through the measures of precision and accuracy. Field documentation, field duplicate analyses, laboratory QC sample results, and data trend analysis all provide indices for the evaluation of data representativeness.

Samples taken must be representative of the population. Where appropriate, the population will be statistically characterized to express the degree to which the data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, process, or environmental condition. Sampling devices will be decontaminated between sampling points to minimize the potential of cross-contamination between samples. Clean sample containers will be used to avoid contamination.

To assess the representativeness of the sample collection procedure, some samples will be collected in duplicate and both samples will be analyzed. Comparison of the results will allow for an evaluation of the representativeness of the sampling. One duplicate will be collected per 10 environmental samples for each analysis.

Comparability is a measure of the degree of confidence with which one set of data can be compared to a related set of data. Comparability addresses consistency in sampling, and consistency within the analytical method applied.

The QA objective for comparability is to ensure that the results of analyses for this project can be compared with potential future sampling events and potentially with analyses by other laboratories. The goals for comparability are summarized in Tables 7-1 to 7-23.

Sensitivity is the ability of the method or instrument to detect the constituent of concern and other target analytes at the levels of interest. Method and instrument sensitivity may be evaluated through instrument detection limit studies, calibration standards, and/or Laboratory Fortified Blanks.

Completeness is a measure of the amount of valid data obtained from a measurement system relative to the amount that would be expected to be obtained under correct, normal conditions.

$$\% \text{ Completeness} = \frac{\text{\# of valid values reported for parameter}}{\text{\# of samples collected for analysis for that parameter}} \times 100$$

A completeness of at least 85 percent is considered acceptable for this soil and groundwater sampling.

Table 7-1
Soil Volatile Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Soil
Analytical Parameter	Volatiles
Concentration Level	Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S4 (Sec. 9.1)	L1	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Accuracy/Bias	as per OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminants)	Equipment blanks, trip blanks, method blanks, instrument blanks	S & A
		Sensitivity	Method Detection Limits	Method Detection Limits	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-2
Soil Semivolatiles Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Soil
Analytical Parameter	Semivolatiles
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S4 (Sec. 9.1)	L2	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Accuracy/Bias	as per OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminates)	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Not applicable, CLP method	Not applicable, CLP method	Not applicable, CLP method

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-3
Soil Pesticide/PCB Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Soil
Analytical Parameter	Pesticide/PCB
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S4 (Sec. 9.1)	L3	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Accuracy/Bias	as per OLM04.2 requirements	Matrix spike/Matrix spike duplicate sample	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminates)	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Not applicable, CLP method	Not applicable, CLP method	Not applicable, CLP method

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-4
Soil Metals Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Soil
Analytical Parameter	Metals
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S4 (Sec. 9.1)	L4	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 5XCRDL	Field duplicate samples	S & A
		Precision-Laboratory	RPD < 35% when both laboratory duplicate samples are ≥ 5XCRDL	Laboratory duplicate samples	A
		Accuracy/Bias	±25% recovery when sample concentration is ≤ 4X the spike concentration	Matrix spike sample	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias	Sample results within standard acceptable criteria defined by vendor	Laboratory control sample	A
		Accuracy/Bias Contamination	No target analytes ≥ QL (CRDL) or 5X ≤ sample concentration	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Not applicable, CLP method	Not applicable, CLP method	Not applicable, CLP method

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-5
Soil Dioxins Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Soil
Analytical Parameter	Dioxins
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S4 (Sec. 9.1)	L5	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Precision-Laboratory	RPD ± 25%	Laboratory duplicate analysis	A
		Accuracy/Bias	70 – 130% Recovery RPD < 20%	Matrix spike/Matrix spike duplicate sample	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PEs	A
		Accuracy/Bias Contamination	No target compounds above 2% of the signal for the associated internal standard	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 6
Groundwater Volatile Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	Volatiles
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L6	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Accuracy/Bias	as per the OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminants)	Equipment blanks, trip blanks, method blanks, instrument blanks	S & A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Sensitivity	Not applicable, CLP method	Not applicable, CLP method	Not applicable, CLP method

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 7
Groundwater Semivolatile Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	Semivolatiles
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L7	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Accuracy/Bias	as per the OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminants)	Equipment blanks, method blanks, instrument blanks	S & A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Sensitivity	Not applicable, CLP method	Not applicable, CLP method	Not applicable, CLP method

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 8
Groundwater Pesticide/PCB Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	Pesticide/PCB
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L8	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Accuracy/Bias	as per the OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminants)	Equipment blanks, method blanks, instrument blanks	S & A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Sensitivity	Not applicable, CLP method	Not applicable, CLP method	Not applicable, CLP method

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 9
Groundwater Metals (Total and Dissolved) Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	Metals
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L9 L10	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 5XQL	Field duplicate samples	S & A
		Precision-Laboratory	RPD < 20% when both laboratory duplicate samples are ≥ 5XQL	Laboratory duplicate samples	A
		Accuracy/Bias	±25% when sample concentration is ≤ 4X the spike concentration	Matrix spike sample	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias	Sample results within standard acceptable criteria defined by vendor	Laboratory control sample	A
		Accuracy/Bias Contamination	No target analytes ≥ QL (CRDL) or 5X ≤ sample concentration	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Not applicable, CLP method	Not applicable, CLP method	Not applicable, CLP method

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 10
Groundwater Dioxins Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	Dioxins
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L11	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	RPD ± 25%	Laboratory duplicate analysis	A
		Accuracy/Bias	70 – 130% Recovery RPD < 20%	Matrix spike/Matrix spike duplicate sample	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds above 2% of the signal for the associated internal standard	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 11
Groundwater Alkalinity Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	Alkalinity
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L12	Data completeness	85% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	< 20%D	Laboratory duplicate analysis	A
		Accuracy/Bias	85 – 115% Recovery	EPA check standard	A
		Accuracy/Bias Contamination	No target compounds ≥ ½ QL	Method blanks, instrument blanks	A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 12
Groundwater Sulfide Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	Sulfide
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L13	Data completeness	85% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	< 20% D	Laboratory duplicate analysis	A
		Accuracy/Bias	80 – 120% Recovery	Matrix spike/Matrix spike duplicate sample	A
		Accuracy/Bias	85 – 115 % Recovery	EPA check standard	A
		Accuracy/Bias Contamination	No target compounds ≥ ½ QL	Method blanks, instrument blanks	A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 13
Groundwater Total Organic Carbon Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Groundwater
Analytical Parameter	TOC
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S6 (Sec. 9.2)	L14	Data completeness	85% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	< 20% RPD	Laboratory duplicate analysis	A
		Accuracy/Bias	80 – 120% Recovery	Matrix spike/Matrix spike duplicate sample	A
		Accuracy/Bias	85 – 115% Recovery	EPA check standard	A
		Accuracy/Bias Contamination	No target compounds ≥ ½ QL	Method blanks, instrument blanks	A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 14
NAPL Volatile Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	NAPL
Analytical Parameter	Volatiles
Concentration Level	Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S2, S4, S6 Sec. 9.2, 9.1 as necessary	L15	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Accuracy/Bias	as per the OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminants)	Equipment blanks, trip blanks, method blanks, instrument blanks	S & A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

NAPL = non-aqueous phase liquid

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 15
NAPL Semivolatile Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	NAPL
Analytical Parameter	Semivolatiles
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S2, S4, S6 Sec. 9.2, 9.1 as necessary	L16	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Accuracy/Bias	as per the OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminants)	Equipment blanks, method blanks, instrument blanks	S & A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

NAPL = non-aqueous phase liquid

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 16
NAPL Pesticide/PCB Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	NAPL
Analytical Parameter	Pesticide/PCB
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S2, S4, S6 Sec. 9.2, 9.1 as necessary	L17	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XQL	Field duplicate samples	S & A
		Accuracy/Bias	as per the OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias Contamination	No target compounds ≥ QL (CRQL) or 5X ≤ sample concentration (10X for common contaminants)	Equipment blanks, method blanks, instrument blanks	S & A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

NAPL = non-aqueous phase liquid

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 17
NAPL Total Metals Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	NAPL
Analytical Parameter	Metals
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S2, S4, S6 Sec. 9.2, 9.1 as necessary	L18	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 5XQL	Field duplicate samples	S & A
		Precision-Laboratory	RPD < 35% when both laboratory duplicate samples are ≥ 5XQL	Laboratory duplicate samples	A
		Accuracy/Bias	±25% when sample concentration is ≤ 4X the spike concentration	Matrix spike sample	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias	Sample results within standard acceptable criteria defined by vendor	Laboratory control sample	A
		Accuracy/Bias Contamination	No target analytes ≥ QL (CRDL) or 5X ≤ sample concentration	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

NAPL = non-aqueous phase liquid

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7- 18
NAPL Dioxins Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	NAPL
Analytical Parameter	Dioxins
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S2, S4, S6 Sec. 9.2, 9.1 as necessary	L19	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	RPD ± 25%	Laboratory duplicate analysis	A
		Accuracy/Bias	70 – 130% Recovery < 20% RPD	Matrix spike/Matrix spike duplicate sample	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds above 2% of the signal for the associated internal standard	Equipment blanks, method blanks, instrument blanks	S & A
		Sensitivity	Method Detection Limit	Method Detection Limit	A

NAPL = non-aqueous phase liquid

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-19
Air Volatile Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Air
Analytical Parameter	Volatiles
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S10 (Sec. 9.3.1)	L20	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	< 20% RPD	Laboratory duplicate analysis	A
		Accuracy/Bias	< 0.5 QL	Humid zero air analysis	A
		Accuracy/Bias	70 – 130% Recovery	Laboratory fortified canister	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL or 5X ≤ sample concentration (10X for common contaminants)	Trip blanks, method blanks, instrument blanks	S & A
		Sensitivity	% RSD < 30 for initial calibration when the lower standard is at QL	Initial calibration	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-20
Air PCB Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Air
Analytical Parameter	PCB
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S10 (Sec. 9.3.1)	L21	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Accuracy/Bias	70 – 130% Recovery	QC check standard	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL or 5X ≤ sample concentration (10X for common contaminants)	Field Blanks, Method blanks, instrument blanks	S & A
		Sensitivity	% RSD <30% for initial calibration when the lower standard is at QL	Initial calibration	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-21
Air Dioxins Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Air
Analytical Parameter	Dioxins
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S10 (Sec. 9.3.1)	L22	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 30% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	± 30% RPD	Laboratory duplicate analysis	A
		Accuracy/Bias	70 – 130% Recovery < 20% RPD	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL or 5X ≤ sample concentration (10X for common contaminants)	Field Blanks, method blanks, instrument blanks	S & A
		Sensitivity	% RSD < 30 for initial calibration when lower standard is at the QL	Initial calibration	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-22
Wipe PCB Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Wipe
Analytical Parameter	PCBs
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S12 (Sec. 9.1)	L23	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Accuracy/Bias	as per OLM04.2 requirements	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL or 5X ≤ sample concentration (10X for common contaminants)	Field Blanks, method blanks, instrument blanks	S & A
		Sensitivity	% RSD < 30 for the initial calibration when the lower standard is at the QL	Initial calibration	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

Table 7-23
Wipe Dioxins Low/Medium Concentration Measurement Performance Criteria
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/Matrix	Wipe
Analytical Parameter	Dioxins
Concentration Level	Low/Medium

Sampling Procedure [1]	Analytical Method/SOP[2]	Data Quality Indicators (DQIs)[3]	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
S12 (Sec. 9.1)	L24	Data completeness	95% Overall	Data completeness check	S & A
		Comparability	No data available for comparison	NA	S & A
		Precision-Overall	Field duplicates RPD < 50% when both field duplicate samples are ≥ 2XCRQL	Field duplicate samples	S & A
		Precision-Laboratory	± 25% RPD	Laboratory duplicate analysis	A
		Accuracy/Bias	70 – 130% Recovery < 20% RPD	Matrix spike/Matrix spike duplicate samples	A
		Accuracy/Bias	No false negatives, no false positives, quantitation within warning limits (± 3σ)	Single blind PE	A
		Accuracy/Bias Contamination	No target compounds ≥ QL or 5X ≤ sample concentration (10X for common contaminants)	Field Blanks, method blanks, instrument blanks	S & A
		Sensitivity	% RSD < 30% for initial calibration when the lower standard concentration is at the QL	Initial calibration	A

1 – Refer to Table 9-1 for sampling procedure reference codes
2 – Refer to Table 12-1 for analytical method reference codes
3 – Data Quality Indicators (PARCC parameters, i.e., precision, accuracy/bias, sensitivity, data completeness, comparability)

8.0 PROJECT DESCRIPTION AND SCHEDULE

This section of the QAPP describes the sampling system in terms of what media/matrices will be sampled, where the samples will be taken, the number of samples to be collected, and the sampling frequency. The overall objectives of this study are to conduct a source area investigation for the Centredale Manor and Brook Village properties to obtain data to evaluate site-related soil and groundwater contamination and migration pathways, to support possible preparation of a human health risk assessment, and possible engineering evaluations for remedial alternatives.

Site visits were conducted on July 7, 2000 and July 26, 2000. During these site visits, the site and surrounding areas were inspected to determine the probable geology of the area. Nearby bedrock outcrops were identified, and the existing conditions of the capped areas, the river and riverbed, the right of way on the west side of the river, and the pond were all evaluated. In addition, the source area and surrounding properties were evaluated for possible access during drilling and other field activities.

The specific objective of each data collection effort is presented in the following sections along with a brief rationale. This information is used with the project quality objectives and action limits identified in Section 7 to devise a site-specific design for data collection.

8.1 Sampling Design Rationale

To complete the source area investigation as described in Section 6, data is needed to determine thickness of fill, the extent of soil contamination that could be liberated by groundwater, and the extent of groundwater contamination. In addition, evaluation of soil types throughout the saturated overburden, and determination of groundwater flow direction (horizontally and vertically) both within and outside of the site boundaries will be necessary to support a conceptual model of groundwater flow and identification of possible contaminant flow paths through the source area and into potential resource areas.

These data needs will be met through installation of piezometers and groundwater level monitoring activities, surface and borehole geophysical investigations, and installation and

sampling of soil borings and groundwater monitoring wells. Installations will be designed to target each of the eight areas identified in Section 5.2.3, and used in conjunction with each other such that the groundwater flow for the entire source area can be evaluated to predict direction and outputs.

Data will also be collected as part of this source area investigation to determine whether residents within the Centredale Manor building are being exposed to site contaminants. These data needs shall be met through collection of air and wipe samples from various areas within this building.

Since one objective of this source area investigation is to support preparation of a human health risk assessment, all soil and groundwater sampling data must be of the most stringent quality to meet the objectives for risk assessment purposes, in accordance with EPA Region I guidelines. Specific exposure scenarios and final site-related contaminants of concern (COCs) have not been finalized at this point, however it is anticipated that the data to be collected may be used to support these evaluations in the future.

HCX will be reported as a tentatively identified compound in the dioxins/furan analysis of samples and matrices for this site.

8.2 Soil Sampling

The rationale for soil sample collections is presented below for each phase of the source area investigation. Tables 8-1 and 8-2 present a summary of soil sample locations, sampling and analysis methods, sample containers, sample preservation, and holding time requirements, for Phase 1 and Phase 2 soil sampling, respectively.

Soil borings will be advanced using drive and washing drilling techniques. Soil samples will be collected for laboratory analysis of SVOCs, pesticides/PCBs, and metals under the CLP program. Soil samples will also be analyzed for VOCs and dioxins under the DAS program.

8.2.1 Phase 1 Soil Investigations

Five soil borings will be installed in the Centredale raceway. The exact locations will be determined in the field using the historic air photos and landmarks, such that the borings are installed as closely as possible to the former centerline of this watercourse. These borings will be installed to determine the thickness of fill (if present) in the former raceway and to provide data for evaluation of the nature and extent of soil contamination. The soils will be classified using the Unified Soil Classification System (USCS). The description of geologic materials will assist in evaluating the presence of confining layers and/or preferential pathways for groundwater transport. This information may also be used to support a conceptual design for the restoration of the raceway as a drainage channel.

Continuous subsurface soil samples will be collected from raceway borings to the depth of fill, which is anticipated to be 8 feet below ground surface (see locations depicted on Figure 6-1). These samples will be collected using a 3-inch diameter split barrel sampling tool from 1-foot intervals beginning at 1 foot below ground surface. The raceway borings will be advanced beyond the depth of fill to a minimum of 20 feet bgs to characterize the upper unconsolidated overburden. Borings may be continued beyond 20 feet bgs as determined by the supervising geologist, if concentrations of total VOCs are detectable by headspace screening. Headspace screening results for VOCs in soils will be used to help identify zones of highest potential for contamination.

Four shallow borings will be installed in the source area as shown on Figure 6-1. The exact locations of these borings will be determined in the field, to be located adjacent to or within areas of ground disturbance shown on the historic air photos and adjacent to (but not within) geophysical anomalies identified by studies described in Section 5.2.2.2. These borings will be installed to determine the thickness of fill (if present) and to evaluate the nature and extent of soil contamination (soils generally at and above the water table).

During installation of the source area borings, continuous samples of subsurface soil for laboratory analysis will be collected to the bottom of fill, which is presumed to be approximately 8 feet below ground surface. These samples will be collected at 1-foot intervals beginning at a point immediately below the cap materials or parking lot bedding materials, as described in

Section 9. The borings will be continued beyond the depth of fill to a minimum of 20 feet bgs to characterize the upper unconsolidated overburden. Borings may be continued beyond the depth of 20 feet bgs as determined by the supervising geologist, if concentrations of total VOCs are detectable by headspace screening. Headspace screening results for VOCs in soils will be used to help identify zones of highest potential for contamination.

The soils will be classified using the USCS. The description of geologic materials will assist in evaluating the presence of confining layers and/or preferential pathways for groundwater transport. Soils will be screened using the jar headspace technique for total VOCs. Screening results will be used to help identify zones of highest potential for contamination within each boring.

Samples of soil presumed or identified as fill will be analyzed for the following parameters: VOC screening using jar headspace, and laboratory analysis for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins.

Possible NAPL Sampling

It is anticipated that NAPL may be encountered during subsurface investigations at the site, particularly during "source area" borings to be advanced during Phase 1, but potentially in other Phase 1 or 2 borings and wells. If NAPL is observed in soil or groundwater, samples of the NAPL will be collected and analyzed for VOCs, SVOCs, pesticides/PCBs, total metals, and dioxins, as available volume allows. Table 8-3 presents information on NAPL sampling and analysis methods, sample container, sample preservation, and holding time requirements.

Well Construction in Phase 1 Borings

Well screens constructed in borings installed during Phase 1 will be constructed in fill or soils exhibiting evidence of contaminants present. Such evidence may include staining of the soils recovered in the split barrel sampler, total VOCs measured by jar headspace screening analysis, or other indicators. Screens will be constructed within the saturated zone and will not be constructed across possible confining layers.

Samples of fill/soils will be collected and analyzed for the following parameters: VOC screening using jar headspace, and laboratory analysis for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins.

If multiple vertical zones of potential contaminants are identified in a single boring, multiple wells may be installed at that location. In addition, if soil conditions vary between borings, and field observations indicate different contaminant layers are being encountered in borings not originally designated for well installations, such borings may also be completed as monitoring wells.

Phase 1 soil sampling locations, sampling and analysis methods, and sample container, preservation, and holding time requirements are summarized in Table 8-1. A summary of proposed Phase 1 installations (borings/wells/piezometers) is presented in Table 8-8.

8.2.2 Phase 2 Soil and Bedrock Investigations

Perimeter Well Clusters:

Four borings will be advanced around the perimeter of the source area and finished as well clusters, consisting of a bedrock well and one to two overburden wells, depending on saturated thickness of the overburden. Since these borings are to be installed outside of the source area, soil contamination is not anticipated, although groundwater contamination may be present, depending on the groundwater flow direction through and between these different zones. These borings will be advanced to provide data on overburden and bedrock conditions in the site vicinity and in possible bedrock valley areas to install groundwater monitoring wells to evaluate the groundwater gradient and flow regime around the source area, and for possible groundwater sample collection. As further detailed in Section 9, these borings will be advanced using temporary steel flush-joint casing with a nominal inside diameter of 4 inches. Soil samples from these borings will be collected for evaluation of soil conditions using a 2-inch split barrel, since laboratory analysis is not anticipated.

"Southern (Downgradient) Area" Soil Borings and Monitoring Well Clusters

Two clusters of two to three monitoring wells per cluster (one bedrock well, plus one to two overburden wells, depending on saturated thickness of the overburden) will be installed in areas

determined by Phase 1 data to be downgradient of the source area. It is anticipated that these well clusters will be located south of the source area near locations of previously detected VOCs (in vapor diffusion sampling conducted by USGS). Potential proposed locations are shown in Figure 6-3, however, actual locations of these wells may be revised following the evaluation of Phase 1 data.

As described previously, these borings/wells are to be advanced to provide information on extent of contamination in soils and groundwater, to confirm depths to bedrock, and to provide water level measurement points for evaluating vertical and horizontal groundwater gradients in these areas south of the source area, in bedrock and in shallow and deep overburden. Soil samples collected during the advancement of these borings will be evaluated in the field using VOC headspace screening techniques, and will be described using the USCS soil classification system. This information, to be collected from the initial (deepest) boring at each cluster location, will be used to select the screened intervals of the overburden wells.

Soil samples for laboratory analysis of VOCs, SVOCs, pesticides/PCBs, metals, and dioxins will also be collected from the initial (deepest) boring at each cluster, however, laboratory samples will be collected only from ground surface to an estimated 8 feet below ground surface, at 1-foot intervals. The rationale for collection and analysis of these shallow soil samples for laboratory analysis is to provide data to evaluate the presence of potential source-area-related contaminants possibly resulting from depositional events from previous flooding or from overland flows from the source area. Based on previous sampling results from comparable areas, contaminants were found up to a depth of approximately 5 feet below ground surface. It is estimated that depositional sediments containing site-related contaminants from flooding events are unlikely to be at depths greater than 8 feet.

<u>"Discharge Area" Soil Borings and Monitoring Well Clusters</u>

An estimated four clusters of up to two monitoring wells per cluster (one deep overburden and one shallow overburden well, depending on saturated thickness of the overburden) will be installed in areas estimated to be potential "discharge areas" of groundwater contaminants originating in the source area, and potentially discharging through groundwater to the Woonasquatucket River and/or to the raceway. These borings/wells are to be advanced to provide information on groundwater contaminants from the source area that are potentially

discharging to the River and/or raceway from shallow and/or deep overburden, and to provide additional data to evaluate the nature and extent of soil contamination (soils generally at and above the water table).

It is anticipated that these well clusters will be located between (downgradient of) potential "hot spots" within the source area and the River and/or raceway, in order to identify concentrations of contaminants which may be discharging to these surface water bodies via groundwater in shallow and/or deep overburden. It is anticipated that one "discharge area" boring of each cluster may be advanced to the top of bedrock, to provide data on the entire saturated thickness within the overburden at each location. Based on available data at the writing of this QAPP, the deep overburden wells may be advanced to approximately 45 to 60 feet, the estimated depth to bedrock. Specific depths, locations, and numbers of wells per cluster for the "discharge area" borings/wells will be selected following the evaluation of Phase 1 results, including geophysical survey results, groundwater flow direction data, and soil and groundwater analytical results. One or more "discharge area" wells may be co-located with one or more existing shallow source area wells that were installed during Phase 1, if appropriate (a deep overburden well could be co-located with an existing Phase 1 shallow overburden well, based on the evaluation of Phase 1 data).

Continuous soil samples collected during the advancement of the initial (deepest) boring at each cluster will be evaluated in the field using VOC headspace screening techniques, and will be described using the USCS soil classification system. This information, as well as total saturated thickness and predicted vertical gradients (from Phase I) will be used to determine the well screen locations and to determine the number of wells per cluster (assuming up to two wells per cluster).

Soil samples for laboratory chemical analysis will also be collected from the initial (deepest) boring at each cluster, however, laboratory samples will be collected only to the bottom of fill materials (estimated to be approximately 8 feet below ground surface). Continuous soil samples will be collected from 1-foot intervals using a 3-inch diameter split barrel sampling tool, to an estimated depth of 8-feet (estimated bottom of fill), and will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins, in addition to VOC headspace field screening.

Soils below the identified fill materials will be collected for VOC headspace screening and visual identification (USCS) only, as stated above.

Phase 2 soil sampling locations, sampling and analysis methods, and sample container, preservation, and holding time requirements are summarized in Table 8-2. A summary of proposed Phase 2 installations (borings/wells) is presented in Table 8-9.

Well Construction in Phase 2 Borings

In order to monitor potential contaminants travelling in shallow overburden and deeper overburden, the rationale for selecting overburden well screen intervals in Phase 2 borings will utilize: VOC field screening results of soil samples (depths with detections of VOCs will be targeted for well screens); and visual/olfactory observations and geologic soil descriptions (areas of potentially more permeable, higher hydraulic conductivity materials may be targeted for well screens). Screens will not be constructed across possible confining layers.

In constructing bedrock wells, it is anticipated that shallow bedrock (estimated 30 feet into bedrock) will be monitored for groundwater contaminants; bedrock wells are anticipated to be completed as open hole borings, and will utilize borehole geophysical data (see Section 9).

8.3 Surface Geophysics

Surface geophysics investigations will be performed prior to Phase 2 drilling and monitoring well installations. The surface geophysics will be performed to identify depth of fill, nature of the overburden and depth to bedrock. In addition, fracture orientation within the bedrock may also be evaluated. Implementing the geophysical surveys after some Phase I subsurface data is available from borings will allow the geophysics instruments to be fine-tuned to identify the targeted features. It is anticipated that successful use of geophysics techniques will allow a more detailed evaluation of subsurface conditions without extensive drilling programs.

At the end of Phase 1 activities, surface geophysical surveys will be implemented in the site vicinity, including Ground Penetrating Radar (GPR) and 2-D Resistivity Imaging, and Seismic Refraction. These surveys will provide data to support characterization of overburden materials, data on depth to bedrock and the general bedrock surface configuration.

These data will also be used to assist in refining the positioning of monitoring wells to be installed during Phase 2 activities, and to provide needed information to refine the site conceptual model. The GPR and 2-D Resistivity will be conducted to provide information on depth of fill, and the configuration of natural organic materials, buried channel deposits, and potential aquitards. The Seismic Refraction survey will provide information on depths to bedrock and the configuration of a potential bedrock valley in the area that may influence contaminant transport at and near the site.

Square Array Azimuthal Resistivity may be used prior to Phase 2 investigations to estimate bedrock fracture orientation in the site vicinity to assist in refining proposed bedrock monitoring well locations, and to provide information to support the site conceptual model of likely groundwater flow direction(s) in bedrock.

Additional information on the proposed geophysical surveys is presented in Section 9.

8.4 Long Term Water level Measurements

Water level measurements will be taken in a network of wells and piezometers to determine hydraulic gradient in the shallow overburden. This information will be used to determine possible locations where contaminants may discharge to the river and raceway. This section describes the selection of water level measurement points.

Phase 1 activities will include the advancement of shallow water table piezometers using the direct push technique (DPT), to establish locations for the measurement of groundwater table elevations across the site. Using DPT methods, an estimated 20 small diameter (1-inch) piezometers with screened lengths of 5 feet will be installed in the source area. Approximate piezometer locations are indicated in Figure 6-1. The piezometers will be advanced and screened in the shallow water table aquifer, strictly for the purpose of providing locations for groundwater table elevation measurements. These installations will not be used for soil or groundwater sample collection purposes.

Locations were selected to provide a series of east-west transects across the river valley evident by surface topography. Five such transects are set at different positions from north to south with river flow direction. Following piezometer installation, recording electronic transducers will be installed at selected piezometer and/or shallow (water table) monitoring well locations for the purpose of long-term groundwater level monitoring at the site. Three surface water gauges will also be installed in the Woonasquatucket River and in the Centredale raceway (approximate proposed locations indicated in Figure 6-1). Water table elevation measurements from these installations and from an existing USGS gauging station in the Woonasquatucket River will provide data on the water table configuration at the site. Phase 1 activities will include one 4-week event of water table elevation monitoring to be conducted near or during the high water table season (spring). A second long-term (6-week) groundwater elevation monitoring event will be conducted near or during the low water table season (summer) to evaluate differences in the gradient in these different conditions. Water levels will be monitored with in situ "Mini Troll" or equivalent data recorders to the nearest 0.01 feet.

Since the summer monitoring event will be implemented after the installation of several bedrock and deep overburden monitoring wells, selected bedrock and deep overburden installations will also be instrumented with recording electronic transducers, in addition to the water table wells/piezometers measured during the Phase 1 event. Specific wells/piezometers to be instrumented and measured during the Phase 2 event will be selected following evaluation of Phase 1 data.

8.5 NAPL Sampling

Due to the nature of waste disposal in the source area described in Section 5, it is anticipated that non-aqueous phase liquids (NAPLs) may be encountered during soil and or groundwater sampling. If these materials are encountered, samples will be collected in an effort to identify the nature of the contaminants within these layers so that transport and disposition of these contaminants can be predicted.

NAPLs may be found in split barrel soil samplers or in groundwater samples extracted as described elsewhere in this section. If found, the samples as collected (either in emulsion with

soil or with a mixed phase or aqueous phase liquid) will be identified as a potential NAPL sample and analyzed as such, rather than the media in which is found.

NAPL samples will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins. These analytes were selected based on the type of contaminants that have been historically detected in the source area or in the adjacent Woonasquatucket River, and/or based on contaminants typically associated with the previous industries that were active at the source area, based on historical records (refer to details in Section 5).

Table 8-3 presents a summary of NAPL sampling and analysis methods, sample containers, sample preservation, and holding time requirements. Since locations are at present unknown, sample identifiers and locations are not described.

8.6 Groundwater Sampling

Two events of groundwater sampling and analysis (Phases 1 and 2) will be conducted from the newly installed monitoring wells within the study area. The groundwater analytical data is needed:

- To support an evaluation of the nature and extent of source-area-related contamination;
- To evaluate the impact of contaminated groundwater discharge to surface waters (Woonasquatucket River and the raceway) in the vicinity of the source area and in downgradient areas.

During both the Phase 1 and Phase 2 events, groundwater samples will be collected using low-flow sampling methods, and will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals (total and dissolved), dioxins, alkalinity, sulfides, and total organic carbon (TOC). These analytes for groundwater samples were selected based on the type of contaminants that have been historically detected in the source area or in the adjacent Woonasquatucket River, and/or based on contaminants typically associated with the previous industries that were active at the source area, based on historical records (refer to details in Section 5). Dissolved and total metals are selected for analysis even though low-flow groundwater sampling will be conducted. Dissolved

metals will be analyzed to provide this information even if low-turbidity samples cannot be acquired.

The following rationale is provided for collection of groundwater samples at monitoring wells proposed on Figures 6-1 and 6-3.

Phase 1:

- Source area wells - groundwater samples will be collected from these wells to identify nature of contaminants in areas where contaminant concentrations are likely to be highest, based on historical information (as provided in Section 5).
- Raceway wells - groundwater samples will be collected from these wells to identify presence of contaminants in shallow overburden groundwater on the east side of the site.

Phase 2:

- Perimeter wells - groundwater samples will be collected from these wells to identify presence of contaminants in areas possibly cross-gradient, upgradient and downgradient of the source area.
- Downgradient wells - groundwater samples will be collected from these wells to identify extent of contamination in areas hydraulically downgradient of the site.
- Discharge area wells - groundwater samples will be collected from these wells to identify contaminants that may be migrating into the river, pond, or raceway from the source area.

Tables 8-4 and 8-5 present summaries of groundwater sample locations, sampling and analysis methods, sample containers, sample preservation, and holding time requirements, for Phase 1 and 2 sampling, respectively.

8.7 Phase 2 – Hydraulic Conductivity Tests

Hydraulic conductivity tests will be performed at each newly installed overburden monitoring well (including Phase 1 and 2 wells) to provide data to evaluate groundwater flow conditions in the water-bearing zones of each well. This data is being collected to define the water-yielding

characteristics of each formation, to develop groundwater velocity values, and to estimate the rate of groundwater movement across and away from the study area.

It is noted that hydraulic conductivity estimates in bedrock wells will be based on packer tests to be conducted during bedrock drilling activities (Section 6.3.1.4).

8.8 Air Sampling

To evaluate the potential presence of site-related contaminants inside the Centredale Manor building, an air sampling investigation will be conducted. Air samples will be collected from five separate locations within the Centredale Manor, including the ground floor, common spaces, and enclosed living spaces, and will be analyzed for VOCs, PCBs, and dioxins. Air sample collection methods are described in Section 9. The sample locations will be determined based on use of the common areas in the Building. The number of samples has been selected based on the number of functional common spaces in the building. These samples are anticipated to provide higher concentrations than those that may be present within the apartments themselves, since these common areas are open to higher flow of traffic, thus a potentially higher dust level entering from outside the building.

Table 8-6 presents a summary of air sample locations, sampling and analysis methods, sample containers, sample preservation, and holding time requirements.

The methods selected for air analysis will provide the appropriate sensitivity, pricing, and accuracy to meet the data quality objectives discussed in Section 6.0. Laboratory analytical methods are presented in Section 12.0.

8.9 Wipe Sampling

To further evaluate the potential presence of site-related contaminants in the Centredale Manor building, wipe samples will be collected from horizontal surfaces in that building, where contaminants possibly present in dust may have settled. Samples will be collected in five separate locations of the Centredale Manor, including the ground floor, common spaces, and enclosed living spaces, and will be analyzed for PCBs and dioxins. Samples will be collected by

wiping designated surface areas to capture dust and other particulates that may contain contaminants. Wipe sample collection methods are described in Section 9.

As is the case with the air samples, the sample locations will be determined based on use of the common areas in the building. The number of wipe samples has been selected based on the number of functional common spaces in the building. These samples are anticipated to provide higher concentrations than those that may be present within the apartments themselves, since these common areas are open to higher flow of traffic, thus a potentially higher dust level entering from outside the building.

Table 8-7 presents a summary of wipe sample locations, sampling and analysis methods, sample containers, sample preservation, and holding time requirements.

Table 8-1
Phase 1 Soil Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Location	Location ID Number	Medium/ Matrix	Depth (feet)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP[1]	Analytical Method/ SOP[2]	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
Phase 1 – Split Barrel Raceway	CMS-SO-01 through CMS-SO-05	Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 – 7 7 – 8	VOCs	Medium	7/1*	S4	L1	120 ml	1 x 40 ml VOA vial	5 ml methanol Cool to 4°C	14 days
										One 2 oz. jar for percent moisture	Cool to 4°C	14 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	SVOCs and Pesticides/ PCBs	Low/ Medium	7/1*	S4	L2	4 oz	One 8-oz amber jar	Cool to 4°C	14 days to extraction, analysis within 40 days of extraction
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	Metals	Low/ Medium	7/1*	S4	L4	4 oz	One 4-oz glass jar	Cool to 4°C	180 days for all metals except mercury, which is 28 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	Dioxins	Low/ Medium	7/1*	S4	L5	4 oz	One 4-oz amber glass jar	Cool to 4°C	30 days to extraction, analysis within 45 days of extraction

Table 8-1 (cont'd)
Phase 1 Soil Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Sampling Location	Location ID Number	Medium/ Matrix	Depth (feet)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP(1)	Analytical Method/ SOP(2)	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
Phase 1 – Split Barrel Source Area	CMS-SO-06 through CMS-SO-13	Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 – 7 7 – 8	VOCs	Medium	7/1	S4	L1	120 ml	1 x 40 ml VOA vial	5 ml methanol Cool to 4°C	14 days
										One 2 oz. jar for percent moisture	Cool to 4°C	14 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 – 7 7 – 8	SVOCs and Pesticides/ PCBs	Low/ Medium	7/1	S4	L1	4 oz	One 8-oz amber jar	Cool to 4°C	14 days to extraction, analysis within 40 days of extraction
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 – 7 7 – 8	Metals	Low/ Medium	7/1	S4	L1	4 oz	One 4-oz glass jar	Cool to 4°C	180 days for all metals except mercury, which is 28 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 – 7 7 – 8	Dioxins	Low/ Medium	7/1	S4	L1	4 oz	One 4-oz amber glass jar	Cool to 4°C	30 days to extraction, analysis within 45 days of extraction

* Depth of field duplicate collection will be determined in the field
(1) Refer to Table 9-1 for Sampling SOP reference
(2) Refer to Table 12-1 for Analytical Method/SOP reference
(3) 20 percent of 140 headspace screening samples will be sent to the laboratory for analysis

Table 8-2
Phase 2 Soil Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Location	Location ID Number	Medium/ Matrix	Depth (inches)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP[1]	Analytical Method/ SOP[2]	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
Phase 2 – Split Barrel Source Area	Location ID To Be Determined. Two clusters installed, one boring sampled from each cluster	Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	VOCs	Medium	14/2*	S4	L1	120 ml	1 x 40 ml VOA vial	5 ml methanol Cool to 4°C	14 days
										One 2 oz. jar for percent moisture	Cool to 4°C	14 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	SVOCs and Pesticides/ PCBs	Low/ Medium	14/2*	S4	L2	8 oz	One 8-oz amber jar	Cool to 4°C	14 days to extraction, analysis within 40 days of extraction
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	Metals	Low/ Medium	14/2*	S4	L4	4 oz	One 4-oz glass jar	Cool to 4°C	180 days for all metals except mercury, which is 28 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	Dioxins	Low/ Medium	14/2*	S4	L5	4 oz	One 4-oz amber glass jar	Cool to 4°C	30 days to extraction, analysis within 45 days of extraction

Table 8-2 (cont'd)
Phase 2 Soil Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Sampling Location	Location ID Number	Medium/ Matrix	Depth (inches)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP(1)	Analytical Method/ SOP(2)	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
Phase 2 – Split Barrel Discharge Area	Location ID To Be Determined. four clusters installed, one boring sampled from each cluster	Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	VOCs	Medium	28/3*	S4	L1	120 ml	1 x 40 ml VOA vial	5 ml methanol Cool to 4°C	14 days
										One 2 oz. jar for percent moisture	Cool to 4°C	14 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	SVOCs and Pesticides/ PCBs	Low/ Medium	28/3*	S4	L2	8 oz	One 8-oz amber jar	Cool to 4°C	14 days to extraction, analysis within 40 days of extraction
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	Metals	Low/ Medium	28/3*	S4	L4	4 oz	One 4-oz glass jar	Cool to 4°C	180 days for all metals except mercury, which is 28 days
		Soil	1 – 2 2 – 3 3 – 4 4 – 5 5 – 6 6 - 7 7 – 8	Dioxins	Low/ Medium	28/3*	S4	L5	4 oz	One 4-oz amber glass jar	Cool to 4°C	30 days to extraction, analysis within 45 days of extraction

(1) Refer to Table 9-1 for Sampling SOP reference
(2) Refer to Table 12-1 for Analytical Method/SOP reference

Table 8-3
Phase 1 and 2 NAPL Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Location	Location ID Number	Medium/ Matrix	Depth	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP[1]	Analytical Method/ SOP[2]	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
Phase 1 and 2, Source Area	TBD	NAPL	Top of Water Top of Till Bottom of Till	VOCs	medium	5 5 5	S	L15	120 ml	1 x 40 ml VOA vial	5 ml methanol	14 days
										One x 2 oz. jar for percent moisture	Cool to 4 °C	14 days
		NAPL	Top of Water Top of Till Bottom of Till	SVOCs Pesticides PCBs	Low/ medium	5 5 5	S	L16	8 oz.	1 x 8-oz. amber glass jar	Cool to 4°C	14 days for extraction, 40 days for analysis
		NAPL	Top of Water Top of Till Bottom of Till	Metals	Low/ medium	5 5 5	S	L18	8 oz.	1 x 8-oz. amber glass jar	Cool to 4°C	180 days for all metals except mercury, which is 28 days
		NAPL	Top of Water Top of Till Bottom of Till	Dioxins	Low/ medium	5 5 5	S	L19	4 oz.	1 x 4 oz. amber glass jar	Cool to 4°C	30 days to extraction, analysis within 45 days of extraction

TBD = To be determined in the field
NAPL = Non-Aqueous Phase Liquid
(1) Refer to Table 9-1 for Sampling SOP reference
(2) Refer to Table 12-1 for Analytical Method/SOP reference

Table 8-4
Phase 1 Groundwater Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Location	Location ID Number	Medium/ Matrix	Depth (feet) (1)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP(2)	Analytical Method/ SOP(3)	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
Source Area and Raceway	CMS-GW-MW01 through MW03 and MW06 through MW09	GW	Shallow	VOCs	Low/ Medium	7/1*	S6	L6	120 ml	Three 40-ml amber VOA vials with Teflon lined septa	HCl to pH <2 Cool to 4 °C	14 days
		GW	Shallow	SVOCs and Pesticides/ PCBs	Low/ Medium	7/1*	S6	L7	80 oz	Two-80-oz amber bottle	Cool to 4°C	7 days for extraction, 40 days for analysis
		GW	Shallow	Metals	Low/ Medium	7/1*	S6	L9	1 L	1-liter poly bottle	HNO3 to pH<2 Cool to 4°C	180 days for all metals except mercury, which is 28 days
		GW	Shallow	Dissolved Metals	Low/ Medium	7/1*	S6	L10	1 L	1-liter poly bottle	HNO3 to pH<2 Cool to 4°C	180 days for all metals except mercury, which is 28 days
		GW	Shallow	Dioxins	Low/ Medium	7/1*	S6	L11	1 L	Two 1-liter amber glass jar	Cool to 4°C	30 days to extraction, analysis within 45 days of extraction
		GW	Shallow	Alkalinity	Low/ Medium	7/1*	S6	L12	1L	1-liter poly bottle	Cool to 4°C	14 days
		GW	Shallow	Sulfide	Low/ Medium	7/1*	S6	L13	1L	1-liter poly bottle	Cool to 4°C Zinc acetate plus sodium hydroxide to pH >9	7 days
		GW	Shallow	TOC	Low/ Medium	7/1*	S6	L14	40 ml	1 x 40-ml VOA vial	Cool to 4°C H_2SO_4 to pH <2	28 days

(*) Location of field duplicate collection will be determined in the field
(1) Sampling interval depths to be field determined
(2) Refer to Table 9-1 for Sampling SOP reference
(3) Refer to Table 12-1 for Analytical Method/SOP reference

Table 8-5
Phase 2 Groundwater Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Location	Location ID Number	Medium/ Matrix	Depth (feet) (1)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP(2)	Analytical Method/ SOP(3)	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
Raceway Perimeter Source Area Small diam piez Discharge Area Contingency downgradient	CMS-GW-MW1 through CMS-GW-MW28 (max total 33)	GW	Shallow OB Deep OB Bedrock	VOCs	Low/ Medium	33/4*	S6	L6	120 ml	Three 40-ml amber VOA vials with Teflon lined septa	HCl to pH <2 Cool to 4 °C	14 days
		GW	Shallow OB Deep OB Bedrock	SVOCs and Pesticides/ PCBs	Low/ Medium	33/4*	S6	L7	80 oz	One-80-oz amber bottle	Cool to 4°C	7 days to extraction, analysis within 40 days of analysis
		GW	Shallow OB Deep OB Bedrock	Metals	Low/ medium	33/4*	S6	L9	1 L	1-liter poly bottle	HNO3 to pH<2 Cool to 4°C	180 days for all metals except mercury, which is 28 days
		GW	Shallow OB Deep OB Bedrock	Dissolved Metals	Low/ medium	33/4*	S6	L10	1 L	Two 1-liter poly bottle	HNO3 to pH<2 Cool to 4°C	180 days for all metals except mercury, which is 28 days
		GW	Shallow OB Deep OB Bedrock	Dioxins/ HCX	Low/ medium	33/4*	S6	L11	1 L	Two 1-liter amber glass jar	Cool to 4°C	30 days to extraction, within 45 days of extraction
		GW	Shallow OB Deep OB Bedrock	Alkalinity	Low/ medium	33/4*	S6	L12	1 L	1-liter poly bottle	Cool to 4°C	14 days
		GW	Shallow OB Deep OB Bedrock	Sulfide	Low/ Medium	33/4*	S6	L13	1 L	1-liter poly bottle	Cool to 4°C Zinc acetate plus sodium hydroxide to pH >9	7 days
		GW	Shallow OB Deep OB Bedrock	TOC	Low/ Medium	33/4*	S6	L14	40 ml	1 x 40-ml VOA vial	Cool to 4°C H_2SO_4 to pH <2	28 days

(1) Sampling interval depths to be field determined
(2) Refer to Table 9-1 for Sampling SOP reference
(3) Refer to Table 12-1 for Analytical Method/SOP reference

Table 8-6
Air Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Location	Location ID Number	Medium/ Matrix	Depth (feet)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP(1)	Analytical Method/ SOP(2)	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
CM Building	CMS-AR-01 through CMS-AR-05	Air	NA	VOCs	Low/ medium	5/1	S10	L20	NA	1-Summa canister	Cool at 4° C	14 days
		Air	NA	PCBs	Low/ medium	5/1	S10	L21	NA	1-PUF cartridge	Cool at 4° C	14 days to extraction, analysis within 40 days of extraction
		Air	NA	Dioxins	Low/ medium	5/1	S10	L22	NA	1-PUF cartridge	Cool at 4° C	30 days to extraction, analysis within 45 days of extraction

(1) Refer to Table 9-1 for Sampling SOP reference
(2) Refer to Table 12-1 for Analytical Method/SOP reference

Table 8-7
Wipe Sampling Locations, Sampling and Analysis Method/SOP Requirements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Location	Location ID Number	Medium/ Matrix	Depth (feet)	Analytical Parameter	Conc. Level	No. of Samples (field samples/ field duplicates)	Sampling SOP(1)	Analytical Method/ SOP(2)	Sample Volume	Containers (Number, size, and type)	Preservation Requirements (Chemical, temperature, light protected)	Maximum Holding Time (Preparation/ analysis)
CM Building	CMS-WI-01 through CMS-WI-05	Wipe	NA	PCBs	Low/ medium	5/1	S12	L23	NA	2 x sterile gauze pads 4 oz jar	Saturate with hexane Cool to 4°	14 days to extraction, analysis within 40 days of extraction
		Wipe	NA	Dioxins	Low/ medium	5/1	S12	L24	NA	2 x sterile gauze pads 4 oz jar	Saturate with hexane Cool to 4°	30 days to extraction, analysis within 45 days of extraction

(1) Refer to Table 9-1 for Sampling SOP reference
(2) Refer to Table 12-1 for Analytical Method/SOP reference

Table 8-8
Phase I Monitoring Well and Boring Locations
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Area and Well Number	Estimated Number of Wells or Borings	Description
Raceway: SB-1 through 5 and associated wells (MW-1 through 3)	5	These borings will be located along the historic centerline of the raceway canal, along the eastern border of the source area. The objective of these borings is to determine the type and thickness of the fill and/or depositional materials at the raceway canal. Data obtained from overburden monitoring wells installed in selected borings will be used to construct a water table map and to evaluate groundwater quality underlying the raceway.
Source Area: SB-6 through 9 and associated wells (MW-6 through 9)	4	These borings will be located adjacent to or within areas of ground disturbance as identified in historic air photos and adjacent to geophysical anomalies identified in 1999. The objective of these borings is to determine the type and thickness of fill and to provide data to evaluate the nature and extent of soil contamination (soils generally at and above the water table). Data obtained from overburden monitoring wells installed in these borings will be used to construct a water table map and to evaluate groundwater quality at these locations.
Piezometers	20	Narrow diameter piezometers will be installed at the site using DPT methods to provide temporary observation points to monitor the groundwater elevation. One objective is to evaluate shallow groundwater flow directions at the site over time and at different seasons (high and low water tables), including evaluation of effects of changing river elevations on changes in the direction of groundwater flow in the overburden aquifer. Piezometers will be equipped with electronic transducers that will measure and record long-term groundwater elevations at the site. It is not anticipated that groundwater samples will be collected from these piezometers.

Table 8-9
Phase II Monitoring Well and Boring Locations
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Area and Well Number	Estimated Number of Wells or Borings	Description
Perimeter Area (I.D. Numbers To Be Determined)	8 to 12 wells at 4 locations (2 to 3 wells per location)	These wells will be installed in areas surrounding the source area: 2 well clusters east of the source area and 2 well clusters west of source area (across the river). Each well cluster will include 1 bedrock well and 1 to 2 overburden wells, depending on saturated thickness. Objectives of these wells are to evaluate hydraulic gradients (vertical and horizontal) and subsurface geology near the source area; to evaluate groundwater quality in areas anticipated to be upgradient to the source area, and possibly downgradient; and to evaluate potential for groundwater contamination to migrate underneath the river.
Discharge Area (I.D. Numbers To Be Determined)	Maximum of 8 overburden wells at 4 locations (2 wells per location)	These wells will be installed in areas where groundwater may discharge to the river or pond. Therefore, they will be installed between potential "hot spots" within the source area and the river, pond, or raceway. It is anticipated that each well cluster will include up to 2 overburden monitoring wells (shallow and deep), depending on saturated thickness encountered. The objectives of these wells are to evaluate the nature of groundwater contaminants that may be discharging to the surface water bodies named above, in shallow and/or deep overburden, and to provide additional information on vertical and horizontal groundwater gradients.
Downgradient Area (I.D. Numbers To Be Determined)	4 to 6 wells at 2 locations (2 to 3 wells per location)	These wells will be installed in likely downgradient areas of the source area (likely south of the site, in areas where VOCs were previously detected in vapor diffusion samples). Objectives are to provide information on the extent of groundwater contamination possibly migrating from the site in overburden and/or bedrock, to confirm depths to bedrock, and to provide water level measurement points for evaluating vertical and horizontal groundwater gradients in shallow and deep overburden and bedrock. Number of overburden wells (1 or 2) will be based on saturated thickness.

9.0 SAMPLING AND DATA ACQUISITION PROCEDURES AND REQUIREMENTS

TtNUS will conduct two phases of field investigations during the Centredale Manor Restoration Project Source Area Investigation.

Phase I includes the drilling of shallow soil borings located within the former raceway and within the source area to collect soil samples and to install groundwater monitoring wells. Additionally, Direct Push Technology (DPT) borings will be used to install piezometers to monitor shallow groundwater elevations. Surface water gauging stations will be constructed and used in conjunction with an existing USGS gauging station to provide surface water level information to evaluate in conjunction with the groundwater level data. Long-term (4-week) groundwater and surface water level measurements will be collected during the spring (high water table season) under Phase I. Groundwater samples will be collected from the Phase I monitoring wells installed in the former raceway and the source area. Surface geophysical surveys will also be conducted as part of Phase I to aid in the selection of monitoring well cluster locations to be installed in Phase II.

The Phase II field investigations include drilling a series of bedrock and overburden monitoring well clusters in perimeter areas of the Site, in likely downgradient areas, and in likely groundwater discharge areas, as described in previous sections. Analytical soil samples will also be collected from overburden soil borings in downgradient areas and in discharge areas, as discussed in Section 8.2.2. Packer testing and borehole geophysics will be conducted within each of the bedrock boreholes. Phase II will also include hydraulic conductivity tests at each of the overburden monitoring wells, and a second groundwater sampling event to include all monitoring wells installed during Phase I and II. A second long-term (6-week) water level measurement round will be conducted during the summer (low water table season) at surface water gauging stations and groundwater locations. In addition, both air sampling and wipe sampling will be conducted within Centredale Manor building during Phase II.

This section of the QAPP discusses procedures to be used for data and samples collection to ensure that representative data is collected in an appropriate and consistent manner to meet project objectives. The Standard Operating Procedures (SOPs) cited for sampling activities are listed in the individual Sections and are summarized in Table 9-1. Site specific modifications to these SOPs are described in detail in this section. Field documentation related to sample

collection, such as boring logs, instrument calibration logs, and site logbooks are detailed in TtNUS SOP SA-6.3 (S1) that is attached in Appendix C.

9.1 Phase I Subsurface Investigations (Borings, Wells, Piezometers, and Geophysical Investigations)

This section discusses procedures to be used during Phase I subsurface investigations, including drilling and soil sampling, monitoring well and piezometer construction, and geophysical investigations.

9.1.1 Phase I - Soil Borings, Soil Sampling and Monitoring Well Installations

This section discusses the soil sampling activities that will be conducted during Phase I field activities including the advancement of borings for soil sample collection and/or monitoring well construction. A drilling subcontractor using drive & wash methods will advance nine soil borings. Soil samples will be collected for evaluation of soil conditions, VOC headspace screening, and laboratory analysis. A summary of samples anticipated to be collected is described in Section 6. The rationale for the collection of this data is presented in Section 8 and the analytical methods are described in Section 12.0.

Detailed descriptions of the materials encountered and sampled in these borings will be recorded on the Boring Logs. An example Boring Log is provided in Appendix D. The soils will be described using the Unified Soil Classification System (USCS) as detailed in TtNUS SOP GH-1.5 Section 5.2 (S2).

Four "source area" borings will be advanced to determine the thickness and character of fill materials and the nature of the underlying natural soils, to determine the depth of the water table, and to determine if non-aqueous phase liquids (NAPL) are present. These four borings will be finished as groundwater monitoring wells as described in Section 6.3.1.1 and 8.2.1. Soil samples will be collected at 1-foot intervals for evaluation of soil conditions and laboratory analysis of VOCs, SVOCs, pesticides/PCBs, metals and dioxins. In addition, separate aliquots will be screened for total VOCs using the headspace screening technique as described in this section.

Five shallow borings will be advanced in the raceway to determine the thickness and character of fill deposits, the nature of the underlying natural soils, to determine the depth of the water table, and to determine the presence of NAPL. Two of these wells will be finished as shallow overburden water table monitoring wells as described in Section 6.1.2.2 and 8.2. Samples will be collected at 1-foot intervals for evaluation of soil conditions and laboratory analysis. These samples will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals and dioxins. In addition, separate aliquots will be screened for total VOCs using the headspace screening technique as described in this section.

Soil samples at each boring location will be collected using the following procedures, prepared for this project in accordance with TtNUS SOP SA-1.3 Sections 5.6 (Subsurface Soil Sampling with a Split-Barrel Sampler) (S4), 5.2.1 (Procedure for Collecting Soil Samples for Volatile Organic Compounds) modified as described below, and 5.2.2 (Procedure for Collecting Non-Volatile Soil Samples) provided in Appendix C.

Subsurface Soil Sample Acquisition:

At each of the nine boring locations laboratory analytical samples will be collected at 1-foot intervals through fill materials to the depth that natural soils are encountered. These analytical samples will be collected beginning from a depth of 1-foot bgs, or from the bottom of new cap or asphalt bedding materials as pertinent to the location. Analytical samples will be collected to a minimum of 8 feet bgs or to the water table whichever is deeper, regardless of subsurface materials encountered at each location. If fill materials extend below either 8 feet bgs or the water table, the continuous 1-foot interval sampling for laboratory analysis will continue until natural soils are encountered. Each sample collected for laboratory analysis from the nine borings will be analyzed for VOCs, SVOCs, pesticides/PCBs, metals, and dioxins.

Once the natural soils are encountered at each location, continuous split-barrel sampling for VOC headspace screening and soil classification will continue to a minimum of 20 feet bgs (Section 8.2.1). In soils encountered below fill, headspace VOC screening samples will be collected every 2-foot long split barrel interval, unless multiple distinctive units are identified within a single 2-foot interval. Laboratory analytical samples may be collected from the natural soils if field observations indicate contamination.

A drilling subcontractor under the supervision of a senior TtNUS geologist will collect all of the subsurface soil samples, as described in Section 8.1 and Section 5.1 of TtNUS SOP SA-1.3. A modified Standard Penetration Test (SPT) based on ASTM D-1586-84 will be used to collect the split barrel samples. The modification to the standard procedure is the use of nominal 3-inch inside diameter (ID) split barrels in place of 2-inch ID split barrels to collect additional volume for analytical samples. In order for the SPT blow-counts to be comparable to standard 2-inch SPT blow counts the use of a 300 lb. hammer with an 18-inch fall shall be used in place of a 140 lb. hammer with a 30-inch fall. This modification is based on an Army Corps of Engineers New England District geotechnical drilling standard of practice.

Samples Collected for Laboratory Analysis:

To provide 1-foot sample increments, two analytical samples will be collected from each 2-foot long split barrel interval, if sufficient soils are recovered. If insufficient sample volume is recovered, the entire 2-foot interval will be collected as one sample. If there is insufficient sample volume to collect all of the analytical parameters due to poor sample recovery, the following priority will be used when filling the appropriate bottleware:

1. VOCs & percent moisture (minimum volume for percent moisture is 1/2 of the 2 oz. container).
2. Dioxin (minimum volume required is 3/4 of the 4 oz. container).
3. SVOCs/Pesticide/PCBs (minimum volume required is 3/4 of the 8 oz. container).
4. Metals (minimum volume required is 3/4 of the 4 oz. container).

With the exception of the VOC samples, the soil samples for all analyses will be collected as a homogenized composite of the target depth interval. The VOC sample will be collected as a grab sample from the most heavily contaminated portion of the split-barrel sampler, based on the Photovac Micro FID headspace screening results and/or visual observations. If no FID readings are noted and no visual evidence of contamination is found, the grab VOC samples will be collected from the center of the target sample interval. Observed geologic conditions possibly effecting contaminant distribution, such as potential confining layers, coarse-grained (relatively high porosity/permeability) soils, or the vadose zone above the water table, will be taken into account when selecting the VOC sample location from the split-barrel sampler.

If free-product or NAPL is identified, the sample will be collected in a similar fashion as the soil described above. This NAPL sample will replace the soil sample from this depth interval and will be sent to a separate DAS analytical laboratory as described in Section 6.3.3. All samples for dioxin analysis, regardless of whether it is considered a soil or NAPL sample, will be shipped to the same DAS laboratory.

Soil Sampling Procedures for VOC Samples (Grab)

Based on the Project Action Limits as discussed in Section 6 and listed in Section 6 tables, only "medium concentration" soil VOC samples (using methanol preservative) will be collected from the nine borings advanced during Phase I operations.

The medium concentration soil VOC samples are preserved with methanol immediately after collection. The holding time from sample collection to analysis is 14 days. The VOC samples will be maintained at 4°C. The following procedure shall be followed:

1. Label a pre-tare weighted 40-ml amber VOC vial (containing 5 ml of purge and trap grade methanol) with the sample location number and depth.

2. Collect a grab core soil about 5 g with a 10-ml pre-cut syringe. **If NAPL is noted within the soils then a reduced volume of approximately 1 - 2 g should be collected for the NAPL sample**. Extrude the sample into the 40-ml VOC vial containing the methanol. The soil must be immersed in the methanol; recollect the sample using a smaller volume if necessary. Avoid touching the thread of the vial neck or spilling methanol. Cap the vial and invert it several times to mix the preservative with the sample.

3. Weigh the sample vial to the nearest 0.01 g and record the weight in the field log sheet. Pack and ship to the laboratory. Include the field log sheet containing the sample weight information with the samples.

Soil sample for percent moisture. Fill one 2-oz. container with sample representing the same locations where the 40-ml vial sample was collected. Every effort should be made to obtain the percent moisture soil aliquot as close as possible from the location where the sample was collected.

Duplicate samples will be collected from the subsurface soils. Following the collection of the first set of VOC containers collect the field duplicate from the same sampling interval.

Soil Sampling Procedures for SVOCs, Pesticide/PCBs, Metals, and Dioxin Samples (Composite)

1. Record all required data on the boring log which will also serve as the sample logsheet (Appendix D), including sampling equipment, sampling personnel, date, time, depth of sample, and sample analyses. The soil boring log will also contain soil descriptions, depth of strata changes, and sample depth intervals. The soil will be visually classified using the Unified Soil Classification System (USCS), as defined by the American Society for Testing and Materials (ASTM) D-2488-98, Standard Method for Classification of Soils.

2. Label appropriate sample jars (Tables 8-1 and 8-2) with the sample location number (see Section 10).

3. Transfer the soil from the split-barrel sampler into a decontaminated stainless-steel bowl using only decontaminated stainless steel trowels and homogenize the sample.

4. Remove any large particles such as gravel or artificial fill too large to be sent for analysis. Note the removal of material on the boring log.

5. Fill the appropriate sample containers.

6. For field duplicate samples, after homogenization fill one set of sample containers for the original sample and fill another set of sample containers for the field duplicate sample.

7. Ensure that the samples are properly labeled, maintained in coolers with ice and the EPA-approved chain-of-custody procedures described in Section 10.3 are followed. Package and ship the sample coolers to the appropriate laboratory for overnight delivery.

8. Decontaminate the sampling equipment before reuse (see Section 9.11).

Jar headspace VOC screening:

1. Collect sufficient soil representative of the sample interval to half-fill one clean 8-oz. glass jar. Quickly cover the jar with clean aluminum foil and apply screw cap to tightly seal the jar. All appropriate analytical sampling procedures should be followed to maintain this sample matrix as representative and to avoid cross-contamination.

2. Vigorously shake jar for 15 seconds. Allow headspace development for at least 10 minutes. Where ambient temperatures are below 32°F (0°C), headspace development should be performed within a heated vehicle or building.

3. Remove screw lid/expose foil seal. Quickly puncture the foil seal with the Photovac Micro FID probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates.

4. Record highest FID reading as the jar headspace VOC concentration. The maximum response should occur between 2 to 5 seconds. Erratic meter response may occur with high organic vapor concentrations or high moisture content. If erratic responses are obtained, stop the headspace screening.

5. The Photovac Micro FID shall be used as the primary air-monitoring instrument. The Photovac 2020 PID will be used as a backup air-monitoring device. Operation, maintenance, and calibration shall be performed in accordance with the manufacturer's specification which are provided in TtNUS SOP ME-12 (Photovac 2020 PID) (S5) and ME-15 (Photovac Micro FID) (S6). For jar headspace screening the instrument calibration shall be checked/adjusted daily unless problems are encountered.

6. The Photovac MicroFID instrument has a digital (LED/LCD) display, which will not discern maximum headspace response unless the "maximum hold" feature has been cleared and reset between each reading. The instrument operator should clear and reset the maximum hold feature prior to each reading.

Due to the potential for significant concentrations of dioxin contamination to be encountered, care should be taken to handle all soil samples and to ensure that the exterior of the sample

containers are clean and free of soils before shipping. All laboratory analytical samples will be kept in coolers on ice and will be shipped with appropriate QA/QC samples as described in Section 10.

9.1.2 Phase I - DPT Piezometers, Surface Water Gauges, and Long-Term Water Table Measurements

This section discusses the activities that will be conducted during Phase I related to gathering water level data to determine groundwater flow patterns. These activities include the advancement of approximately 20 small diameter DPT borings for piezometer installation. These activities also include the construction of three temporary surface water gauging stations which will be used in conjunction with a permanent USGS surface water gauging station to collect long-term water level measurements. Both groundwater level measurements from selected wells, piezometers and surface water stations will be collected over an 8-week period. The rationale for the collection of this data is presented in Section 8.

9.1.2.1 Direct Push Technology (DPT) Borings and Piezometers

Using a truck-mounted DPT drilling rig or equivalent the subcontractor will advance approximately 20 borings to an estimated depth of 10 feet below ground surface. Approximate depth to water will be determined prior to boring advancement, based on surface topography, river water level, and groundwater level measured in nearby wells. After advancing the boring to the required depth a 1-inch inside diameter schedule 40 PVC pipe (piezometer) shall be installed in the completed borehole. The piezometer shall consist of a 5-foot long 0.010-inch factory-slotted PVC well screen. Nominal mesh size 20-30-silica sand shall be placed around the PVC well screen to a depth of 2 feet above the slotted section to the extent practicable. The intent of the sand pack is to stabilize the formation around the well screen and provide support for a bentonite seal. The bentonite seal shall be installed above the sand pack to a depth of approximately 2 feet below ground surface. A sand drain layer shall be installed above the bentonite seal.

The piezometer installation shall be completed with a flush-mount 6-inch inside diameter steel road box equipped with a watertight cover secured with a bolt. The PVC riser pipe shall be secured with a lockable watertight cap. The flush-mount, steel protective casing shall be

secured using a mixture of cement and water. At locations where the piezometers are installed through the asphalt parking area the cement shall be stopped 3-inches below the ground and the installation finished with cold patch. The actual depths, thickness and materials used in the piezometer construction shall be determined in the field by the TtNUS site geologist overseeing the installation.

At the completion of the installations, the piezometers shall be developed using an inertial pump and tubing provided by TtNUS. The DPT subcontractor shall provide personnel to conduct the developing and collect the development water in 55-gallon drums. The development water drums shall be staged at an on-site area designated by TtNUS.

9.1.2.2 Surface Water Gauges

A total of four surface water gauging stations will be used to collect surface water elevation data to compare with groundwater elevations from the site and surroundings. Each of these locations is indicated on Figure 6-1. One of the four gauging stations is United States Geological Survey/Water Resources Division Station No. 01114500, located immediately upstream from the site on the Woonasquatucket River. This station collects continuous water level data every 15 minutes and is scheduled to be upgraded in March 2001 to provide near real-time Internet access to preliminary data no more than 4 hours old.

Three other surface water gauging stations will be constructed from steel sign-post/rails driven into the river bottom and raceway sediments. PVC well screen with an end cap will be attached to the signpost using wire and cable-ties. Each surface water gauging station will have a clearly marked and surveyed measurement point to allow for periodic manual measurements as a check against instrument drift over time.

One of the three stations to be constructed will be located in proximity to MW-09 to provide surface water elevations on the downstream portion of the site within the Woonasquatucket River. The second surface water station will be built within the raceway channel adjacent to MW-02. The third surface water station will be built at the confluence of the raceway discharge and tributary leading from the Woonasquatucket River. This location is just south of Cap Area 2.

9.1.2.3 Phase I Long-Term Water Level Measurements

The Phase I long-term water level measurement round is anticipated to include up to 24 locations (four surface water gauging stations and 20 newly installed piezometers and monitoring wells), which will be equipped with "mini troll" pressure-transducer/data loggers to measure and record water table elevations in shallow overburden and in nearby surface water bodies. the groundwater wells and piezometers will be selected based on water levels, response during development, and final location of installation.

The transducers will be secured within the protective steel casing of the wells and piezometers, and will be installed at a depth sufficient to ensure that the transducer will not become dewatered. The transducers will be installed and initialized to provide water level elevation data in order to reduce the amount of data conversion from depth to elevation, and thereby reduce opportunity for mathematical errors. The transducer cable will be marked at the appropriate location so that if it becomes necessary to remove the transducer for maintenance it can be replaced accurately. The transducer cable will be secured within the PVC so that no vertical movement can occur which could create error in the measurements during data retrieval activities and manual measurements.

Each transducer will be left in place for approximately 4 weeks though the spring (high water table) season. All of the transducers will be initialized to collect readings on the hour or every 15 or 30 minutes as described below. The transducers installed within the groundwater data point locations (wells/piezometers) will be initialized to collect readings once every 30 minutes. The transducers installed at the surface water gauge locations will be initialized to collect readings once every 15 minutes. The transducer data will be downloaded as needed onto a laptop computer and will be field verified using manual measurements to identify potential problems such as instrument drift and need for maintenance/replacement.

9.1.3 Phase I - Geophysical Surveys

TtNUS will subcontract a geophysical surveyor to conduct seismic refraction surveys to define the top of bedrock, and determine the thickness of the overburden materials at the site and it's surroundings. In addition, the subcontractor will evaluate the GPR data collected by Weston in 1999 to determine if additional GPR can be performed to locate bottom of fill, geologic contacts,

and top of bedrock. The geophysical subcontractor shall also employ 2-D resistivity to help identify channel deposits and fill, as well as top of bedrock. Finally, the subcontractor may be directed to conduct a square array azimuthal resistivity survey at selected locations on and surrounding the site to assist in determining the orientation of bedrock fractures. Bedrock outcrops surrounding the site will be investigated and their structural features and geologic characteristics noted to add detail to the bedrock fracture characteristics. A TtNUS representative will record all site activities in the site logbook. Any deviations from standard procedures will be recorded on a Field Modification Report (FMR). All verbal findings shall be recorded in the logbook, but the final survey results will be prepared and presented to TtNUS by the subcontractor within 14 calendar days of the field work completion.

9.1.3.1 Seismic Refraction, 2D resistivity and GPR Investigation Survey

The geophysics subcontractor will conduct seismic refraction, 2D resistivity and GPR surveys to define the top of bedrock and determine the thickness of the overburden materials at the site and it's surroundings. To meet this objective a series of investigation lines will be run at an orientation that is both parallel and perpendicular to the orientation of the suspected bedrock valley. The geophysical survey shall be performed along a series of transect lines having a total length of approximately 4,500 feet. The locations of the proposed geophysical survey lines are presented on Figure 6-2.

Each geophysical technique will undergo a brief test. The purpose of the test survey is to demonstrate the effectiveness to delineate the top of bedrock and to identify the optimum spacing and other survey parameters. The geophysical survey shall be conducted in a phased manner. At the end of each day's work the data will be evaluated to determine the quality of the data, the use of the technique, and the exact location of the next line. The spacing of the stations or geophones along the lines may also be adjusted based on a review of the previous day's data.

Bedrock depths identified with seismic surveys and other geophysical techniques should be ground-truthed or confirmed with borings at multiple locations. This will assure accuracy of the survey, and allow for correction if needed. Bedrock borings are anticipated as a part of Phase 2 geologic investigations, and these can be used for confirmation.

The geophysics subcontractor shall be responsible for marking actual line and geophone point locations on the ground and on maps provided by TtNUS. A registered land surveyor will determine the location of each geophysical line at the completion of the investigation. This will include determining the horizontal and vertical location of the ends of each line and geophone location points along the length of the line to the nearest 0.1 foot. This data will allow the depths to bedrock to be converted to elevation such that a bedrock contour map can be developed.

9.1.3.2 Square Array Azimuthal Resistivity Survey

The geophysics subcontractor will conduct Square Array Azimuthal Resistivity surveys to detect fractures in the bedrock and determine the orientation of the fractures in the bedrock at the site and its surroundings. After the seismic refraction survey is complete the location and number of Square Array Azimuthal Resistivity surveys will be selected. This will be done since the slope of the bedrock surface can have an influence of the Square Array Azimuthal Resistivity results. A resistivity sounding will be conducted to determine the spacing of the electrodes. The possible locations for the Square Array Azimuthal Resistivity surveys are presented on Figure 6-2. The actual locations and number of surveys will be determined in the field based on the initial survey results.

An initial array will be set up based on the seismic refraction results and the resistivity sounding. The spacing of the electrodes will be selected so that the resistivity survey will penetrate into the bedrock. The resistivity survey will be conducted using Alpha, Beta, and Gamma configurations. The electrodes will then be moved so that the square is rotated in 15-degree increments and the Alpha, Beta and Gamma configurations will be used for each rotated square.

After the first square array is completed a second square array will be completed in the same manner as the first array using the same center point but with larger electrode spacing. The larger electrode spacing will provide deeper penetration into the bedrock. The deeper penetration also evaluates a larger volume of rock.

The geophysics subcontractor will be responsible for marking actual resistivity survey point locations on the ground and on maps provided by TtNUS. At the completion of the investigation a registered land surveyor will determine the location of each of the Square Array Azimuthal

Resistivity surveys. This will include determining the horizontal and vertical location of the ends of each array line center points to the nearest 0.1 foot.

9.2 Phase I Groundwater Sampling

Low-flow (low-stress) groundwater sampling will be conducted during two sampling events, using the EPA Region I Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells Revision 2, dated July 30, 1996. The Phase I event involves sampling the groundwater monitoring wells installed within the source area and raceway during the Phase I drilling effort. The Phase II event includes sampling the proposed monitoring wells scheduled for Phase II drilling, as well as the monitoring wells installed during Phase I, and is discussed further in Section 9.7. Table 8-4 lists the proposed wells to be sampled, the number of samples to be collected, and the analyses to be performed during the groundwater monitoring for Phase I. Phase I groundwater samples will be analyzed for VOCs, SVOCs, pesticides/PCBs, Dioxins, metals (total and dissolved), alkalinity, sulfides, and TOC. Newly installed wells will be sampled no less than 3 days following development.

Work elements for the low-flow groundwater sampling task include the following:

- Measure presence/absence of NAPL using ORS probe 1 day before sampling.
- Measure water levels in wells to be sampled 1 day before sampling.
- Purge wells using low-stress (low-flow) methodology.
- Measure pH, temperature, specific conductivity, redox potential, dissolved oxygen, turbidity, water level, and pumping rate periodically while water is being extracted from the well.
- Collect samples using the low-stress methodology.
- Document, package, and ship all samples for chemical analysis.

9.2.1 Groundwater Level Measurements

Prior to groundwater sampling, water levels for all monitoring wells to be sampled will be measured on the same day, in as short a time span as possible. This information is used by the

groundwater sampling crew to determine appropriate tubing/pump intake depths prior to groundwater sampling.

Groundwater levels will be measured with an electronic water-level indicator relative to a marked point on the top of the well casing, which is the surveyed top of casing elevation. Water level measurements will be recorded to the nearest 0.01 foot. The measuring device will be calibrated and decontaminated prior to use. The measuring device will also be decontaminated between use in each well. Rinsing the device with deionized water will constitute the decontamination process unless significant contamination such as free-product is encountered. If free-product is encountered, liquinox soap and isopropyl alcohol will be used to remove the product, followed by rinsing with deionized water.

9.2.2 Well Purging Procedure

The procedures for sampling each well follow:

1. The depth to water in the well will be measured from a surveyed mark on each well with a water level indicator (M-scope) and recorded to the nearest 0.01 foot, minimizing immersion of the M-scope probe within the standing water column to avoid disturbance of colloidal particles.

2. The required length of tubing will be calculated, measured, and marked with tape for attachment to the pump such that the intake end of tubing is placed at the midpoint of the saturated screened interval. Note that the tubing will be measured to allow a minimum distance between the well head and the discharge point (field testing equipment), to minimize temperature changes in the groundwater discharged from the well. Tubing will be used and disposed of after sampling is complete.

3. The tubing will be slowly and smoothly lowered to the required depth to minimize the amount of mixing in the well. The tubing will be secured to the well casing (or PVC stick-up) to minimize movement.

4. The field testing equipment will be placed as close as possible to the well head/discharge tubing and adjusted to minimize air bubble entrapment within the tubing or flow-through cell.

5. The pump (submersible impeller type, or bladder pump) will be connected to the power supply (battery or other power source), and the power supply turned on (without starting the pump).

6. The depth to water with the tubing in the well will be re-measured and compared with the initial reading; if the readings vary by more than 0.05 foot, field personnel will wait for 5 minutes, remeasure the water, and begin pumping.

7. The pump will be started at the lowest flow setting (attempt 100 to 200 milliliters per minute). The pump start time will be recorded and the flow rate will be measured and recorded using a graduated cylinder and stopwatch. (Note that during the initial period of pumping, about 5 to 10 minutes, the depth to water in the well should be measured approximately once per minute to enable timely pump flow adjustments to minimize significant drawdown in the well).

8. The initial groundwater sample discharged from the tubing will be collected and field parameters (pH, temperature, conductivity, redox potential, turbidity, and dissolved oxygen) and time will be measured and recorded.

9. These field parameters (pH, temperature, conductivity, turbidity, and dissolved oxygen) and the depth to water in the well (using the M-scope) will be measured at 5-minute intervals (initially the water level will be measured more frequently, as discussed in step 7). The data and the associated time will be recorded on the low-flow sampling data sheet. Attempts will be made to maintain the drawdown in the well during pumping to 0.3 foot or less, by adjusting the pump flow rate. Drawdown for each well will vary depending on the recharge capacity of the well. Drawdown may exceed 0.3 foot in some wells.

10. Groundwater samples will be collected following the stabilization of measured field parameters. "Stabilization" is considered to be achieved when three consecutive readings, taken at 3- to 5- minute intervals, are within the following limits:

    - Turbidity (<5 NTU)
    - Dissolved oxygen (10 percent)
    - Temperature (3 percent)
    - pH (within 0.1 unit)

All measurements, except turbidity, must be obtained using a flow-through cell. A ball-valve diverter will be placed in-line in the discharge tubing prior to the inlet for the flow-through cell to allow the collection of the turbidity measurement sample aliquot prior to entering the flow-through cell. The minimum purge volume is the stabilized drawdown volume plus the extraction tubing volume. Detailed information on stabilization is found in the EPA Region I Low Stress Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells Revision 2, dated July 30, 1996.

9.2.3 Groundwater Sample Collection

Groundwater samples for laboratory analyses must be collected before water has passed through a flow-through cell. Following purging procedures the flow-through cell will be disconnected from the discharge tubing and samples will be collected directly through the tubing into appropriate sample bottles. For VOC analysis, the sample aliquot will be collected directly into a pre-preserved 40-ml amber vial. VOC samples will not be opened after collection. An extra vial will be collected to check the pH of the sample. If the desired pH is not obtained, five drops of hydrochloric acid (HCl) will be placed into new 40-ml vials and the sample will be recollected. The process is repeated with increasing quantities of HCl until pH < 2 is achieved in the test vial. If effervescence is noted when the samples are collected, the samples will be recollected without any preservative and shipped to the laboratory as soon as possible.

All pertinent field data will be recorded on "Low-Flow Groundwater" Sample Log Sheets (see Appendix D) and referenced in the field logbook. Any field deviations will be recorded on an FMR.

Appropriate chain-of-custody procedures will be followed (see Section 10.3). Samples will be labeled, preserved, packed, and shipped according to TtNUS SOPs.

Phase I groundwater analytical parameters, methods, sample preservation, and required sample containers are provided in Tables 6-22 and 8-4.

9.3 Phase II - Soil Borings, Soil Sampling and Monitoring Well Installations

Procedures for Phase II soil and bedrock drilling/sampling, monitoring well installation, and related activities are described in this section, according to the following subsections: soil sample collection, bedrock coring, drilling fluids, well installation (bedrock and overburden), and well development. As part of Phase II drilling activities, up to an estimated 26 borings may be advanced and completed as monitoring wells in shallow and deep overburden and in bedrock.

TtNUS will subcontract a drilling company to advance the borings, collect soil and rock samples, conduct bedrock packer tests, and install monitoring wells in areas on and near the source area. The Subcontractor will also be responsible for developing the new monitoring wells with assistance from TtNUS.

9.3.1 Phase II - Soil Sample Collection

During Phase II, soil borings (well clusters) will be advanced as summarized in Section 6, in areas described as the "Perimeter Area", the "Southern (Downgradient) Area", and "Discharge Areas". During advancement of these borings, soil samples will be collected from the initial (deepest) boring advanced at each well cluster, for evaluation of soil conditions and VOC headspace screening, and soils from designated depths will also be collected for laboratory analysis, as summarized in Section 6.3.1.4. A summary of soil samples estimated for laboratory analysis of VOCs, SVOCs, pesticides/PCBs, metals and dioxins, and analytical methods are presented in Table 8-2. The rationale for the collection of this data is presented in Section 8. The VOC headspace screening procedure is presented in Section 9.1.1.

Detailed descriptions of the materials encountered and sampled in these borings will be recorded on the Boring Logs (example in Appendix D). Soils will be described using the USCS as detailed in TtNUS SOP GH-1.5 Section 5.2 (S2).

Soil samples will be collected using a 2-inch or 3-inch split-barrel sampler: soil borings and depths requiring laboratory analysis will be collected with 3-inch split-barrel samplers (for additional soil volume), and depths below this may be collected using a 2-inch split-barrel sampler. The sampler will be advanced in accordance with ASTM-D-1586-84.

Soil samples collected from the "Perimeter Area" borings will be evaluated using VOC jar headspace screening techniques and will be described using the USCS in soils encountered down to bedrock (no analytical samples are anticipated). All soil samples collected from the "Southern (Downgradient) Area" borings and from "Discharge Areas" borings will also be evaluated using these methods, and in addition, designated soils from these areas (down to a depth of approximately 8 feet), will also be collected for laboratory analysis.

The detailed procedures for Phase II soil sample collection, including VOC jar headspace screening, and collection of soil samples for laboratory analysis, including VOC grab sample procedures and other analyte collection procedures (composite samples) are described in Section 9.1.1.

9.3.2 Phase II - Bedrock Coring

At locations requiring a boring advanced into bedrock, a 4-inch I.D. casing will be seated up to 2 feet into bedrock. Bedrock coring will be advanced an estimated 30 feet into bedrock at each well cluster using a double walled NX or NQ core barrel or equivalent. The length of bedrock coring is estimated to be 30 feet, unless observations of the recovered rock core and the borehole response to water level changes or the results of the packer testing indicate that the bedrock hole may be dry. If the rock hole is dry, the TtNUS field geologist will continue coring until groundwater enters the boring or observations of the recovered rock core indicate the potential for water bearing fractures. The packer test results will be evaluated by the project manager and the technical staff to determine if a monitoring well should be installed, or another action taken, such as drilling deeper or abandoning the borehole.

Rock Core Documentation

Each rock core will be documented in accordance with TtNUS SOP No. GH-1.3. At a minimum, the following information will be documented:

- Date of activity
- Name of person(s) overseeing work activity
- Project name
- Project number
- Boring number
- Core Run numbers
- Footage (depths)
- Recovery
- RQD (%)
- Box number and total number of boxes for that boring (Example: Box 1 of 2)
- Rock type
- Fracturing
- Weathering

9.3.3 Drilling Fluids

Drilling fluids will consist of potable water. The use of drilling mud consisting of pure bentonite and water requires prior Project Manager approval and should only be used if technical problems arise from the use of potable water. No synthetic additives may be used in the mud, if approved for use. Rock cores will be advanced with potable water only. The potable water source will be pre-approved by TtNUS. Random tanks of water transported to the drill sites will be screened for VOCs according to TtNUS procedures described in SOP SF-1.5. Drilling fluids and wash-tub contents will be removed and replaced with fresh potable water prior to bedrock coring.

9.3.4 Bedrock Monitoring Well Installation

The bedrock monitoring well in each cluster will be installed first. The boring will be advanced using standard drive and wash drilling methods and rotary rock coring methods. The bedrock portion of the boring will be evaluated using data gathered from the recovered rock core and packer tests. These data will be evaluated to select the pump intake interval for groundwater sampling and provide bulk hydraulic conductivity data on the bedrock aquifer. No well screens will be placed in the bedrock boreholes. The bedrock borehole will remain open for implementing borehole geophysical investigations (see Section 9.4).

The bedrock monitoring wells will be constructed of 2-inch ID, non-glued, flush joint, threaded, Schedule 40 PVC riser casing with either an O-ring or Teflon-tape at each threaded joint. A tight fitting Teflon or PVC ring will be attached to the base of the PVC riser to form a base for the bedrock/overburden seal. This ring must fit snugly into the 2-foot deep 4-inch diameter bedrock socket and rest on the lip created at the transition point where the NX or NQ coring began. The entire PVC riser will rest on this ring which will also act as a trap for the bentonite seal & backfill materials. A stainless steel or PVC centralizer will be installed approximately 5 feet above the top of bedrock on the riser to ensure proper alignment and to secure the bentonite seal to the riser. The bedrock/overburden seal will consist of bentonite chips to a minimum of one foot above the bedrock surface. The placement of this seal will be monitored using a weighted-tape to ensure a lack of bridging and proper placement. A bentonite and potable water slurry may be used as backfill above the seal following a minimum of one hour to allow the seal to set. Bentonite chips may be used as backfill in place of a slurry at the drillers discretion. The well installation will be completed with a protective casing. Additional well construction details will be provided in the drilling technical specification.

9.3.5 Overburden Monitoring Well Construction

The overburden wells in each well cluster will be installed using standard drive and wash drilling methods. The deepest boring at each cluster (bedrock or deep overburden borehole) will include split-barrel soil sampling. The evaluation of these soil samples including results of jar-headspace soil VOC screening and visual observations made by the rig geologist will be used to determine the location/well screens/depths for the shallower borings within that cluster. The location of each shallower well in a cluster will be determined by the TtNUS Project Manager

and site geologist based on a review of the results of data gathered from the initial deepest boring.

Guidelines for monitoring well construction follow:

- All monitoring wells will be constructed of 2-inch ID, non-glued, flush joint, threaded, Schedule 40 PVC casing with either Teflon tape or O-rings at each joint. Well screens will be equipped with a screw-in PVC end plug.

- Well screen lengths will be determined based on the jar headspace VOC screening results, and visual observations such as soil classification, staining, and structure.

- Well screen slot sizes will be 10 (0.010-inch slot opening) or 20 (0.020-inch slot opening) based on visual soil classification in accordance with the Unified Soil Classification System.

- All wells located on or adjacent to a public way will be completed with a traffic-rated, flush-mount locking well cover. Remote or cross country wells will be completed with a steel protective casing that extends a minimum of 2 feet above ground surface.

- The drilling program will be designed to protect against cross-contamination of aquifers. This effort will be accomplished by telescoping casing when it is necessary to penetrate a potential confining layer when drilling in known or suspected source areas of contamination.

The well screen lengths will be determined using the approach presented below.

Water table monitoring wells will be completed with 15 feet of well screen. If possible, the well screens will be set across the water table so that potential floating product can enter the well and the well screen will not become submerged during periods of high groundwater elevations. Because the water table is shallow (less than 2 feet below ground surface in some cases), the well screens may not be able to intersect the water table, and still be installed with a proper surface seal.

Intermediate or deep overburden wells will be screened to monitor potential contaminant pathways, as determined from field screening and field observations. If field screening does not detect VOCs in the deeper soils, the well screen will be set in that portion of the overburden aquifer which is expected to have the highest hydraulic conductivity. The relative hydraulic conductivity will be estimated based on the type of material encountered. Portions of the aquifer that contain clean sand and gravel will be judged to have a higher hydraulic conductivity than areas that contain silt and clay.

The screen slot size will be determined based on the texture of the soil samples from areas adjacent to the proposed well screen location. Medium to fine sand is expected to have a 10 slot well screen, and coarse sand and gravel is expected to have a 20 slot well screen. Sand pack materials will be selected to stabilize the aquifer formation during well development and provide a good hydraulic connection to the aquifer.

Additional details for completing overburden monitoring wells are presented in the drilling technical specification. The field geologist or engineer will document the well construction details on a well construction log (Appendix D). Any deviations from standard procedures will be documented using a Field Modification Record (FMR, Appendix A).

9.3.6 Well Development

Monitoring wells will be developed after installation to remove fines and sediments from around the well screens and to remove drill cuttings and residual drilling fluids from the area around the monitored interval. Development may include bailing, pumping, and surging, as determined by the field geologist. Well development will continue until turbidity is less than 5 nephelometric turbidity units (NTUs), determined by measuring the turbidity every 15 minutes, and until the pH and specific conductivity have stabilized, or until approved by the field geologist/engineer. A Horiba U-10 water quality meter and a Hach Turbidity meter will be used to collect the periodic readings during development. If a well is not completely developed after 4 hours, the FOL will notify the TtNUS Project Manager. The TtNUS Project Manager will consult with technical advisors and the EPA to determine the course of action for continued development. Development water will be collected in 55-gallon drums (DOT Specification 17) or equivalent storage tanks until disposal can be arranged.

9.4 Borehole Geophysics

The objective of the borehole geophysical survey is to determine the orientation of linear features in the borehole, to determine the zones that produce water under static and stressed conditions and measure natural gamma radiation in each of the bedrock boreholes. All of the bedrock boreholes will be drilled to a minimum of 30 feet into bedrock.

A geophysics subcontractor shall perform appropriate testing to complete a heat pulse flow meter log, caliper log, natural gamma log, and borehole acoustic televiewer log of each bedrock borehole installed during the source area investigation.

9.4.1 Heat Pulse Flowmeter

The heat pulse flowmeter (HPFM) shall be used to measure of the rate of fluid flow in a borehole at discrete depths with low flow rates. A thin sheet of water is heated in a short time interval (less than 0.05 sec) and that sheet moves along the borehole in the direction of flow. Temperature sensors located on each side of the heater grid at a short distance from the grid monitor the temperature of the borehole fluid as a function of time for 30 seconds. The time required for the sheet of heated water to reach one of the sensors is calibrated in terms of the flow rate, and the direction of flow in the borehole is determined by noting which sensor detects the change of temperature. The Subcontractor shall show documentation of calibration by the manufacturer, and the documentation of calibration check by the Subcontractor before mobilizing at the start of the project.

In order to detect productive fractures, water must be flowing from the fracture into the borehole. Pumping at a constant rate using a submersible pump will induce flow through water-bearing fractures. The pump should be capable of pumping from 100 ml/minute to 9 gal/min. The Subcontractor will be responsible for determining an appropriate flow rate. The pumping rate will be minimized to avoid drawdown in the well. As the drawdown increases, the hydrostatic head increases which causes a reduction in the flow rate of the pump.

The HPFM log shall consist of a set of measurements at discrete depths in a well. A 2.5 foot interval is required at this site.

Three HPFM measurements should be made in the well at each measurement depth. If any value differed from the average of the other two measurements by more than about 30%, it is omitted from the accepted "average" for the measurement.

9.4.2 Natural Gamma Ray Measurement

The geophysics subcontractor shall record relative values of gamma radiation. These measurements shall determine variations in the natural radioactivity of rocks and sediments within the bedrock borehole to be used as an indicator of changes in lithology and structural features such as fractures. Radioactive minerals tend to accumulate in clays, with the practical result that clay layers and clay-rich layers are commonly expressed in the natural gamma ray log as relative highs. Clean sands, which are normally low in radioactivity, produce relative lows in this log. The radioactivity of a formation increases as the amount of fine material increases. The natural radioactivity of silts is usually between that of sands and clays. The actual values of the count rates for a particular type of material are highly variable, and it is the relative values that are useful for the interpretation of the natural gamma ray log.

Fractures in igneous and metamorphic rock, especially water bearing fractures, commonly contain significant amounts of clay, which typically hosts radioactive minerals. Thus, high count rates for short depth intervals on the bedrock portion of a natural gamma ray log may indicate such fractures. Clay-filled fractures can usually be distinguished from a layered stratigraphy inasmuch as fractures are typically much thinner than individual stratigraphic layers.

9.4.3 Caliper Measurement

The geophysics subcontractor shall collect caliper log measurements of the average borehole diameter as a function of depth. The caliper log shall be completed to record the locations of non-vertical fractures (regardless of whether or not the fractures are productive) and to help in the interpretation of other logs. The sonde shall be lowered to the bottom of the hole, the arms opened, and the borehole diameter shall be recorded continuously (to 0.01 inch) as the sonde is drawn from the hole.

9.4.4 Borehole Acoustic Televiewer

The Borehole Acoustic Televiewer (BHTV) probe shall be used by the geophysics subcontractor to collect continuous images the surface of the borehole wall. Images are created by measuring variations in the returned signal amplitude and two-way travel time as the tool travels up the borehole. The lower section of the probe contains a transducer that rotates at a rate of 10 times per second. Measured amplitude and time data values are collected on a spiral pitch as the tool is raised up the borehole. These data are transmitted to the surface computer along with a magnetic north mark from an on board electronic compass that orients each 360 degree scan. Subsequent processing of the spiral BHTV record produces two-dimensional "unwrapped" image plots of the borehole wall in either amplitude or time-travel mode as a function of depth. Magnetic north shall be recorded in the margin of the plot. Compass direction unfolds left to right as east, south (middle of the plot), west and finally north also positioned at the right margin of the plot. Moderate to high angle (15 to 80 degrees from horizontal) planar bedding and fracture features that intersect the borehole wall appear as sinusoidal traces on both time and amplitude plots. Low angle to horizontal planar features will appear as near horizontal traces across BHTV plots.

The geophysics subcontractor shall present the field data as graphs showing the depth vs. data value for each logging tool (flow meter, caliper, gamma,). For the borehole acoustic televiewer, the subcontractor shall provide a table summarizing the strike, dip, depth and aperture width of each recorded fracture. Electronic records shall be provided to a TtNUS representative at the site within 24 hours after data acquisition. A written data report will be required following data reduction. The report shall provide field notes, raw data collected, and an interpretation of that data. Limitations of the processes, post-processing corrections, and interpretations shall be clearly stated. A draft copy of the data report will be required within one week of the completion of data collection. A final copy of the data report may be required pending a review of the draft report by TtNUS and the U.S. EPA. The data report shall include at a minimum: completed data reduction, copies of all instrument calibration information, field notes and maps, calculation sheets, and any other pertinent data.

9.5 Phase II – Hydraulic Conductivity Tests

Hydraulic conductivity tests will be performed on all bedrock and overburden monitoring wells installed as part of this site investigation. The objective of this testing is to provide estimates of the hydraulic conductivity of the aquifer materials within the study area. These data will be used, along with other data, to refine the site conceptual model and divide the study area into hydrostratigraphic units.

The bulk hydraulic conductivity of the bedrock will be calculated from packer testing conducted at each of the bedrock boreholes prior to completion as a monitoring well (Section 9.5.3). The bedrock packer tests should provide sufficient data to calculate the bulk hydraulic conductivity of the bedrock. Other hydraulic conductivity tests, such as slug tests (Section 9.5.2) and constant discharge tests (Section 9.5.1), will not be performed at these locations unless it is determined during the field activities that one of these other methods would be more efficient at providing similar information.

For overburden monitoring wells, hydraulic conductivity tests will be conducted using either a constant discharge or slug test method, as described in TtNUS SOP GH-2.4. To determine which method will be used, observations such as pumping rate and drawdown, made during the well development and groundwater sampling of the wells, will be evaluated to determine the appropriate test method. Monitoring wells that are determined to be capable of producing water at a reasonable rate will undergo constant discharge tests. Other wells that are not expected to support a constant discharge rate will undergo slug tests.

9.5.1 Constant Discharge Test Method

The majority of wells will be tested using a constant discharge test method. Following completion of the Phase II low-flow groundwater sampling as described in Section 9.7, the pump used to purge and sample will remain in the well and the pumping rate will be increased to approximately 3 to 5 gallons per minute in an attempt to achieve a stabilized drawdown. Water level readings, pump discharge rates, and the time will be recorded approximately every 1-minute for approximately 15 minutes, when stabilization should have occurred. If drawdown reaches 10 feet in the bedrock wells or de-waters the well screen in the overburden wells and stabilization has not occurred, the pumping rate should be decreased and testing continued.

The test is completed after a minimum of 15 minutes has lapsed and stabilization has been achieved.

9.5.2 Slug Tests

To aid in determining the bulk hydraulic conductivity of the aquifer(s) beneath the site, slug tests will be performed on overburden and bedrock wells that cannot support a constant discharge rate. Rising head slug tests will be performed in all of the wells that cannot support a constant discharge rate. Falling head slug tests will only be conducted in wells with fully saturated well screens.

Prior to initiating slug testing at each selected well, the water level will be recorded to the nearest 0.01 foot using an electronic water level indicator. After the static water level has been established, a decontaminated PVC slug will be lowered into the well to a point just above the water table. The slug will be quickly inserted into the well so that its entire length will be below the water table. Water level measurements will be taken at regular intervals as the water "falls" back to its static level (falling head test).

Once the water level has returned to static conditions, a rising head test will be performed by withdrawing the slug from the well, and measuring the water level at regular intervals, a procedure identical to that of the falling head test. The slug will be decontaminated between wells by rinsing with a non-phosphate soap solution, tap water rinse, distilled water rinse, and isopropanol rinse, followed by a final deionized water rinse.

In-situ hydraulic conductivity testing procedures and recording requirements are described in SOP GH-2.4.

The hydraulic conductivity data will be evaluated in the field and, if necessary, a decision will be made to determine if a second test is required to collect additional data in order to calculate accurate hydraulic conductivity from each location. In some cases, a different method or frequency of measurements may be required to collect sufficient data to calculate the hydraulic conductivity.

9.5.3 Bedrock Packer Testing

Each bedrock hole will be packer tested to determine what part of the bedrock yields the most water. A "double packer" set up is expected at this time, which will allow for discrete zones of the bedrock to be isolated and tested. The interval between the packers is expected to be approximately 10 feet, however, actual packer test set up and length between packers will be determined in the field based on spacing and frequency of water bearing fractures identified in the rock core. The entire length of the bedrock hole, to the extent practicable, will be packer tested. The test intervals will be selected so that areas where groundwater movement is expected will be isolated and tested as a separate interval.

Once the packer testing setup is assembled and installed to the initial interval to be tested, the packers will be inflated/expanded to isolate the testing interval. After packer inflation, water will be pumped through the packer testing setup at the desired pressure(s), as directed by the TtNUS Site Representative. After water pressure has stabilized at the desired testing pressure, the test will begin. The flow meter reading at the beginning of the testing period will be recorded, then flow meter readings will be taken at 15 to 30 second intervals, for the duration of the test. A minimum of 5 minutes of readings will be taken for each test. If no measurable flow occurs within the 5 to 10 minutes of testing, a holding test will be performed for several minutes as a check. The flow or bypass valve will be shut to completely isolate the system, then the water pressure gauge checked for a drop in pressure over time. Each interval may be tested at three pressure intervals. Once one interval testing is complete, the downhole packer assembly will be moved to the next interval to be tested, and the testing procedures repeated.

The TtNUS field representative will record gauge pressures, water flow meter readings, and test times to calculate pumping rates on field forms. The TtNUS Project Manager and technical advisor will review the results of the packer tests to determine the location of the pump intake for low-stress groundwater sampling. Packer test procedures are detailed in SOP GH-2.2, and the packer test assembly will be detailed in the Drilling Services Technical Specification.

9.6 Phase II Long-Term Water Level Measurements

Following completion of the Phase II groundwater sampling event, the Phase II long-term water level measurement round will be initiated. This round is anticipated to include up to 24

locations, (four surface water gauging stations and 20 piezometers and monitoring wells) which will be equipped with pressure-transducer/data loggers to measure and record groundwater elevations in both shallow and deep overburden, bedrock, and in nearby surface water bodies. It is anticipated that approximately 10 locations used during phase 1 will be included in phase 2, for comparative purposes. In addition to these locations, several wells to be installed during Phase II activities will also be selected to collect data from the deeper overburden and bedrock portions of the groundwater flow system during the Phase II monitoring event.

The transducers will be secured within the protective steel casing of the wells and piezometers, and will be installed at a depth sufficient to ensure that the transducer will not become dewatered. The transducers will be installed and initialized to provide water level elevation data in order to reduce the amount of data conversion from depth to elevation, and thereby reduce opportunity for mathematical errors. The transducer cable will be marked with duct-tape at the appropriate location so that if it becomes necessary to remove the transducer for maintenance it can be replaced accurately. The transducer cable will be secured within the PVC so that no vertical movement can occur which could create error in the measurements during data retrieval activities and manual measurements.

Each transducer will be left in place for approximately six weeks though the summer/fall (low water table) season. All of the transducers will be initialized to collect readings on the hour or every 15 or 30 minutes as described below. The transducers installed within the groundwater data point locations (wells/piezometers) will be initialized to collect readings once every 30 minutes. The transducers installed at the surface water gauge locations will be initialized to collect readings once every 15 minutes. The transducer data will be downloaded as needed onto a laptop computer and will be field verified using manual measurements to identify potential problems such as instrument drift and need for maintenance/replacement.

9.7 Phase II Groundwater Sampling

The Phase II groundwater sampling event includes sampling the monitoring wells scoped for installation during Phase II drilling, as well as the monitoring wells installed and sampled during Phase I activities. Table 8-5 lists the proposed wells to be sampled, the number of samples to be collected, and the analyses to be performed during the groundwater monitoring for Phase II.

Phase II groundwater samples will be analyzed for VOCs, SVOCs, pesticides/PCBs, dioxins, metals (total and dissolved), alkalinity, sulfides, and TOC.

The Phase II groundwater sampling will also be conducted using the low-flow procedures previously outlined in Section 9.2. Specific pump intake depths will be determined following installation of Phase II wells, based on observations made during the advancement of the borings, testing conducted at each location such as packer testing, borehole geophysics, and based on observations of well performance during well development activities. It is anticipated that either a bladder pump or submersible impeller pump will be required for the bedrock wells.

For wells previously sampled during Phase I activities, target pumping rates and tubing/pump intake depths will be established based on the Phase I purging/sampling observations and analytical results. The TtNUS hydrogeologist will review this data and make recommendations to the TtNUS Project Manager who will review the recommendations with EPA personnel prior to Phase II sampling.

Section 9.2 presents the work elements for the low-flow groundwater sampling tasks.

9.8 NAPL Sampling Procedures

If free product or non-aqueous phase liquids (NAPL) are encountered at any point during either the soil sampling or groundwater sampling efforts in Phase I or Phase II, samples will be collected for laboratory analysis, as indicated in Section 6.3.3. Sampling procedures for NAPL encountered in soils are discussed in Section 9.1.1.

All monitoring wells and piezometers constructed during the Centredale Manor Restoration Project Investigation will be checked for LNAPL and DNAPL prior to groundwater sampling activities using an interface probe. If free product is noted within a well or piezometer, either bailers or pumps will be used to obtain sample aliquots. Depending on the thickness of the free product, numerous methods may be employed. If the product layer is very thin, multiple attempts may be required to obtain sufficient volume for analysis. Floating free product (LNAPL) with sufficient thickness may be obtained using a bailer with a trap-door type valve in place of a check ball valve to allow maximum access into the bailer for the free product. A peristaltic pump may be used for either LNAPL or DNAPL layers of lesser thickness. Another

method for the collection of sufficient volume involves collecting a larger quantity of the product mixed with water into laboratory clean bottleware using a larger pump and allowing the NAPL to separate within these containers. Once the NAPL has separated from the water portion of the sample it may be extracted using a peristaltic pump under controlled conditions and transferred into the appropriate bottleware.

9.9 Air Sampling Procedures

Air samples will be collected from inside the Centredale Manor building. Five samples will be collected for VOC analysis using 6-liter summa canisters. In addition, five samples will be collected for dioxin and PCB analysis using filters polyurethane foam (PUF) and low flow air pumps.

Random checks will be performed to insure proper operation of all five samplers and to take readings from an FID and PID. Air sampling activities will be documented in an air sampling field log sheet. PUF samplers and Summa canister samples will be analyzed by an off-site DAS laboratories. Analysis for VOCs will be performed by Method TO-15 using selective ion monitoring mode in order to meet the quantitation limits required by the project. Air samples will be collected in accordance with TtNUS SOP SA-2.2, modified as per sections 9.9.1 and 9.9.2.

All pertinent sampling data for air sampling will be recorded on a Sample Log (see Appendix D) and referenced in the field logbook. Appropriate chain-of-custody procedures will be followed as described in Section 10.3.

9.9.1 PUF Air Sampling Procedures

Low volume flow of Polyurethane Foam (PUF) sampling is based on the EPA Method TO-10 for PCB analysis and EPA Method TO-9 for dioxin analysis. The sampling module consists of a borosilicate glass sampling cartridge in which the pre-cleaned PUF plug is retained. The sampling cartridge is connected to a continuous-flow sampling pump with Teflon tubing.

Sampling procedure:

- One field blank and one field duplicate sample will be collected. The field blank is treated exactly like a sample except that no air is drawn through the cartridge. The field duplicate will be collected co-located to a field sample using another identical sample collection setup.

- The prepared sampling cartridge should be used within 30 days of loading and should be handled with latex gloves.

- Calibrate the flow rate of the pump before sample collection at 4 liters per hour.

- The cleaned sample cartridge is then carefully attached to the pump with flexible tubing. The sampling assembly is positioned with the intake downward or horizontally. The sampler is located in an unobstructed area at least 30 cm from any obstacle to air flow. The PUF cartridge intake is positioned 1 to 2 meters above ground level. The cartridge height above ground is recorded on the PUF Sampling Data Sheet.

- After the PUF cartridge is correctly inserted and positioned, the pump power switch is turned on and the sampling begins. The elapsed time meter is activated and the start time is recorded.

- The pumps should be checked during the sampling process and any abnormal conditions discovered should be recorded on the data sheet. Ambient temperatures, relative humidity, and barometric pressures are measured hourly and recorded in the air sampling field log sheet.

- After 8 hours of sampling the pump is turned off, the PUF cartridges are wrapped with aluminum foil and placed in labeled containers, sealed, and packed for shipping to the laboratory.

9.9.2 Summa Canister Air Sampling Procedures

Leak-free, pre-cleaned 6-liter Summa passivated stainless steel canisters will be used to collect integrated air samples over a period of 8 hours for VOC analysis. The sample enters the canister through a high temperature, stainless steel bellows valve. Each Summa canister will hold a high vacuum (greater than 28 inches of Mercury) for 30 days. It is recommended that the Summa canister be exchanged if not used within 30 days of its issue. The holding time for VOC analysis by Method TO-14 is 14 days from the date of sample collection to VOC analysis.

Each canister comes with a brass plug. The plug ensures that there is no loss in vacuum and that no dust or other particulate material fouls the valve. This brass plug is removed prior to sampling and reinstalled following sample collection.

A filter is used to prevent particulate material from entering the canister. Filters are always used with the canisters.

A stainless steel vacuum gauge is used to measure the initial and final vacuum of the canister and to monitor the filling of the canister when collecting a sample. Always check the vacuum of the canister prior to use; the initial vacuum should be greater than 25 inches of Mercury.

The mechanical stainless steel flow controllers will be pre-set at the laboratory for an 8-hour sample interval.

<u>Sampling Procedure</u>:

- Verify that the canister valve is closed.
- Remove the brass plug and attach the gauge tightly.
- If the gauge has a "Tee" fitting, it is necessary to cap the side arm of the "Tee" (use the brass plug for this purpose).

- Open and close the canister valve and record the initial vacuum pressure on the valve. If the canister vacuum is less than 25 inches of Mercury, do not use the canister.

- Remove the gauge from the canister and attach the flow controller and the filter. Check the connections to make sure they are tight enough so that the flow controller cannot be rotated.

- Use one canister to verify that the flow meter is calibrated correctly.

- Place the canister in the appropriate location determined by the TtNUS Site Representative, and avoiding direct sunlight on the canister.

- Check the canister hourly during the sampling interval to insure that the canister is not filling too slowly or too quickly. Keep a record of vacuum pressure in the canister each hour in the air sampling field log book.

- The final vacuum of the canister at the end of the sample collection should be recorded on the sample log sheet and on the chain-of-custody form.

9.10 Wipe Sampling Procedures

Wipe samples will be collected from horizontal smooth surfaces using the method described in Attachment A to EPA Method 8290, modified for risk-based project-specific action levels described in Tables 6-22 and 6-23.

At each sample station, a sample area will be marked out at 100 cm x 100 cm. Two sterile gauze pads saturated with pesticide grade hexane will be used to wipe the surface area for each sample. The marked surface area will be wiped with two gauze pads using firm strokes, first horizontally and then vertically to ensure that all the designated surface area is wiped. All handling of the sample media will be done using only decontaminated stainless steel forceps.

Both gauze pads will be combined into a single amber sample jar and shipped to the laboratory at 4 degrees centigrade. Two unused gauze pads will be sent to the laboratory as a field blank.

A field duplicate sample will be collected by wiping two 100 x 100 cm areas adjacent to each other.

Samples will be shipped on ice to the DAS analytical laboratory.

9.11 Cleaning and Decontamination of Equipment / Sample Containers

TtNUS will obtain pre-cleaned sample containers for CLP analysis. The DAS laboratories will provide the appropriate sample containers. These containers will meet the requirements of the US EPA Specification and Guidance for Contaminant-Free Sample Containers, OSWER Directive No. 9240.0-05A.

The detailed decontamination and waste handling procedures are described in this section, which has been prepared in accordance with TtNUS SOP No. SA-7.1 (S7) provided in Appendix C. The non-disposable equipment that will come in contact with the media to be sampled and that will require decontamination are identified in the table below. If the equipment is new, the initial cleaning will consist only of a soapy water wash followed by a tap water and distilled water rinse. Sterile disposable sampling materials, which are individually packaged from the factory, will not require decontamination before sampling. Disposable sampling materials will be kept to a minimum to reduce the amount of solid investigation-derived waste (IDW) requiring disposal.

Equipment that will be used at the Centredale Manor Restoration Project site to collect soil, groundwater, air, and wipe samples is summarized in the table below:

Matrix: Soil	**Parameter**	
Equipment	**Metals**	**VOCs, SVOCs, Pesticide/PCBs, Percent Moisture, Dioxins**
Drill Rig & Drilling tools	X	X
Stainless Steel Trowel	X	X
Split-Barrel sampler	X	X
Stainless Steel Bowl	X	X
Disposable Sampling Trowel	X	X
Disposable 10 ml Syringe		X
PPE	X	X

Matrix: Groundwater	**Parameter**	
Equipment	**Metals & Dissolved Metals**	**VOCs, SVOCs, Pesticide/PCBs, Dioxins, TOC, Alkalinity, Sulfides**
HDPE Tubing	X	X
Pharmaceutical-grade Silicon Tubing	X	X
Submersible Pumps	X	X
PPE	X	X

Matrix: Air	**Parameter**	
Equipment	**VOCs**	**PCBs, Dioxin**
Low Flow Air Sampling Pumps		X
Summa Canisters	X	
PUF Cartridges		X
Teflon Tubing		X
Temperature/Humidity Instrument & Barometer	X	X
PPE	X	X

Matrix: Wipe	
Equipment	**PCBs, Dioxin**
Stainless Steel Forceps	X
Sterile Gauze Wipes	X
PPE	X

9.11.1 Decontamination Procedure

Prior to the initiation of drilling activities all downhole drilling equipment and tools will be high-pressure steam cleaned at a decontamination pad to be constructed within a fenced-off portion of the Site. This decontamination procedure will apply to all downhole tools, the rear of the drill rig, any tool racks, and support vehicles which come into contact with contaminated media. This decontamination procedure will be repeated between each soil boring and prior to demobilization of this equipment from the site.

Non-disposable sampling equipment such as split-barrel samplers, submersible pumps and stainless-steel supplies will undergo the following decontamination procedure prior to being used to collect analytical samples:

1. Potable water rinse

2. Alconox or Liquinox detergent wash
3. Potable water wash
4. Deionized water rinse
5. Pesticide-grade Isopropyl alcohol rinse
6. Pesticide-grade Hexane rinse
7. Thorough deionized water rinse
8. Air dry
9. Wrap in aluminum foil for storage if not reused

9.11.2 Control and Disposal of Investigation Derived Waste (IDW)

Procedures for handling investigation derived waste are described in this section which has been prepared in accordance with TtNUS SOP SA-7.1 Section 5.4 (Waste Handling) (S7).

Contaminated PPE, soils, and liquids generated during decontamination activities will be containerized in labeled Department of Transportation (DOT) approved 55-gallon drums. These drums will be stored within a designated storage area at Cap Area 1 until characterization and disposal is arranged. Prior to the drilling subcontractor's demobilization from the site, all drums will be moved to the drum storage area. Containerized IDW will be secured at the drilling locations until activities at that respective location are completed. In addition, IDW from drilling locations outside of fenced areas will be moved to the staging area between work shifts. The IDW staging area will be prepared with secondary containment and emergency spill supplies in the form of shovels and vermiculite absorbent. All drums will be labeled as to the date of generation, contents, location of generation, and site name.

Drill cuttings and solids will be segregated from the liquid IDW as much as possible. IDW from each boring location will be stored in a separate drum to attempt to reduce the quantity of high level contaminated IDW for disposal.

PPE and any other disposable supplies (i.e. paper-towels, poly sheeting, buckets, scrub brushes) which may be contaminated through sampling activities will be containerized in trash bags inside DOT approved 55-gallon drums.

During Phase I, liquid IDW from all the investigation activities at the Site will be collected daily and containerized temporarily in DOT approved 55-gallon drums. Prior to demobilization these drums will be staged at the drum storage area along with all other IDW. Decontamination fluids containing soap and solvents from cleaning split-barrel samplers and stainless-steel equipment will be containerized separately from rig decontamination waters. Due to the quantities of liquid expected to be generated during the Phase II investigation (water-drilling, well development, hydraulic conductivity testing, groundwater sampling, decontamination) all liquid IDW will be collected from the individual working locations in either DOT approved 55-gallon drums or equivalent storage tanks until characterization is complete and disposal can be arranged.

9.12 Sampling SOP Modifications

The following sampling SOPs have been modified for the purposes of collecting representative data for use in the Centredale Manor Restoration Project:

TtNUS SOP GH-1.5 – Borehole and Sample logging (S2) was modified to allow the use of a modified Boring Log from the example shown to serve in place of multiple individual Soil Sample Log Sheets for each analytical sample. This change also modifies TtNUS SOP SA-1.3 – Soil Sampling Section 5.9 (S3) and TtNUS SOP SA-6.3 – Field Documentation (S1).

TtNUS SOP SA-1.3 (S3) was also modified in Section 9.1.1 to account for the use of a 3-inch ID split-barrel sampler to collect additional volume required for the laboratory analyses.

TtNUS SOP SA-2.2 (S8) was modified in Section 9.1.1 to account for the detailed site-specific jar headspace VOC screening procedure.

9.13 Field Equipment Calibration

Calibration of direct read instruments will be performed as described in this section, which has been prepared in accordance with TtNUS SOP SA-2.2 (Air Monitoring) (S8).

The Field Instrument Calibration TtNUS SOPs for the Photovac 2020 PID (ME-12) and the Photovac MicroFID (ME-15) (S4 & S5) are provided in Appendix C in addition to TtNUS SOP SA-2.2 Section 5.6 (Air Monitoring and Sampling) (S8). Field analytical equipment will be calibrated prior to each day's use and the calibration will be checked at the end of each day.

The calibration procedures used will conform to manufacturer's standard instructions. Records of instrument calibration will be maintained in a field log. Field personnel will maintain instrument manuals on site. Table 9-2 summarizes the field equipment calibration frequency.

9.14 Field Equipment Maintenance, Testing, and Inspection Requirements

Equipment, instruments, gauges, and other items requiring preventive maintenance will be serviced in accordance with the manufacturer's recommendations. Manufacturer's procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to this maintenance schedule and to arrange any necessary and prompt service required. Service to the equipment, instruments, tools, gauges, etc. shall be performed by qualified personnel. Logs shall be established to record maintenance, service procedures, and schedules. Maintenance records will be documented and traceable to the specific equipment, instruments, and gauges. Table 9-3 summarizes the equipment and maintenance frequency for the field equipment to be used during the soil, groundwater, and air sampling activities at the Centredale Manor Restoration Project Site.

9.15 Inspection and Acceptance Requirements for Supplies/Sample Containers

It will be the responsibility of the field personnel to inspect all supplies to be used as part of the field program during mobilization and use. Supplies to be inspected include sampling equipment, field meters, sampling containers, and summa canisters.

If the field crew encounters any problem with the supplies, the FOL should consult the QA/QC officer for instruction. The QA/QC Officer will instruct the field crew on any corrective actions that should be implemented.

Table 9-1
Project Sampling SOP Reference
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Identification	Modified Project Work Y or N
S1	Field Documentation SOP SA-6.3, January 2000	TtNUS	NA	N
S2	Borehole and Sample Logging SOP GH-1.5, June 1999	TtNUS	(1)	Y See Section 9.1.1
S3	Soil Sampling SOP SA-1.3 June, 1999	TtNUS	(1)	Y See Section 9.1.1
S4	Specialized Media Sampling SOP SA-5.1, March 2000	TtNUS	(1)	Y See Section 9.8
S5	Field Instrument Calibration SOP-ME-12, June 1999	TtNUS	NA	N
S6	Field Instrument Calibration SOP- ME-15, June 1999	TtNUS	NA	N
S7	Decontamination of Field Equipment and Waste SOP SA-7.1, March 1998	TtNUS	NA	N
S8	Air Monitoring and Sampling SOP SA-2.2 March, 1996	TtNUS	(1)	Y See Section 9.9

(1) The equipment that will be used for sample collection is listed in Section 9.4.

Table 9-2
Field Sampling Equipment Calibration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Equipment	Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP References
LEL/O2 - Meter	Per operations manual	daily during field activities	per operations manual	replace instrument if criteria exceeded	field personnel with oversight by QA/QC Officer	NA
Photovac MicroFID Flame Ionization Detector (FID)	Per operations manual	daily during field activities	per operations manual	replace instrument if criteria exceeded	field personnel with oversight by QA/QC Officer	SOP ME-15
Photovac 2020 Photoionization Detector (PID)	Per operations manual	daily during field activities	per operations manual	replace instrument if criteria exceeded	field personnel with oversight by QA/QC Officer	SOP ME-12
Digital Scale	Per operations manual	daily during field activities	per operations manual	replace instrument if criteria exceeded	field personnel with oversight by QA/QC Officer	NA
Horiba U-10 Water Quality Meter	Per operations manual	daily during field activities	per operations manual	replace instrument if criteria exceeded	field personnel with oversight by QA/QC Officer	NA

Note: EPA Region I Calibration of Field Instruments, June 3, 1998 will be used for instruments that are not accompanied by manufacturer's Calibrations and Operations Manual

Table 9-3
Field Equipment, Maintenance, Testing and Inspection
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling Equipment/ Instrument	Maintenance Activity	Testing Activity	Inspection Activity	Responsible Person	Frequency	Acceptance Criteria	Corrective Action	SOP Reference
Photovac MicroFID F Ionization Detector (	cleaning	operation	visual	project field personnel	Prior to use	no visual defect: conformance with manufacturer standards	repair or use alternate equipment	SOP ME-15
Photovac 2020 Photoionization Detector (PID)	cleaning	operation	visual	project field personnel	Prior to use	no visual defect: conformance with manufacturer standards	repair or use alternate equipment	SOP ME-12
Horiba U-10 Water Q Meter	cleaning	operation	visual	project field personnel	Prior to use	no visual defect: conformance with manufacturer standards	repair or use alternate equipment	NA
Digital Scale	cleaning	operation	visual	project field personnel	prior to use	no visual defect: conformance with manufacturer standards	repair or use alternate equipment	NA
LEL/O2 - Meter	cleaning	operation	visual	project field personnel	prior to use	no visual defect: conformance with manufacturer standards	repair or use alternate equipment	NA

10.0 SAMPLE HANDLING, TRACKING AND CUSTODY REQUIREMENTS

The sample handling, field documentation, and chain-of-custody procedures are documented in this section.

10.1 Sample Collection Documentation

The following sections outline the procedures that will be used by field personnel to document project activities and sample collection procedures at the Centredale Manor Restoration Project Site. Detailed and accurate documentation is necessary in order to ensure data integrity.

10.1.1 Field Notes

Documentation of field observations will be recorded in a field logbook and/or field sampling log sheets. Field logbooks utilized on this project will consist of a bound, water-resistant logbook. All pages of the logbook will be numbered sequentially and observations will be recorded with indelible ink. Field logbooks will be maintained according to TtNUS SOP No. SA-6.3 Section 5.2. Field sample sheets will be used to document sample collection details, while other observations and activities will be recorded in the field logbook. Instrument calibration logs will be used to record the daily instrument calibration.

For sampling and field activities, the following types of information may be recorded:

- Project name
- Date and time of logbook entries
- Personnel
- Weather conditions
- Activities involved with the sampling
- Subcontractor information
- Site observations
- Site sketches
- Visitors
- Health & Safety issues including Personal Protective Equipment (PPE)

- Log of photographs

The following sections outline the information that will be documented in the field according to the media to be sampled and the activities to be performed.

Soil Sampling

Sample Log Sheets – Solid Phase forms will be used to document each soil sample collection. The following information will be recorded:

- Personnel performing the sampling
- Diagram of soil sampling locations
- Date and time of sample collection
- Sample location identification
- Depth interval of sample collection
- Parameters to be analyzed
- Description of sampling procedures
- PID/FID readings
- Description of visual observations of soil properties (type, color, odors, etc.)
- General observations
- Identification and description of any duplicate samples

The field logbooks and sample sheets will remain on-site for the duration of the investigation. After the investigation, all documents will be archived in project files.

Groundwater Sampling

Groundwater Sample Log Sheets will be used to document each groundwater sample collection. The following information will be recorded:

- Personnel performing the sampling
- Diagram of groundwater sampling locations
- Date and time of sample collection

- Sample location identification
- Low-Flow well purge data
- Parameters to be analyzed
- Description of sampling procedures
- General observations
- Identification and description of any duplicate samples

Air/Wipe Sampling

Sample Log Sheets will be used to document each filtered air/wipe sample collection. The following information will be recorded:

- Personnel performing the sampling
- Diagram of air/wipe sampling locations
- Date and time of sample collection (initial and final)
- Sample location identification
- Parameters to be analyzed
- Description of sampling procedures
- General observations
- Identification and description of any duplicate samples
- Weather conditions: temperature, relative humidity, barometric pressure
- Summa canister vacuum: initial, final
- Identification serial number for summa canisters and controllers

Drilling

Boring Log Sheets will be used to document each soil boring including the small diameter borings and borings advanced using drive and wash methods and bedrock coring. The following information will be recorded:

- Drilling subcontractor
- Name of the rig geologist
- Soils/fill/bedrock description using the Unified Soils Classification System

- Depth of water
- General observations
- Blow Counts, sample depths, penetration and recovery lengths
- PID/FID Screening and jar headspace results
- Depth to bedrock, if encountered
- End of boring depth

Well Construction

Well Construction Log Sheets will be used to document each well installation. The following information will be recorded:

- Drilling subcontractor
- Name of the geologist performing oversight of the installation
- Diagram of well installation activities
- Depth of water
- Well construction materials and design
- Well depth and screen intervals
- Depth to bedrock if encountered
- Description of any atypical installation procedures
- General observations

The field logbooks and sample log sheets will remain on-site for the duration of the field investigation. After the investigation, all documentation will be stored in the project files.

10.1.2 Field Documentation Management

After the investigation is completed, the field sampling sheets will be organized by date and media and filed in the project files. The field logbooks for this project will be used only for this site, and will also be categorized and maintained in the project files after the completion of the field program. Project personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled based on date and activity.

10.2 Sample Identification and Tracking System

This section outlines the procedures that will be followed to identify and track samples taken during field activities. The term "sample" refers to a representative part of the media quantity that is extracted from a larger group as a whole and presented for quantitative analysis. In this field investigation, samples include soil, groundwater samples, air, wipes, and NAPL samples. Each sample collected will be assigned a unique sample tracking number. The sample tracking number will consist of three or four alphanumeric code segments, with each segment separated by a hyphen. The sample tracking number will identify the site, the sample medium, the sample area, the sample location, the sample depth (if appropriate), the sample date, and quality control sample designation (if appropriate). Other pertinent information regarding sample identification, such as the time the sample was collected and measurements of sample locations and observations will be recorded on the sample collection log sheets and in the site logbook.

The sample tracking number format will be as follows:

AA Site Identifier	-	AA Sample Medium	-	NNNN (varies) Sample Location	-	NNNN or NN Sample Depth Code or Sample Round (for groundwater)

Where: A alpha character
N numeric character

Site Identifier – This first segment will consist of a two-character code identifying the site:

CMS Centredale Manor Restoration Project Site

The sample medium will consist of a two-character code as follows:

Sample Medium:

GW	groundwater
SO	soil
AR	air
WI	wipe

Sample Location Number (or QA/QC Sample Code) – For field samples, the characters in this segment identify the sample location number as follows:

Sample Location Number: For soils samples, a two-digit sample location number (01, 02, 03...) will be applied to the sample as the sampling progresses. For groundwater samples, the pre-established monitoring well identification number will be used.

For QA/QC samples, the segment will consist of a two to three character code to identify the type of QA/QC sample as follows:

QA/QC sample type:	DUP	field duplicate
	RB	equipment (rinsate) blank
	TB	trip blank

Sample Depth Code – For soil samples, the fourth segment will be four digits consisting of the upper and lower limits of the sample interval below the ground surface in feet. For groundwater samples the fourth segment will consist of two digits representing the number of the sampling round (01 or 02). QA/QC samples will be numbered sequentially per type (01, 02, 03...).

For example, the surface soil sample collected from soil boring location number 3, collected from 0 to 1 feet bgs, would be designated as:

CMS - SO - 03 – 0001

The subsurface soil sample collected from soil boring location number 3, collected from 1 to 10 feet bgs, would be designated as:

CMS - SO - 03 - 0110

The groundwater sample collected from MW-2B during the initial groundwater sampling round will be designated as:

CMS - GW – MW2B – 01

The first duplicate soil sample collected, regardless of location or depth, will be identified as:

CMS – SO – DUP – 01

The duplicate soil location and depth will be recorded in the field data sheet.

10.3 Sample Handling and Custody

Following collection, samples will be stored on ice in a secure cooler until they are shipped to the laboratories. Custody of the samples will be maintained at all times and documented in the chain-of-custody forms to ensure the integrity of a sample from collection through analysis. The chain of custody begins at the time the sample is collected. Custody will be maintained by TtNUS prior to sample shipment by ensuring that the sample is in the physical possession or view of an authorized person, or the sample is in a secure area, restricted to authorized personnel only.

The samples will be shipped to the laboratories in coolers packed with ice and vermiculite, or equivalent packing material, to cushion the samples to prevent breakage. The coolers will be taped and sealed with a signed custody seal to ensure the chain of custody is maintained. The chain-of-custody forms are shipped to the laboratory with the samples.

Samples will be shipped to the laboratories by an overnight courier (Federal Express) to ensure that maximum sample holding times are not exceeded. The maximum allowable sample holding times before sample extraction, digestion, or analysis are presented in Tables 8-1 to 8-6. These tables also list the sample containers and preservatives used to maintain the integrity of the sample.

Each sample collected will be assigned a unique sampling tracking number, as described in Section 10.2. In addition, organic and inorganic CLP sample numbers will be assigned to the samples to be analyzed through the CLP and a six-digit sample code will be assigned to each DAS sample. Serialized EPA Region I sample tags will be attached to all samples submitted for CLP analysis. The sample number, CLP/DAS number, and the tag number for each sample will

be recorded on the appropriate Chain-of-Custody forms. CLP Organic Traffic Report & Chain-of-Custody records will be used for the CLP organic samples. CLP Inorganic Traffic Report and Chain-of-Custody records will be used for the CLP inorganic samples. An analytical service packing list/chain-of-custody forms will be used for the DAS samples.

A container filled with water and labeled "Temperature Blank" will be included in each cooler. The temperature of this blank will be measured by the laboratory upon sample receipt to verify acceptable cooling of samples.

11.0 FIELD ANALYTICAL METHOD REQUIREMENTS

No field analysis is anticipated for the Centredale Manor Restoration Project Source Area Investigation.

12.0 FIXED LABORATORY ANALYTICAL METHOD REQUIREMENTS

This section of the QAPP describes the analytical techniques that will be used by the fixed laboratory to generate definitive data for the project. It documents the fixed laboratory analytical methods and SOPs that will be used to meet measurement performance criteria and achieve project-required quantitation limits for the COCs and other target compounds.

12.1 Fixed Laboratory Analytical Methods and SOPs

Analytical methods to be used by Katahdin Analytical and their associated SOPs for the soil, groundwater, NAPL, and wipe analyses are presented in Table 12-1. The analytical methods to be used by Air Toxics, LTD for the air analyses, and the analytical methods to be used by Triangle Labs for the dioxin analysis, and associated SOPs are also presented in Table 12-1.

CLP laboratories, to be assigned at a later date, will perform soil and groundwater analyses. Analytical methods, instrument maintenance, instrument calibration, quality control samples, and acceptable limits are specified in the CLP Statements of Work OLM04.2 (organics) and ILM04.1 (metals).

12.2 Fixed Laboratory Analytical Method/SOP Modification

The procedures to be followed by Katahdin Analytical to perform VOC soil analysis, PCB wipe analysis, groundwater alkalinity, sulfide, total organic carbon analysis, VOC, SVOC, pesticide/PCB, and metals NAPL analysis are described in the SOPs listed in Table 12-1 of this QAPP. The procedures to be followed by Air Toxics, LTD to perform the VOC and PCB air analyses, and the procedures to be followed by Triangle Labs to perform the soil, groundwater, NAPL, air, and wipe dioxin analyses are also described in the SOPs listed in Table 12-1 of this QAPP.

1,2,4,5,7,8-Hexachloro(9H)xanthene (HCX) will be reported as a tentatively identified compound from the dioxin analysis by EPA Method 8290. The identification criteria for HCX is described in the Tetra Tech Technical Specification S00-RAC1-150 presented in Appendix C.

The CLP laboratories will follow the CLP Statements of Work required without modification.

12.3 Fixed Laboratory Instrument Calibration

To ensure that the methods performed by the DAS laboratories meet the project requirements for selective, sensitive, accurate, and precise detection and quantitation of the contaminants of concern for the Centredale Manor Restoration Project site, the calibration procedures will follow the requirements summarized in Tables 12-2 through 12-4.

12.4 Fixed Laboratory Instrument/Equipment Maintenance, Testing, and Inspection Requirements

The procedures to be followed by Katahdin Analytical, Air Toxics, LTD, and Triangle Labs to ensure that the laboratory instruments are available and in working order to meet the required turn-around time of these analyses are included in several SOPs listed in Tables 12-1 through Table 12-4 of this QAPP.

The DAS laboratories will check the instruments used for the analyses as described in Tables 12-2 through Table 12-4 of this QAPP. The instruments are monitored on a daily basis for potential failure. The analysis of blanks and control standards at the start and at the end of the day provides real time information to the analyst on the conditions of the instruments. Records of equipment maintenance logs are maintained for the gas chromatograph, mass spectrometer, ICP, and all instruments used.

The CLP laboratories will perform instrument/equipment maintenance and inspection as required in the organic and inorganic CLP Statements of Work.

12.5 Fixed Laboratory Inspection and Acceptance Requirements for Supplies

All supplies used by the CLP and DAS laboratories will be free of contaminants of concern, other target compounds, and interferences. Method blanks will be performed at the rate specified in each method to ensure that reagents and equipment are free of contamination. The corrective actions specified in the CLP and DAS laboratory statements of work will be followed if

laboratory contamination is detected. Purity and accuracy of the standards is also checked by analyzing performance evaluation samples.

Air Toxics, LTD will provide the Summa canisters and PUF cartridges to be used at the Centredale Manor Restoration Project site for the air sampling. All the canisters cleaned by Air Toxics will be certified to be used for by TO-15/SIM GC/MS analysis. Individually certified summa canister will be used for this project. Air Toxics identifies and tracks the history and maintenance of each canister with a bar code.

PUF cartridges are cleaned using solvents and vacuum dried. Each batch of PUF cartridges is certified by the laboratory. Cartridges from the same batch to be provided to TtNUS will be analyzed by gas chromatograph to be free target compounds. In addition, the laboratory will analyze one clean PUF cartridge for each extraction set-up to serve as laboratory blank. The cartridges will be sent to TtNUS wrapped tightly in aluminum foil to prevent UV light degradation.

Table 12-1
Fixed Laboratory Analytical Method/SOP Reference
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Reference Number	Fixed Laboratory Performing Analysis	Title, Revision Date and/or Number	Definitive or Screening Data	Region I NESTS Method Code	Analytical Parameter	Instrument	Modified for Project Work Y or N
L1	DAS/Katahdin Analytical	Soils – Volatile Organic Compounds, US EPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999, Modified Laboratory SOP # CA-214, 7/98 - Medium Concentration	Definitive	5035/OLM04.2VM	VOCs	GC/MS	Y[920]
L2	CLP/TBD	Soils – Semivolatile Organic Compounds, US EPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999 - Low/Medium Concentration	Definitive	OLM04.2S	SVOCs	GC/MS	N
L3	CLP/TBD	Soils – Pesticides/PCBs, US EPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999 - Low/Medium Concentration	Definitive	OLM04.2P	Pesticides/ PCBs	GC/ECD	N
L4	CLP/TBD	Soils – Total Metals, US EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media Multi-Concentration, Effective March 2000 Low/Medium Concentration	Definitive	ILM04.1MT	Metals	ICP/CV	N
L5	DAS/Triangle Labs	Soils – Dioxins, US EPA SW-846 Method 8290 Laboratory SOP # DSP105, version 15, 7/31/98, DHR182, version 6, 3/25/98 - Low/Medium Concentration	Definitive	8290	Dioxins	HRGC/HRMS	Y[1]
L6	CLP/TBD	GW – Volatile Organic Compounds, US EPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999 Low/Medium Concentration	Definitive	OLM04.2V	VOCs	GC/MS	N
L7	CLP/TBD	GW – Semivolatile Organic Compounds, US EPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999 Low/Medium Concentration	Definitive	OLM04.2S	SVOCs	GC/MS	N
L8	CLP/TBD	GW – Pesticides/PCBs, US EPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999 – Low/Medium Concentration	Definitive	OLM04.2P	Pesticides/ PCBs	GC/ECD	N
L9	CLP/TBD	GW – Total Metals, US EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, Effective March 2000 Low/Medium Concentration	Definitive	ILM04.1MT	Metals	ICP/CV	N
L10	CLP/TBD	GW – Dissolved Metals, US EPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, Effective March 2000 Low/Medium Concentration	Definitive	ILM04.1MD	Metals	ICP/CV	N
L11	DAS/Triangle Labs	GW – Dioxins, US EPA SW-846 Method 8290 Laboratory SOP# DSP161, version 16, 10/23/98, DHR182, version 6, 3/25/98 - Low/Medium Concentration	Definitive	8290	Dioxins	HRGC/HRMS	Y[1]
L12	DAS/Katahdin Analytical	GW – Alkalinity, US EPA method 310.1 Laboratory SOP#CA-739, 4/98 - Low/Medium Concentration	Definitive	310.1	Alkalinity	Autotitrator	N

Table 12-1 (cont'd)
Fixed Laboratory Analytical Method/SOP Reference
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Reference Number	Fixed Laboratory Performing Analysis	Title, Revision Date and/or Number	Definitive or Screening Data	Region I NESTS Method Code	Analytical Parameter	Instrument	Modified for Project Work Y or N
L13	DAS/Katahdin Analytical	GW – Sulfide US EPA Method 376.1 Laboratory SOP#CA-722, Draft, 2/99 Low/Medium Concentration	Definitive	376.1	Sulfide	Titration	N
L14	DAS/ Katahdin Analytical	GW – Determination of Total Organic Carbon US EPA Method 415.1 - Laboratory SOP#CA-702, 10/97 Low/Medium Concentration	Definitive	415.1	TOC	Dohrman Carbon Analyzer	N
L15	DAS/ Katahdin Analytical	NAPL – Volatile Organic Compounds, USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999, Modified Laboratory SOP#CA-214, 7/98 Medium Concentration	Definitive	OLM04.2VM	VOCs	GC/MS	Y(2)
L16	DAS/ Katahdin Analytical	NAPL- Semivolatile Organic Compounds, USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999, Modified Low/Medium Concentration	Definitive	OLM04.2SM	SVOCs	GC/MS	Y(2)
L17	DAS/ Katahdin Analytical	NAPL – Pesticides/PCBs, USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, May 1999, Modified Low/Medium Concentration	Definitive	OLM04.2PM	Pesticides/ PCBs	GC/ECD	Y(2)
L18	DAS/ Katahdin Analytical	NAPL – Total Metals, USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, Effective March 2000 Low/Medium Concentration	Definitive	ILM04.1MTM	Metals	ICP/CV	Y(2)
L19	DAS/ Triangle Labs	NAPL – Dioxins, USEPA SW-846 Method 8290 Laboratory SOP# DSP105, version 15, 7/31/98, DHR182, version 6, 3/25/98 - Low/Medium Concentration	Definitive	8290	Dioxins	HRGC/HRMS	Y(1)
L20	DAS/Air Toxics, LTD	Air – Volatile Organic Compounds, US EPA Method TO-15/SIM Laboratory SOP# 38, Revision 2, 10/22/99 Low/Medium Concentration	Definitive	TO-15	VOCs	GC/MS/SIM	N
L21	DAS/ Air Toxics, LTD	Air – PCBs, US EPA Method TO-10 Laboratory SOP# 26, Revision3, 5/25/00 Low/Medium Concentration	Definitive	TO-10	Pesticides/ PCBs	GC/ECD	N
L22	DAS/Triangle Labs	Air – Dioxins, US EPA Method 8290 Laboratory SOP# DSP112, version 7, 3/24/99, DHR182, version 6, 3/25/98 - Low/Medium Concentration	Definitive	TO-09/8290	Dioxins	HRGC/HRMS	N
L23	DAS/ Katahdin Analytical	Wipes – Pesticides/PCBs US EPA OLMO4.2 Statement of Work for Organic Analysis - Low/Medium Concentration	Definitive	OLM4.2PM	Pesticides/ PCBs	GC/ECD	Y(2)
L24	DAS/Triangle Labs	Wipes – Dioxins, US EPA SW-846 Method 8290 Laboratory SOP# DSP105, version 15, 7/31/98, DHR182, version 6, 3/25/98 - Low/Medium Concentration	Definitive	8290	Dioxins	HRGC/HRMS	Y(1)

CLP/TBD = Contract Laboratory Program, laboratory to be determined
DAS = Delivery of Analytical Services
NAPL = Non-Aqueous Phase Liquid
(1) Modified according to Tetra Tech Technical Specification S00-RAC1-150 to include HCX.
(2) Modified according to Tetra Tech Technical Specification S00-Rac1-151.

Table 12-2
Katahdin Laboratory Instrument Maintenance and Calibration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Instrument	Activity	List Maintenance, Testing and Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	Method/SOP Reference[1]
GC	Pesticides/ PCBs	• Failure of DDT and Endrin to meet the breakdown check indicates active sites in the inlet system. If the breakdown check fails, the following may need to be performed: cleaning and deactivating the injection port, deactivating or replacing the injection port liner, clipping or replacing the guard column, and deactivating or replacing the "Y"-splitter. • If the daily check fails, the standard must be checked and re-prepared if needed. If the standard is acceptable, the analytical system must be evaluated. Front end maintenance as described above including septum replacement may be needed. ECDs may require thermal cleaning if a high background signal is indicated. All maintenance on the ECDs beyond thermal cleaning is performed by the manufacturer.	Prior to sample analysis	%RSD ≤ 20	Use linear regression per SW-846 or recalibrate	Analyst	L3, L8, L17, L21, L23
GC/MS	VOC SVOC	Instruments are monitored on a daily basis by the bench analyst for any potential failure. The analysis of blanks and control standards at the start of the day and as analysis continues helps to provide real time feedback to the analyst on the condition of the instruments. Routine maintenance for the (1) mass spec, (2) sample introduction system, and (3) GC are presented below.	Prior to sample analysis	%RSD ≤ 30% for all "Standard" compounds and %RSD ≤ 40% for all "Non-standard" compounds	Correct problem then repeat initial calibration curve	Analyst	L1, L2, L6, L7, L15, L16
ICP	Metals	Clean torch assembly and spray chamber when discolored or when degradation in data quality, clean nebulizer, check argon, replace peristaltic pump tubing.	ICAL – At the beginning of each day or if QC does not meet criteria	90 - 110%	Recalibrate	Analyst/Supervisor	L4, L9, L10, L18
			ICV – Immediately after every ICAL	90 – 110%	Recalibrate or reanalyze affected data	Analyst/Supervisor	L4, L9, L10, L18
			CCV – Every 10 samples or every two hours	90 – 110%	Recalibrate or reanalyze affected data	Analyst//Supervisor	L4, L9, L10, L18

Table 12-2
Katahdin Laboratory Instrument Maintenance and Calibration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Instrument	Activity	List Maintenance, Testing and Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	Method/SOP Reference[1]
CVAA	Mercury	Replace peristaltic pump tubing, replace mercury lamp as necessary, clean optical cell, clean liquid/gas separator as needed. Replace peristaltic pump tubing, replace mercury lamp as necessary, clean optical cell, clean liquid/gas separator as needed.	ICAL – At the beginning of each day or if QC does not meet criteria	90 – 110%	Recalibrate	Analyst/Supervisor	L4, L9, L10, L18
			ICV – Immediately after every ICAL	90 – 110%	Recalibrate or reanalyze affected data	Analyst/Supervisor	L4, L9, L10, L18
			CCV – Every 10 samples or every two hours	90 – 110%	Recalibrate or reanalyze affected data	Analyst/Supervisor	L4, L9, L10, L18

(1) = Refer to Table 12-1 for Method/SOP Reference

1) Mass Spectrometers
- Daily check of vacuum ion gauge (Increase in ion count indicates a potential leak)
- Daily (every 24 hours) autotune check with BFB
- Cleaning of ion source on quarterly basis or as needed
- The oil level and quality is visually checked on a monthly basis to insure proper vacuum pump function, and oil is changed every 6 months.

2) Sample Introduction System
- The mass flow controller used for sample introduction is sent for off-site calibration against a NIST-certifiable source once every two years.
- To ensure a clean sample introduction system, if necessary, the lines and trap are "steam-cleaned" by analyzing a humidified system blank. This takes place every day following standards (i.e., CCV) analysis. Humidified system blanks are also analyzed after saturation-level detections in samples.

3) Gas Chromatograph

Basic maintenance includes the following: (Every 6 months or more frequently if needed)
- Clip 3 feet off the front end of the capillary column, and if necessary, the back end as well.
- Replace the injection port liner. The liner is replaced by removing the inlet cap using a wrench and releasing the liner from the inlet body using a pair of tweezers. Care should be taken not to get finger prints on any inside surface.
- Once per week change septa on the GC and once per day change the septa on the valve syringe interface (injection port). Always use Supelco Thermogreen septa and take care not to leave finger prints on any inside heated surface. Wear a pair of white cotton gloves or use tweezers to handle the septa. Lower the oven temperature to 40° C. Remove the inlet cap with a wrench, remove the old septa with a pair of tweezers and insert the new septa.
- The column is replaced when chromatography peak shape or resolution degrades. Similarly, if the column bleed profile rises with age then the column needs replacing. Use new black graphite ferrules each time and clip off approximately 1" of column after inserting it through the ferrule. This will remove any graphite particles that may have scraped off into t he column. Tighten the column nut and ferrule finger tight and one quarter turn with a wrench. Tightening any more only crushes the ferrule and may damage the column.
- The branch analyst will document any routine or major maintenance in the bound instrument logbook assigned to each instrument. The date of the maintenance, what work was performed and analyst initials are included.

Table 12-3
Triangle Labs Instrument Maintenance and Calibration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Instrument	Activity	List Maintenance, Testing and Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	Method/SOP Reference[1]
HRGC/HRMS	Dioxins	Instruments are monitored on a daily basis by the bench analyst for any potential failure. The analysis of blanks and control standards at the start of the day and as analysis continues helps to provide real time feedback to the analyst on the condition of the instruments. Routine maintenance for the (1) mass spec, (2) sample introduction system, and (3) GC are presented below.	Prior to sample analysis	%RSD ≤ 30% for all "Standard" compounds and %RSD ≤ 40% for all "Non-standard" compounds	Correct problem then repeat initial calibration curve	Analyst	L5, L11, L19, L22, L24

(1) = Refer to Table 12-1 for Method/SOP Reference

1) Mass Spectrometers
- Daily check of vacuum ion gauge (Increase in ion count indicates a potential leak)
- Daily (every 24 hours) autotune check with BFB
- Cleaning of ion source on quarterly basis or as needed
- The oil level and quality is visually checked on a monthly basis to insure proper vacuum pump function, and oil is changed every 6 months.

2) Sample Introduction System
- The mass flow controller used for sample introduction is sent for off-site calibration against a NIST-certifiable source once every two years.
- To ensure a clean sample introduction system, if necessary, the lines and trap are "steam-cleaned" by analyzing a humidified system blank. This takes place every day following standards (i.e., CCV) analysis. Humidified system blanks are also analyzed after saturation-level detections in samples.

3) Gas Chromatograph

Basic maintenance includes the following: (Every 6 months or more frequently if needed)
- Clip 3 feet off the front end of the capillary column, and if necessary, the back end as well.
- Replace the injection port liner. The liner is replaced by removing the inlet cap using a wrench and releasing the liner from the inlet body using a pair of tweezers. Care should be taken not to get finger prints on any inside surface.
- Once per week change septa on the GC and once per day change the septa on the valve syringe interface (injection port). Always use Supelco Thermogreen septa and take care not to leave finger prints on any inside heated surface. Wear a pair of white cotton gloves or use tweezers to handle the septa. Lower the oven temperature to 40° C. Remove the inlet cap with a wrench, remove the old septa with a pair of tweezers and insert the new septa.
- The column is replaced when chromatography peak shape or resolution degrades. Similarly, if the column bleed profile rises with age then the column needs replacing. Use new black graphite ferrules each time and clip off approximately 1" of column after inserting it through the ferrule. This will remove any graphite particles that may have scraped off into t he column. Tighten the column nut and ferrule finger tight and one quarter turn with a wrench. Tightening any more only crushes the ferrule and may damage the column.
- The branch analyst will document any routine or major maintenance in the bound instrument logbook assigned to each instrument. The date of the maintenance, what work was performed and analyst initials are included.

Table 12-4
Air Toxics Laboratory Instrument Maintenance and Calibration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Instrument	Activity	List Maintenance, Testing and Inspection Activities	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	Method/SOP Reference[1]
GC	TO-10 PCB	• Failure of DDT and Endrin to meet the breakdown check indicates active sites in the inlet system. If the breakdown check fails, the following may need to be performed: cleaning and deactivating the injection port, deactivating or replacing the injection port liner, clipping or replacing the guard column, and deactivating or replacing the "Y"-splitter. • If the daily check fails, the standard must be checked and re-prepared if needed. If the standard is acceptable, the analytical system must be evaluated. Front end maintenance as described above including septum replacement may be needed. ECDs may require thermal cleaning if a high background signal is indicated. All maintenance on the ECDs beyond thermal cleaning is performed by the manufacturer.	Prior to sample analysis	%RSD ≤ 20	Use linear regression per SW-846 or recalibrate	Analyst	L21
GC/MS/SIM	TO-15 VOC	Instruments are monitored on a daily basis by the bench analyst for any potential failure. The analysis of blanks and control standards at the start of the day and as analysis continues helps to provide real time feedback to the analyst on the condition of the instruments. Routine maintenance for the (1) mass spec, (2) sample introduction system, and (3) GC are presented below.	Prior to sample analysis	%RSD ≤ 30% for all "Standard" compounds and %RSD ≤ 40% for all "Non-standard" compounds	Correct problem then repeat initial calibration curve	Analyst	L20

(1) = Refer to Table 12-1 for Method/SOP Reference

1) <u>Mass Spectrometers</u>
- Daily check of vacuum ion gauge (Increase in ion count indicates a potential leak)
- Daily (every 24 hours) autotune check with BFB
- Cleaning of ion source on quarterly basis or as needed
- The oil level and quality is visually checked on a monthly basis to insure proper vacuum pump function, and oil is changed every 6 months.

Table 12-4
Air Toxics Laboratory Instrument Maintenance and Calibration
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

2) Sample Introduction System

- The mass flow controller used for sample introduction is sent for off-site calibration against a NIST-certifiable source once every two years.
- To ensure a clean sample introduction system, if necessary, the lines and trap are "steam-cleaned" by analyzing a humidified system blank. This takes place every day following standards (i.e., CCV) analysis. Humidified system blanks are also analyzed after saturation-level detections in samples.

3) Gas Chromatograph

Basic maintenance includes the following: (Every 6 months or more frequently if needed)

- Clip 3 feet off the front end of the capillary column, and if necessary, the back end as well.
- Replace the injection port liner. The liner is replaced by removing the inlet cap using a wrench and releasing the liner from the inlet body using a pair of tweezers. Care should be taken not to get finger prints on any inside surface.
- Once per week change septa on the GC and once per day change the septa on the valve syringe interface (injection port). Always use Supelco Thermogreen septa and take care not to leave finger prints on any inside heated surface. Wear a pair of white cotton gloves or use tweezers to handle the septa. Lower the oven temperature to 40° C. Remove the inlet cap with a wrench, remove the old septa with a pair of tweezers and insert the new septa.
- The column is replaced when chromatography peak shape or resolution degrades. Similarly, if the column bleed profile rises with age then the column needs replacing. Use new black graphite ferrules each time and clip off approximately 1" of column after inserting it through the ferrule. This will remove any graphite particles that may have scraped off into t he column. Tighten the column nut and ferrule finger tight and one quarter turn with a wrench. Tightening any more only crushes the ferrule and may damage the column.
- The branch analyst will document any routine or major maintenance in the bound instrument logbook assigned to each instrument. The date of the maintenance, what work was performed and analyst initials are included.

13.0 QUALITY CONTROL REQUIREMENTS

Two types of QC checks and samples will be utilized for this project. Batch specific QC will include QC samples that are handled, prepared and analyzed concurrently with the environmental samples. This data will be used to ensure that the proper procedures used to collect, transport, and analyze a batch of samples was performed under known, well-defined conditions. Examples of batch specific QC are trip blanks, equipment blanks, laboratory control samples, performance evaluation samples, and calibration checks. Sample specific QC will be used to evaluate potential sources of error in the collection, transport and analysis of individual samples. Examples of sample-specific QC are matrix spikes and sample duplicates.

The type and frequency of laboratory quality control checks are defined by the methods listed in Table 12-1.

13.1 Sampling Quality Control

The following field quality control samples will be collected to monitor the quality of the sampling to be performed at the Centredale Manor Restoration Project Site. Tables 13-1 to 13-24 summarize the field quality control requirements for soil, groundwater, wipes, NAPL, and air.

Rinsate Blank: Rinsate blanks or equipment blanks, are obtained under representative field conditions by running analyte-free deionized water through decontaminated sample collection equipment. Equipment rinsate water is collected in appropriated sample containers and preserved as required by the analysis. Rinsate blanks are used to assess the effectiveness of decontamination procedures. Rinsate blanks are required at a rate of one in ten samples, per matrix, or one per sampling event if less than ten samples are collected.

Trip Blanks: Methanol VOC trip blanks are prepared in the laboratory (or in the field, in an area outside the zone of contamination) prior to the sampling event. Trip blanks are packaged and shipped with the field samples. The results obtained from trip blank analysis are used to assess the purity of the methanol and cross contamination during sample transport and storage. These trip blanks will be prepared with the same methanol used for the field samples. Trip blanks are required at the rate of one in ten samples, or one per shipping container, whichever is greater.

Field Duplicates: Field duplicates will be submitted at the rate of one for every ten field samples, per matrix. For soil sampling, field duplicates will be collected by mixing the soil and then dividing it into two containers (with the exception of VOC duplicates, collected prior to mixing). For groundwater sampling, field duplicates are collected by filling one complete set of sample containers for the original sample, and collecting another aliquot for the second (duplicate) sample.

Field duplicates provide precision information regarding homogeneity and distribution of the contaminants; they measure the bias of sub-sampling.

Performance Evaluation (PE) Samples: PE samples will be sent to the laboratory at a rate of one for every 20 samples per analysis and per matrix, or one per sampling activity if fewer than 20 samples are collected per analysis (except for dioxins). A set of two PE samples per data package are required by EPA Region I for dioxin analysis. PE samples will be analyzed for the same parameters as the field samples. PE samples are used to assess laboratory accuracy.

13.2 Analytical Quality Control

The groundwater and soil analysis to be performed under the CLP will comply with the requirements and quality control procedures specified in the OLM04.2 and ILM04.1 Statements of Work. The laboratory quality control and acceptance limits for the CLP analyses are summarized in Tables 13-1 to 13-24.

The VOC soil, the NAPL, and wipe sample analyses to be performed by Katahdin Analytical laboratory will follow the requirements specified in the TtNUS technical specification S00-RACI-151. The dioxin analysis to be performed by Triangle Labs for soil groundwater, NAPL, air, and wipe samples will follow the requirements specified in the TtNUS technical specification S00-RACI-150. The analytical specification for the VOC air analysis by EPA Method TO-15/SIM has not been finalized, but it will be based on Technical Specification S99-RAC1-099 with the modifications for the SIM analysis required to meet the project action limits. The laboratory quality control and acceptance limits for the DAS analyses are summarized in Table 13-25 to 13-40 (also see Appendix C).

Table 13-1
Soil Volatiles Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S4
Medium/Matrix	Soil
Analytical Parameter	Volatiles
Concentration Level	Medium
Analytical Method(1)	L1
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	126

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Trip Blanks, Equipment Blanks/Rinsate Blanks	28	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	14	< 50% RPD	Qualify data	Data validator	Precision	< 50% RPD
PES sent to Laboratory	8	No false positives, no false negatives, VOCs within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	VOCs within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-2
Soil Semivolatiles Pesticide/PCBs Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S4
Medium/Matrix	Soil
Analytical Parameter	Semivolatiles/Pesticide/ PCBs
Concentration Level	Low/medium
Analytical Method(1)	L2
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	98

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	11	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	11	< 50% RPD	Qualify data	Data validator	Precision	< 50% RPD
PES sent to Laboratory	6	No false positives, no false negatives, SVOCs within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	SVOCs within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-3
Soil Metals Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S4
Medium/Matrix	Soil
Analytical Parameter	Metals
Concentration Level	Low/medium
Analytical Method(1)	L4
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	98

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	11	No target analyte ≥ CRDL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target analyte ≥CRDL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	11	< 50% RPD	Qualify data	Data validator	Precision	< 50% RPD
PES sent to Laboratory	6	No false positives, no false negatives, metals within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	metals within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13- 4
Soil Dioxins Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S4
Medium/Matrix	Soil
Analytical Parameter	Dioxins
Concentration Level	Low/medium
Analytical Method(1)	L5
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	98

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	11	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	11	< 50% RPD	Qualify data	Data validator	Precision	< 50% RPD
PES sent to Laboratory	12	No false positives, no false negatives, dioxins within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Dioxins within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-5
Groundwater Organics Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S6
Medium/Matrix	Groundwater
Analytical Parameter	VOCs/SVOCs/Pesticide/ PCBs
Concentration Level	Low/medium
Analytical Method(1)	L6
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	46

Field QC:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Trip Blanks/Equipment Blanks/Rinsate Blanks	10	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥ CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2° C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	5	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	3	No false positives, no false negatives, VOCs within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	VOCs within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-6
Groundwater Metals Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S6
Medium/Matrix	Groundwater
Analytical Parameter	Metals
Concentration Level	Low/medium
Analytical Method(1)	L9
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	46

Field QC:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	5	No target analyte ≥ CRDL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target analyte ≥ CRDL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2° C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4°C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	5	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	3	No false positives, no false negatives, metals within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Metals within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-7
Groundwater Dioxin Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S6
Medium/Matrix	Groundwater
Analytical Parameter	Dioxins
Concentration Level	Low/medium
Analytical Method(1)	L11
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	46

Field QC:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	5	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥ CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2° C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	5	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	6	No false positives, no false negatives, Dioxins within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Dioxins within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-8
Groundwater Alkalinity Sulfide, TOC Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S6
Medium/Matrix	Groundwater
Analytical Parameter	Alkalinity/Sulfides/TOC
Concentration Level	Low/medium
Analytical Method(1)	L12
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	46

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	N/A	N/A	N/A	N/A	N/A	N/A
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	5	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
Other:	None	NA	NA	NA	NA	NA

(1) Refer to Table 12-1 for Method/SOP References

Table 13-9
NAPL Organics Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S2, S4
Medium/Matrix	NAPL
Analytical Parameter	VOCs/SVOCs/Pesticide/ PCBs
Concentration Level	Low/medium
Analytical Method(1)	L15
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	15

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Trip Blanks, Equipment Blanks/Rinsate Blanks	4	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	2	< 50% RPD	Qualify data	Data validator	Precision	< 50% RPD
PES sent to Laboratory	1	No false positives, no false negatives, within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Target compounds within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References
NAPL = Non-Aqueous Phase Liquid

Table 13-10
NAPL Metals Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S2, S4
Medium/Matrix	NAPL
Analytical Parameter	Metals
Concentration Level	Low/medium
Analytical Method(1)	L18
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	15

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	2	No target analyte ≥ CRDL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target analyte ≥CRDL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	2	< 50% RPD	Qualify data	Data validator	Precision	< 50% RPD
PES sent to Laboratory	1	No false positives, no false negatives, metals within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	metals within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References
NAPL = Non-Aqueous Phase Liquid

Table 13-11
NAPL Dioxins Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S2, S4
Medium/Matrix	NAPL
Analytical Parameter	Dioxins
Concentration Level	Low/medium
Analytical Method(1)	L19
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	15

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Equipment Blanks/Rinsate Blanks	2	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	2	< 50% RPD	Qualify data	Data validator	Precision	< 50% RPD
PES sent to Laboratory	2	No false positives, no false negatives, dioxins within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Dioxins within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References
NAPL = Non-Aqueous Phase Liquid

Table 13-12
Air Volatiles Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S10
Medium/Matrix	Air
Analytical Parameter	Volatiles
Concentration Level	Low/medium
Analytical Method(1)	L20
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	5

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Trip Blanks	1	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	1	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	1	No false positives, no false negatives, VOCs within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	VOCs within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-13
Air PCB Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S10
Medium/Matrix	Air
Analytical Parameter	PCBs
Concentration Level	Low/medium
Analytical Method(1)	L21
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	5

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Blanks	1	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	1	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	1	No false positives, no false negatives, PCBs within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	PCBs within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-14
Air Dioxins Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S10
Medium/Matrix	Air
Analytical Parameter	Dioxins
Concentration Level	Low/medium
Analytical Method(1)	L22
Sampler's Name	Amy Putnam/Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	5

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Blanks	1	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	1	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	2	No false positives, no false negatives, Dioxin within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Dioxins within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-15
Wipe Pesticide/PCB Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S12
Medium/Matrix	Wipe
Analytical Parameter	Pesticides/PCBs
Concentration Level	Low/medium
Analytical Method(1)	L23
Sampler's Name	Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	5

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Blanks	1	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	1	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	1	No false positives, no false negatives, pesticides/PCBs within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Pesticides/PCBs within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-16
Wipe Dioxins Field Sampling QC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP	S12
Medium/Matrix	Wipe
Analytical Parameter	Dioxins
Concentration Level	Low/medium
Analytical Method(1)	L24
Sampler's Name	Amy Putnam/Tracy Dorgan
Field Sampling Organization	Tetra Tech NUS, Inc.
No. of Sample Locations	5

Field QC:	Frequency /Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	Data Quality Indicator (DQI)	Measurement Performance Criteria
Field Blanks	1	No target compound ≥ CRQL	Qualify data. Re-sample	Data validator, field sampler	Accuracy/bias contamination	No target compound ≥CRQL
Cooler Temperature Blanks	1 per cooler	4° C, ± 2°C	Re-sample or qualify the data	Data validator, field sampler	Accuracy/bias/ preservation	4° C, ± 2° C
Field Duplicate Pairs (Duplicate Samples)	1	< 30% RPD	Qualify data	Data validator	Precision	< 30% RPD
PES sent to Laboratory	2	No false positives, no false negatives, dioxin within acceptable range	Qualify data , contact lab to check problem	Data Validator and laboratory QA/QC Officer	Accuracy/bias	Dioxin within limits, no false positives or false negatives
Other:	None					

(1) Refer to Table 12-1 for Method/SOP References

Table 13-17
Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L1
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S4
Analytical Method/SOP: L1
VOCs/5035/OLM04.2

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg/kg)	Analytical Precision	Analytical Accuracy/Bias
Dichlorodifluoromethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Chloromethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromomethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Vinyl Chloride	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Chloroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Methylene Chloride	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Acetone	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Methyl Acetate	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Carbon Disulfide	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Trichlorofluoromethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1-Dichloroethene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,2-Ttrichloro-1,2,2-trifluoroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1-Dichloroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Methyl tert-Butyl Ether	600	As per OLM04.2 criteria	As per OLM04.2 criteria
cis-1,2-Dichloroethene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
trans-1,2-Dichloroethene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Chloroform	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dichloroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
2-Butanone	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,1-Trichloroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromochloromethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Cyclohexane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Carbon Tetrachloride	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromodichloromethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Methylcyclohexane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dichloropropane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
cis-1,3-Dichloropropene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Trichloroethene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Dibromochloromethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,2-Trichloroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Benzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
trans-1,3-Dichloropropene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Isopropylbenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromoform	600	As per OLM04.2 criteria	As per OLM04.2 criteria

Table 13-17
Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L1
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg/kg)	Analytical Precision	Analytical Accuracy/Bias
4-Methyl-2-pentanone	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Isopropylbenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromoform	600	As per OLM04.2 criteria	As per OLM04.2 criteria
4-Methyl-2-pentanone	600	As per OLM04.2 criteria	As per OLM04.2 criteria
2-Hexanone	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Tetrachloroethene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,2,2-Tetrachloroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Ethylene Dibromide	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Toluene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dibromoethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Chlorobenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Ethylbenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Styrene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
Total Xylenes	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,3-Dichlorobenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,4-Dichlorobenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dichlorobenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dibromo-3-chloropropane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2,4-Trichlorobenzene	600	As per OLM04.2 criteria	As per OLM04.2 criteria

Table 13-18
Triangle Lab Method/SOP Precision and Accuracy, Dioxin-L5
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S4
Analytical Method/SOP: L5
Dioxin/8290

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (ng/kg)	Analytical Precision	Analytical Accuracy/Bias
1,2,3,4,6,7,8-HpCDD	2.4/2.55	25%-130%	70%-130%
1,2,3,4,6,7,8-HpCDF	1.2/2.5	25%-130%	70%-130%
1,2,3,4,7,8,9-HpCDF	4.0/2.5	25%-130%	70%-130%
1,2,3,4,7,8-HxCDD	1.0/2.5	40%-130%	70%-130%
1,2,3,4,7,8-HxCDF	1.9/2.5	40%-130%	70%-130%
1,2,3,6,7,8-HxCDD	1.0/2.5	40%-130%	70%-130%
1,2,3,6,7,8-HxCDF	1.4/2.5	40%-130%	70%-130%
1,2,3,7,8,9-HxCDD	2.5/2.5	40%-130%	70%-130%
1,2,3,7,8,9-HxCDF	4.3/2.5	40%-130%	70%-130%
1,2,3,7,8-PeCDD	1.2/2.5	40%-130%	70%-130%
1,2,3,7,8-PeCDF	1.3/2.5	40%-130%	70%-130%
HCX	-/2.5	NA	NA
2,3,4,6,7,8-HxCDF	1.9/2.5	40%-130%	70%-130%
2,3,4,7,8-PeCDF	1.5/1.0	40%-130%	70%-130%
2,3,7,8-TCDD	0.78/1.0	40%-130%	70%-130%
2,3,7,8-TCDF	0.49/1.0	40%-130%	70%-130%
OCDD	0.70/5.0	40%-130%	70%-130%
OCDF	3.8/5.0	25%-130%	70%-130%

Table 13-19
Triangle Laboratory Method/SOP Precision and Accuracy, Dioxin-L11
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S6
Analytical Method/SOP: L11
Dioxin/8290

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (pg/L)	Analytical Precision	Analytical Accuracy/Bias
1,2,3,4,6,7,8-HpCDD	11.3/25	25%-130%	70%-130%
1,2,3,4,6,7,8-HpCDF	12.4/25	25%-130%	70%-130%
1,2,3,4,7,8,9-HpCDF	16.3/25	25%-130%	70%-130%
1,2,3,4,7,8-HxCDD	13.6/25	40%-130%	70%-130%
1,2,3,4,7,8-HxCDF	10.4/25	40%-130%	70%-130%
1,2,3,6,7,8-HxCDD	10.9/25	40%-130%	70%-130%
1,2,3,6,7,8-HxCDF	10.7/25	40%-130%	70%-130%
1,2,3,7,8,9-HxCDD	17.4/25	40%-130%	70%-130%
1,2,3,7,8,9-HxCDF	14.2/25	40%-130%	70%-130%
1,2,3,7,8-PeCDD	10.1/10	40%-130%	70%-130%
1,2,3,7,8-PeCDF	11.7/10	40%-130%	70%-130%
HCX	-/25	NA	NA
2,3,4,6,7,8-HxCDF	14.5/25	40%-130%	70%-130%
2,3,4,7,8-PeCDF	27.9/10	40%-130%	70%-130%
2,3,7,8-TCDD	3.0/10	40%-130%	70%-130%
2,3,7,8-TCDF	3.1/10	40%-130%	70%-130%
OCDD	25.8/50	40%-130%	70%-130%
OCDF	17.9/50	25%-130%	70%-130%

Table 13-20
Katahdin Laboratory Method/SOP Precision and Accuracy, Alkalinity
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S6
Analytical Method/SOP: L12
Alkalinity/310.1

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (mg/L)	Analytical Precision	Analytical Accuracy/Bias
Alkalinity	5.0/5.0	± 20%	80-120%

Table 13-21
Katahdin Laboratory Method/SOP Precision and Accuracy, Sulfide
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S6
Analytical Method/SOP: L13
Sulfide/376.1

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (mg/L)	Analytical Precision	Analytical Accuracy/Bias
Sulfide	1.0/1.0	±20%	80-120%

Table 13-22
Katahdin Laboratory Method/SOP Precision and Accuracy, TOC
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S6
Analytical Method/SOP: L14
TOC/415.1

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (mg/L)	Analytical Precision	Analytical Accuracy/Bias
Total Organic Carbon	0.05/1.0	±20%	80-120%

Table 13-23
Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L15
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP:
Analytical Method/SOP: L15
VOCs/5035/OLM04.2, modified

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg/kg)	Analytical Precision	Analytical Accuracy/Bias
Dichlorodifluoromethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Chloromethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromomethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Vinyl Chloride	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Chloroethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Methylene Chloride	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Acetone	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Methyl Acetate	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Carbon Disulfide	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Trichlorofluoromethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1-Dichloroethene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,2-Ttrichloro-1,2,2-trifluoroethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1-Dichloroethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Methyl tert-Butyl Ether	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
cis-1,2-Dichloroethene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
trans-1,2-Dichloroethene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Chloroform	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dichloroethane	600	As per OLM04.2 criteria	As per OLM04.2 criteria
2-Butanone	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,1-Trichloroethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromochloromethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Cyclohexane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Carbon Tetrachloride	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromodichloromethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Methylcyclohexane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dichloropropane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
cis-1,3-Dichloropropene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Trichloroethene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Dibromochloromethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,2-Trichloroethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Benzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
trans-1,3-Dichloropropene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria

Table 13-23
Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L15
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg/kg)	Analytical Precision	Analytical Accuracy/Bias
Isopropylbenzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Bromoform	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
4-Methyl-2-pentanone	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
2-Hexanone	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Tetrachloroethene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,1,2,2-Tetrachloroethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Ethylene Dibromide	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Toluene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dibromoethane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Chlorobenzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Ethylbenzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Styrene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
Total Xylenes	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,3-Dichlorobenzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,4-Dichlorobenzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dichlorobenzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2-Dibromo-3-chloropropane	1200	As per OLM04.2 criteria	As per OLM04.2 criteria
1,2,4-Trichlorobenzene	1200	As per OLM04.2 criteria	As per OLM04.2 criteria

Table 13-24
Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L16
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP:
Analytical Method/SOP: L16
SVOC/OLM04.2

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg/kg)	Analytical Precision	Analytical Accuracy/Bias
Benzaldehyde	-/330	As per 0LM04.2	As per 0LM04.2
Phenol	34/330	As per 0LM04.2	As per 0LM04.2
Bis-(2-Chloroethyl) ether	24/830	As per 0LM04.2	As per 0LM04.2
2-Chlorophenol	42/330	As per 0LM04.2	As per 0LM04.2
2-Methylphenol	40/330	As per 0LM04.2	As per 0LM04.2
2,2-oxybis(1-Chloropropane)	18/330	As per 0LM04.2	As per 0LM04.2
Acetophenone	-/830	As per 0LM04.2	As per 0LM04.2
4-Methylphenol	40/330	As per 0LM04.2	As per 0LM04.2
N-Nitroso-di-n propylamine	21/830	As per 0LM04.2	As per 0LM04.2
Hexachloroethane	22/830	As per 0LM04.2	As per 0LM04.2
Nitrobenzene	23/330	As per 0LM04.2	As per 0LM04.2
Isophorone	18/330	As per 0LM04.2	As per 0LM04.2
2-Nitrophenol	37/330	As per 0LM04.2	As per 0LM04.2
2,4-Dimethylphenol	31/330	As per 0LM04.2	As per 0LM04.2
Bis(2-Chloroethoxy) methane	19/330	As per 0LM04.2	As per 0LM04.2
2,4-Dichlorophenol	37/830	As per 0LM04.2	As per 0LM04.2
Naphthalene	21/830	As per 0LM04.2	As per 0LM04.2
4-Chloroaniline	17/330	As per 0LM04.2	As per 0LM04.2
Hexachlorobutadiene	29/330	As per 0LM04.2	As per 0LM04.2
Caprolactam	-/330	As per 0LM04.2	As per 0LM04.2
4-Chloro-3-methylphenol	37/330	As per 0LM04.2	As per 0LM04.2
2-Methylnaphthalene	19/830	As per 0LM04.2	As per 0LM04.2
Hexachlorocyclopentadiene	14/330	As per 0LM04.2	As per 0LM04.2
2,4,6-Trichlorophenol	30/330	As per 0LM04.2	As per 0LM04.2
2,4,5-Trichlorophenol	33/330	As per 0LM04.2	As per 0LM04.2
1,1'-Biphenyl	-/330	As per 0LM04.2	As per 0LM04.2
2-Chloronaphthalene	15/330	As per 0LM04.2	As per 0LM04.2
2-Nitroaniline	16/330	As per 0LM04.2	As per 0LM04.2
Dimethylphthalate	15/330	As per 0LM04.2	As per 0LM04.2
2,6-Dinitrotoluene	24/330	As per 0LM04.2	As per 0LM04.2
Acenaphthylene	21/330	As per 0LM04.2	As per 0LM04.2
3-Nitroaniline	63/330	As per 0LM04.2	As per 0LM04.2
Acenaphthene	18/330	As per 0LM04.2	As per 0LM04.2
2,4-Dinitrophenol	230/330	As per 0LM04.2	As per 0LM04.2
4-Nitrophenol	21/330	As per 0LM04.2	As per 0LM04.2
Dibenzofuran	20/330	As per 0LM04.2	As per 0LM04.2

Table 13-24 (cont.)
Katahdin Laboratory Method/SOP Precision and Accuracy, VOCs-L16
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg/kg)	Analytical Precision	Analytical Accuracy/Bias
2,4-Dinitrotoluene	20/330	As per 0LM04.2	As per 0LM04.2
Diethylphthalate	17/330	As per 0LM04.2	As per 0LM04.2
Fluorene	20/330	As per 0LM04.2	As per 0LM04.2
4-Chlorophenyl-phenyl ether	20/330	As per 0LM04.2	As per 0LM04.2
4-Nitroaniline	74/830	As per 0LM04.2	As per 0LM04.2
4,6-Dinitro-2-methylphenol	150/830	As per 0LM04.2	As per 0LM04.2
N-Nitroso diphenylamine	8.3/330	As per 0LM04.2	As per 0LM04.2
4-Bromophenyl-phenylether	23/330	As per 0LM04.2	As per 0LM04.2
Hexachlorobenzene	23/330	As per 0LM04.2	As per 0LM04.2
Atrazine	-/330	As per 0LM04.2	As per 0LM04.2
Pentachlorophenol	120/830	As per 0LM04.2	As per 0LM04.2
Phenanthrene	19/330	As per 0LM04.2	As per 0LM04.2
Anthracene	19/330	As per 0LM04.2	As per 0LM04.2
Carbazole	20/330	As per 0LM04.2	As per 0LM04.2
Di-n-butylphthalate	-26/330	As per 0LM04.2	As per 0LM04.2
Fluoranthene	19/330	As per 0LM04.2	As per 0LM04.2
Pyrene	28/330	As per 0LM04.2	As per 0LM04.2
Butylbenzylphthalate	24/330	As per 0LM04.2	As per 0LM04.2
3,3'-Dichlorobenzidine	62/330	As per 0LM04.2	As per 0LM04.2
Benzo (a) anthracene	17/330	As per 0LM04.2	As per 0LM04.2
Chrysene	18/330	As per 0LM04.2	As per 0LM04.2
bis(2-Ethylhexyl) phthalate	24/330	As per 0LM04.2	As per 0LM04.2
Di-n-octylphthalate	16/330	As per 0LM04.2	As per 0LM04.2
Benzo (b) fluoroanthene	26/330	As per 0LM04.2	As per 0LM04.2
Benzo (k) fluoroanthene	21/330	As per 0LM04.2	As per 0LM04.2
Benzo (a) pyrene	17/330	As per 0LM04.2	As per 0LM04.2
Indeno (1,2,3-cd)-pyrene	18/330	As per 0LM04.2	As per 0LM04.2
Dibenzo (a,h)-anthracene	18/330	As per 0LM04.2	As per 0LM04.2
Benzo (g,h,il) perylene	20/330	As per 0LM04.2	As per 0LM04.2

Table 13-25
Katahdin Laboratory Method/SOP Precision and Accuracy, Pesticides/PCBs
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP:
Analytical Method/SOP: L17
Pesicides/PCBs/OLM04.2

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg/kg)	Analytical Precision	Analytical Accuracy/Bias
alpha-BHC	0.34/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
beta-BHC	0.5/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
delta-BHC	0.38/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
gamma-BHC	0.37/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
Heptachlor	0.66/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
Aldrin	0.56/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
Heptachlor epoxide	0.56/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
Endosulfan I	0.55/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
Dieldrin	0.49/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
4,4'-DDE	0.45/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Endrin	0.56/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Endosulfan II	0.57/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
4,4'-DDD	0.45/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Endosulfan sulfate	0.72/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
4,4'-DDT	0.46/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Methoxychlor	0.58/17	As per OLM04.2 criteria	As per OLM04.2 criteria
Endrin ketone	0.54/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Endrin aldehyde	0.53/3.3	As per OLM04.2 criteria	As per OLM04.2 criteria
alpha-Chlordane	0.57/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
gamma-Chlordane	0.55/1.7	As per OLM04.2 criteria	As per OLM04.2 criteria
Toxaphene	8.78/170	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1016	2.60/33	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1221	5.80/67	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1232	6.10/33	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1242	7.40/33	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1248	3.00/33	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1254	7.10/33	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1260	2.60/33	As per OLM04.2 criteria	As per OLM04.2 criteria

Table 13-26
Katahdin Laboratory Method/SOP Precision and Accuracy, Metals
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP:
Analytical Method/SOP: L18
Metals/ILM04.1

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (mg/kg)	Analytical Precision	Analytical Accuracy/Bias
Aluminum	2.68/40	As per ILM04.1criteria	As per ILM04.1criteria
Antimony	0.21/12	As per ILM04.1criteria	As per ILM04.1criteria
Arsenic	0.14/2	As per ILM04.1criteria	As per ILM04.1criteria
Barium	0.38/40	As per ILM04.1criteria	As per ILM04.1criteria
Beryllium	0.005/1	As per ILM04.1criteria	As per ILM04.1criteria
Cadmium	0.02/1	As per ILM04.1criteria	As per ILM04.1criteria
Calcium	0.29/1000	As per ILM04.1criteria	As per ILM04.1criteria
Chromium	0.07/2	As per ILM04.1criteria	As per ILM04.1criteria
Cobalt	0.06/10	As per ILM04.1criteria	As per ILM04.1criteria
Copper	0.05/5	As per ILM04.1criteria	As per ILM04.1criteria
Iron	2.18/20	As per ILM04.1criteria	As per ILM04.1criteria
Lead	0.10/0.6	As per ILM04.1criteria	As per ILM04.1criteria
Magnesium	0.59/1000	As per ILM04.1criteria	As per ILM04.1criteria
Manganese	0.02/3	As per ILM04.1criteria	As per ILM04.1criteria
Mercury	0.004/0.1	As per ILM04.1criteria	As per ILM04.1criteria
Nickel	0.07/8	As per ILM04.1criteria	As per ILM04.1criteria
Potassium	43.2/1000	As per ILM04.1criteria	As per ILM04.1criteria
Selenium	0.21/1	As per ILM04.1criteria	As per ILM04.1criteria
Silver	0.11/2	As per ILM04.1criteria	As per ILM04.1criteria
Sodium	3.00/1000	As per ILM04.1criteria	As per ILM04.1criteria
Thallium	0.36/2	As per ILM04.1criteria	As per ILM04.1criteria
Vanadium	0.07/10	As per ILM04.1criteria	As per ILM04.1criteria
Zinc	0.12/4	As per ILM04.1criteria	As per ILM04.1criteria

Table 13-27
Triangle Laboratory Method/SOP Precision and Accuracy, Dioxin-L19
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP:
Analytical Method/SOP: L19
Dioxin/8290A

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (ng/kg)	Analytical Precision	Analytical Accuracy/Bias
1,2,3,4,6,7,8-HpCDD	2.4/12.5	25%-130%	70%-130%
1,2,3,4,6,7,8-HpCDF	1.2/12.5	25%-130%	70%-130%
1,2,3,4,7,8,9-HpCDF	4.0/12.5	25%-130%	70%-130%
1,2,3,4,7,8-HxCDD	1.0/12.5	40%-130%	70%-130%
1,2,3,4,7,8-HxCDF	1.9/12.5	40%-130%	70%-130%
1,2,3,6,7,8-HxCDD	1.0/12.5	40%-130%	70%-130%
1,2,3,6,7,8-HxCDF	1.4/12.5	40%-130%	70%-130%
1,2,3,7,8,9-HxCDD	2.5/12.5	40%-130%	70%-130%
1,2,3,7,8,9-HxCDF	4.3/12.5	40%-130%	70%-130%
1,2,3,7,8-PeCDD	1.2/5.0	40%-130%	70%-130%
1,2,3,7,8-PeCDF	1.3/5.0	40%-130%	70%-130%
HCX	-/12.5	NA	NA
2,3,4,6,7,8-HxCDF	1.9/12.5	40%-130%	70%-130%
2,3,4,7,8-PeCDF	1.5/5.0	40%-130%	70%-130%
2,3,7,8-TCDD	0.78/5.0	40%-130%	70%-130%
2,3,7,8-TCDF	0.49/5.0	40%-130%	70%-130%
OCDD	0.70/25.0	40%-130%	70%-130%
OCDF	3.8/25.0	25%-130%	70%-130%

Table 13-28
Katahdin Laboratory Method/SOP Precision and Accuracy, Metals
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S10
Analytical Method/SOP: L20
VOCs/TO-15/SIM

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (mg/kg)	Analytical Precision	Analytical Accuracy/Bias
Vinyl Chloride	0.01	±25	70-130
Chloroethane	0.22	±25	70-130
1,1-Dichloroethene	0.22	±25	70-130
Methylene Chloride	0.22	±25	70-130
1,1-Dichloroethane	0.22	±25	70-130
Cis-1,2-Dichloroethene	0.22	±25	70-130
Chloroform	0.22	±25	70-130
1,1,1-Trichloroethane	0.22	±25	70-130
Carbon Tetrachloride	0.22	±25	70-130
Benzene	0.05	±25	70-130
1,2-Dichloroethane	0.22	±25	70-130
Trichloroethene	0.22	±25	70-130
1,2-Dichloropropane	0.22	±25	70-130
Toluene	0.22	±25	70-130
1,1,2-Trichloroethane	0.22	±25	70-130
Tetrachloroethene	0.22	±25	70-130
Ethylene Dibromide	0.22	±25	70-130
Chlorobenzene	0.22	±25	70-130
Ethylbenzene	0.22	±25	70-130
m-, p-Xylene	0.22	±25	70-130
o-Xylene	0.04	±25	70-130
Styrene	0.22	±25	70-130

Table 13-29
Air Toxics Laboratory Method/SOP Precision and Accuracy, PCBs-L21
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S10
Analytical Method/SOP: L21
PCBs/TO-10

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg)	Analytical Precision	Analytical Accuracy/Bias
Aroclor-1016	0.52	±20	80-115
Aroclor-1242	0.52	±20	80-115
Aroclor-1248	0.52	±20	80-115
Aroclor-1254	0.52	±20	80-115
Aroclor-1260	0.52	±20	80-115

Table 13-30
Triangle Laboratory Method/SOP Precision and Accuracy, Dioxin-L22 & L24
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S10 & S12
Analytical Method/SOP: L22 & L24
Dioxin/8290

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (pg)	Analytical Precision	Analytical Accuracy/Bias
1,2,3,4,6,7,8-HpCDD	250	25%-130%	70%-130%
1,2,3,4,6,7,8-HpCDF	250	25%-130%	70%-130%
1,2,3,4,7,8,9-HpCDF	250	25%-130%	70%-130%
1,2,3,4,7,8-HxCDD	250	40%-130%	70%-130%
1,2,3,4,7,8-HxCDF	250	40%-130%	70%-130%
1,2,3,6,7,8-HxCDD	250	40%-130%	70%-130%
1,2,3,6,7,8-HxCDF	250	40%-130%	70%-130%
1,2,3,7,8,9-HxCDD	250	40%-130%	70%-130%
1,2,3,7,8,9-HxCDF	250	40%-130%	70%-130%
1,2,3,7,8-PeCDD	250	40%-130%	70%-130%
1,2,3,7,8-PeCDF	250	40%-130%	70%-130%
2,3,4,6,7,8-HxCDF	250	40%-130%	70%-130%
2,3,4,7,8-PeCDF	250	40%-130%	70%-130%
2,3,7,8-TCDD	50	40%-130%	70%-130%
2,3,7,8-TCDF	50	40%-130%	70%-130%
OCDD	500	40%-130%	70%-130%
OCDF	500	25%-130%	70%-130%

Table 13-31
Katahdin Laboratory Method/SOP Precision and Accuracy, Pesticides/PCBs-L23
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sampling SOP: S12
Analytical Method/SOP: L23
Pesticides/PCBs/OLM04.2

Analyte	Achievable Laboratory Sensitivity/Quantitation Limits (µg)	Analytical Precision	Analytical Accuracy/Bias
Aroclor-1016	1.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1221	1.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1232	1.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1242	1.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1248	1.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1254	1.3	As per OLM04.2 criteria	As per OLM04.2 criteria
Aroclor-1260	1.3	As per OLM04.2 criteria	As per OLM04.2 criteria

14.0 DATA ACQUISITION REQUIREMENTS

This section of the QAPP identifies the sources of previously collected data and other information that will be used to make project decisions.

There is a substantial body of historical data for the Centredale Manor Restoration Project, all collected within the past 5 years. TtNUS will review and evaluate existing data and documents, including the previous site investigations, Preliminary Assessment Reports, Site Inspection Reports, and other data and documents as directed by EPA. This information will be used to determine if any additional data are needed for RI/FS implementation. Existing information includes:

EPA, January 2000. Centredale Manor Restoration Project Superfund Site - Approval Memorandum to Perform an Engineering Evaluation/Cost Analysis for a Non-Time Critical Removal Action. Historical information and background describing the introduction of contaminants into the Woonasquatucket River system

EPA, Environmental Interpretation Center, March 2000. Remote sensing orthoimage and topographic survey of Allendale and Lymansville Ponds - Topography and recent photoimagry of the site.

IT Corp., March 2000. Final Site Investigation Report, Centredale Manor Restoration Project, N. Providence, Rhode Island - Surface soil, limited subsurface soil and sediment sampling data from the source area and Allendale Pond area.

U.S. Army Corps of Engineers, June 1997. Specifications for the Reconstruction of Allendale Dam, Providence, Rhode Island. Project 96-230 - Description of a potential reconstruction of the Allendale Dam.

U.S. Army Corps of Engineers, July 1997. Drawings for the Reconstruction of Allendale Dam, Providence, Rhode Island - Drawings to accompany the specifications described above.

U.S. Army Corps of Engineers, October 2000, Centredale Manor Restoration Project Superfund Site Former Tailrace Preliminary Investigation, North Providence, Rhode Island - Description of the existing raceway on the east side of the source area at Centredale, and preliminary sketches on how to improve drainage flow from this area.

US Geological Survey and USEPA, September 1999 Distribution of Selected Volatile Organic Compounds Determined with Water to Vapor Diffusion Samplers at the Interface Between Groundwater and Surface Water, Centredale Manor Site, North Providence Rhode Island - Data from a passive soil gas sampling effort focusing on the east bank of the Woonasquatucket River, and south of cap area 1.

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15.0 DOCUMENTATION, RECORDS, AND DATA MANAGEMENT

This section describes how all project information will be managed, organized, and maintained for efficient use by the project personnel. The information management process is outlined, from the point of data generation to ultimate storage.

15.1 Project Documentation and Records

A summary of Centredale Manor Restoration Project site records and documentation to be generated and stored in the TtNUS project files is provided in Table 15-1. Information to be maintained in the laboratory files is outlined in Section 15.3 of this QAPP.

15.2 Field Screening Data Package Deliverables

No field screening will be performed. The only field measurements to be collected are FID breathing zone or headspace readings for health and safety purposes and for use in selecting monitoring well screen intervals. These readings will be recorded on field sampling sheets, boring logs, or in the field logbooks.

15.3 Fixed Laboratory Data Package Deliverables

A turn-around time of 21 days will be requested for all the CLP analyses and 35 days for the DAS analysis. The itemized data package deliverables for the CLP and DAS analyses are presented in Table 15-2. CLP electronic deliverables formatted according to the requirements of Exhibit H of the CLP SOW OLM04.2 (organics) and ILM04.1 (metals) will be provided by the CLP laboratories. Electronic deliverable requirements for DAS analyses are specified in the analytical TtNUS technical specifications provided in Appendix C.

15.4 Data Reporting Formats

Field data will be recorded in the field log books and field forms. All log book and log sheet entries must be made in indelible ink (blank pen is preferred). No erasures or liquid paper/white out are permitted. If an incorrect entry is made, the data will be crossed out with a single strike mark, and initialed and dated. The field personnel will sign and date the log book pages and

field forms. Examples of the forms to be used in the field are presented in Appendix D of this QAPP.

The CLP data reporting forms required in CLP SOWs OLM04.2 and ILM04.1 will be submitted by the CLP laboratories for the soil, surface water, and groundwater sample results.

The DAS data reporting forms required in the CLP statements of work modified for the DAS list of parameters will be provided by the DAS laboratories. The DAS laboratories will provide CLP-type data package deliverables.

15.5 Data Handling and Management

The data handling procedures to be followed by the CLP and DAS laboratories will meet the requirements of the subcontracts.

15.6 Data Tracking and Control

Data Tracking. Data is tracked from its generation to its archiving in the TtNUS project specific files. The TtNUS Project Manager is responsible for tracking the data generated for the project. The Lead Chemist is responsible for tracking the samples collected and shipped to the CLP and DAS laboratories. In addition, the Lead Chemist receives the data packages and oversees the data validation effort.

The sample shipping information for CLP and DAS analysis will be submitted to the EPA Region I RSCC. The RSCC maintains a database to track the CLP and DAS samples, analysis and data validation turn-around times. TtNUS will perform data validation for the CLP and DAS data results.

Data Storage, Archiving, and Retrieval. The data packages received from the CLP and DAS laboratories are tracked in the data validation log book. After the data is validated, the data packages are entered into the TtNUS Docu-log system and archived in secure files.

The field records including field log book, sample logs, chain-of-custody records, and field calibration logs will be submitted by the FOL to be entered into the Docu-log system prior to

archiving in secure project files. The project files are audited for accuracy and completeness. At the completion of the work assignment the records will be transferred to EPA.

Data Security. Data security is the responsibility of the Project Manager. The TtNUS project files are restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The TtNUS Data Manager maintains the electronic data files. Access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

Table 15-1
Project Documentation and Records
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Sample Collection Records	Fixed Laboratory Records	Data Assessment Records	Other
Field Logbooks	Sample Receipt, Custody and Tracking Records	Field Sampling Audit Check List	
Sample Log Sheet-Solid Phase	Standards Traceability Logs	Fixed Laboratory Check List	
Sample Log-Liquid Phase	Equipment Calibration Logs	Audit Report and Quality Notices	
Sample Log Sheet-"Low Flow" Groundwater	Sample Prep Logs	PE Evaluation Scores	
Boring Logs	Sample analysis Logs	Data Validation Report	
Well Construction Logs	Equipment Maintenance and Testing Logs	Telephone Logs	
Well Development Logs	Corrective Action Forms		
Chain-Of Custody Records	Data Results Forms		
Air Bills Records	Reported Results for Standards, QC Checks, and QC Samples		
Sample Tags	Instrument Print-outs for Samples and Standards		
Custody Seals	Data Verification Check List		
Telephone Logs	Sample Disposal Records		
Field Modification Records	Telephone Logs		
Field Instrument Calibration Logs			

Table 15-2
Laboratory Data Package Elements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

DATA PACKAGE ELEMENTS	VOA	SVOA	Pest/ PCB	Metals	Dioxin	TOC	Alkalinity	Sulfide
♦ **INVENTORY SHEET (Org. and Inorg. DC-2 Form)**	X	X	X	X	X	X	X	X
♦ **NARRATIVE (Org. Narrative, Inorg. Cover Page)**	X	X	X	X	X	X	X	X
♦ **EPA SHIPPING/RECEIVING DOCUMENTS AND INTERNAL LABORATORY COC RECORDS:**								
- Airbills	X	X	X	X	X	X	X	X
- Chain-of-Custody Records/Forms (Traffic Report)	X	X	X	X	X	X	X	X
- Sample Tags		X	X	X				
- Sample Log-In Sheet (Org. and Inorg. DC-1 Form)	X	X	X	X	X	X	X	X
- Miscellaneous Shipping/Receiving Records	X	X	X	X	X	X	X	X
- Internal Lab. Sample Transfer Records and Tracking Sheets	X	X	X	X	X	X	X	X
♦ **SAMPLE DATA:**								
- Tabulated Summary Form for Field Sample and PE Sample Results (Org. and Inorg. Form I)	X	X	X	X	X	X	X	X
- Tentatively Identified Compounds Tabulate Summary Form (Org. Form I TIC)	X	X			X			
- Reconstructed Total Ion Chromatogram (RIC) for each sample	X	X			X			
- Raw spectra of target compound and background subtracted spectrum of target compound for each sample	X	X			X			
- Mass spectra of all reported TICs/three best library matches for each sample	X	X			X			
- Chromatograms from both columns for each sample			X					
- GC Integration report or data system printouts and calibration plots for each sample	X	X	X	X	X	X	X	X
- Pesticide/PCB Identification Tabulated Summary Form (Org. Form X)			X					
- For Pest/PCB confirmed by GC/MS, copies of raw spectra and background subtracted spectrum of target compounds			X					
- GPC sample chromatograms		X	X					
- Manual worksheets	X	X	X	X	X	X	X	X
- Sample preparation/extraction/digestion log (Inorg. Form XIII) and logbook pages	X	X	X	X	X	X	X	X
- Sample analysis run log (Inorg. Form XIV) and logbook pages	X	X	X	X	X	X	X	X
- ICP Raw Data				X				
- Furnace AA Raw Data								

Table 15-2 (cont.)
Laboratory Data Package Elements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 3

DATA PACKAGE ELEMENTS	VOA	SVOA	Pest/ PCB	Metals	Dioxin	TOC	Alkalinity	Sulfide
♦ **SAMPLE DATA(continued):**								
- Mercury Raw Data				X				
- Cyanide Raw Data								
- Other Analytical Raw Data	X	X	X	X	X	X	X	X
♦ **STANDARDS DATA:**								
- Method Detection Limit Study Tabulated Summary Form								
- Initial Calibration Tabulated Summary Form (Org. Form VI, Inorg. Form IIA)	X	X	X	X	X	X	X	X
- Continuing Calibration Tabulated Summary Form (Org. Form VII, Inorg. Form IIA)	X	X	X	X	X	X	X	X
- RICs and Quan Reports for all GC/MS standards	X	X			X			
- Pesticides Analyte Resolution tabulated Summary Form (Org. Form VI, Pest-4)			X					
- Pesticides Calibration Verification Tabulated Summary Form (Org. Form VII, Pest-1 and Pest-2)			X					
- Pesticide Analytical Sequence Tabulated Summary Form (Org. Form VIII-Pest)			X					
- GC Chromatograms and data system printouts for all GC standards			X					
- For Pesticides/Aroclors confirmed by GC/MS, copies of spectra for standards data			X					
- GPC Calibration Tabulated Summary Form (Org. Form IX, Pest-2)		X	X					
- Florisil Cartridge Check Tabulated Summary Form (Org. Form IX, Pest-1)		X	X					
- Instrument Detection Limits Tabulated Summary Form (Inorg. Form X)				X				
- ICP Interelement Correction Factors Tabulated Summary Form (Inorg. Form XIA and XIB)				X				
- ICP Linear Ranges Tabulated Summary Form (Inorg. Form XII)				X				
- CRDL Standards for AA and ICP Tabulated Summary Form (Inorg. Form IIB)				X				
- Standards preparation logbook pages	X	X	X	X	X	X	X	X
♦ **QC DATA:**								
- Tuning and Mass Calibration Tabulated Summary Form (Org. Form V)	X	X			X			
- Surrogate Percent Recovery Tabulated Summary Form (Org. Form II)	X	X	X		X			
- MS/MSD Recovery Tabulated Summary Form (Org. Form III)	X	X	X		X			

Table 15-2 (cont.)
Laboratory Data Package Elements
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 3 of 3

DATA PACKAGE ELEMENTS	VOA	SVOA	Pest/ PCB	Metals	Dioxin	TOC	Alkalinity	Sulfide
♦ **QC DATA (continued):**								
- Method Blank Tabulated Summary Form (Org. Form IV and Inorg. Form III)	X	X	X	X	X	X	X	X
- Internal Standard Area and RT Tabulated Summary Form (Org. Form VIII)	X	X			X			
- QC Raw Data – RICs, Chromatograms, Quan Reports, Integration Reports, Mass Spectra, etc.	X	X	X	X	X	X	X	X
- Spike Sample Recovery Tabulated Summary Form (Inorg. Form IV)				X				
- Duplicates Tabulated Summary Form (Inorg. Form VI)				X		X		
- Internal Laboratory Control Sample Tabulated Summary Form (Inorg. Form VII)				X		X		
- Continuing Calibration Tabulated Summary Form (Org. Form VII, Inorg. Form IIA)	X	X	X	X	X	X	X	X
- Standard Addition Results Tabulated Summary Form (Inorg. Form VIII)				X				
- ICP Serial Dilutions Tabulated Summary Form (Inorg. Form IV)				X				
- QC Raw Data – ICP, Furnace, Mercury computer printouts, etc.				X				
- QC sample preparation logbook pages	X	X	X	X	X	X	X	X
♦ **MISCELLANEOUS DATA:**								
- Original preparation and analysis forms or copies of preparation and analysis logbook pages	X	X	X	X	X	X	X	X
- Screening records	X	X	X	X	X	X	X	X
- All instrument output, including strip charts from screening activities	X	X	X	X	X	X	X	X
- Preparation Logs Raw Data	X	X	X	X	X	X	X	X
- Percent Solids Determination Log	X	X	X	X	X	X	X	X
- Other Records (ex. Telephone Communication Log)	X	X	X	X	X	X	X	X

VOA = volatile organic compounds
SVOA = semivolatile organic compounds
PEST = pesticide organic compounds
PCB = polychlorinated biphenyls

HCX = Hexachloroxanthene
TOC = Total Organic Carbon
( ) = Form Number; refer to CLP SOW forms

16.0 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities ensure that the resultant data quality is adequate for its intended use and that appropriate corrective actions are implemented to address non-conformances and deviations from the QAPP.

16.1 Planned Assessments

The assessments planned for this project are identified in Table 16-1 and discussed below.

Field Audit

The TtNUS Project Manager will be responsible for this field investigation. The Project Manager will communicate daily with the Field Operation Leader. In addition, senior geologists, hydrogeologists, and environmental engineers will technically oversee the field tasks. The Project Manager will keep the EPA RPM up to date on the field activities and the progress of the investigation.

Quality assurance audits will be performed by the Quality Assurance Officer (QAO) or QA Representative during field investigations. The audits will include checks on adherence to the QAPP and all applicable SOPs. The QAO will prepare audit checklists or audit guides. The depth and scope of the audit will be determined and incorporated into the checklist or guidelines. As a minimum, the audit will cover the following items:

- Adherence to sample collection QAPP and SOPs
- Chain of custody
- Documentation of field activities consistent with the SOP
- Equipment maintenance and calibration
- Training requirements for site workers

Performance Evaluation Samples

Performance Evaluation (PE) samples will be submitted to the CLP and DAS laboratories to assess their precision and accuracy. The TtNUS Lead Chemist will contact EPA if PE results are unacceptable. EPA may direct the laboratory to take corrective actions, re-analyze a new PE sample, and re-analyze all the associated field samples.

16.2 Assessment Findings and Corrective Action Responses

Assessment findings that require corrective action initiate a sequence of events that include documentation of deficiencies, notification of findings, request for corrective action, implementation of corrective action, and follow-up assessment of the corrective action effectiveness. Table 16-1 describes how QAPP deviations and project deficiencies, which are identified through the planned project assessments, will be handled.

16.3 Additional QAPP Non-conformances

Deviations from the QAPP noted by project personnel outside of the formal assessment process will be documented and resolved using the procedures and personnel that were detailed for planned assessments in Section 16.1.

Table 16-1
Project Assessment
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) responsible for performing assessment, title and organizational affiliation	Person(s) responsible for responding to assessment findings, title and organizational affiliation	Person(s) responsible for identifying and implementing corrective actions (CA), title and organizational affiliation	Person(s) responsible for monitoring effectiveness of CA, title and organizational affiliation
Project Oversight	Continuously	I	TtNUS	TtNUS PM: S. Parker	TtNUS Field Personnel	TtNUS Field Personnel	TtNUS RAC Program Manager: G. Gardner
Field Audit	Once during field activities	I	TtNUS	TtNUS QAO: L. Guzman	TtNUS PM: S. Parker	TtNUS FOL: K. O'Neill/ T. Dorgan	TtNUS QAO: L. Guzman
Performance Evaluation Samples	Periodic	E	TtNUS	EPA QA	Laboratory Manager	TtNUS Data Validator	EPA QA

17.0 QA MANAGEMENT REPORTS

This section presents the activities that will be performed to keep management updated on the project status. Open communication pathways will benefit the project, by allowing all appropriate personnel to be aware of activities and have the ability to provide input in a timely manner. Input from these parties will be used to make necessary corrective actions so project quality objectives are met.

The information to be included in each of the QA Management Reports listed in Table 17-1 is summarized as follows.

Verbal Status Reports

The Lead Chemist, FOL, and project personnel will give verbal status reports to the Project Manager on a daily basis or more frequently if needed. The status reports will include the field activities completed for the day, the personnel who completed each activity, the anticipated activities to be completed during the next day, and any issues or problems identified.

Project Status Reports

Project Status Reports will be submitted by the FOL to the TtNUS Project Manager on a weekly basis. The project status reports will include daily site activities performed, any unexpected site conditions, problem resolutions, and corrective actions or violations of this QAPP that have been discovered or addressed. Any findings that require input from EPA will be communicated promptly to the RPM.

Field Audit Report

Quality assurance audits will be performed by the Quality Assurance Officer (QAO) or QA Representative during field investigations. The audits will include checks on adherence to the QAPP and all applicable SOPs. The QAO will then prepare an audit report summarizing the findings. Nonconformance Quality Notices will be issued to document each observation, deficiency, or concern discovered during the audit. This report is distributed to the RAC

Program Manager, the Project Manager, the FOL, and the Program and Project QA/QC files. Any findings that require immediate corrective action will be communicated immediately to the FOL and to the Project Manager.

Data Validation Reports

Tier I and Tier II data validation reports will be developed for this project. Tier I validation will be conducted for alkalinity, sulfide and TOC results. Tier II validation will be performed for the VOCs, SVOCs, pesticides, PCBs, and metals results. Tier III data validation for dioxin analysis will be performed by EPA/OEME. The data validation reports will be formatted in accordance with the requirements of the Region I, EPA New-England Data Validation Functional Guidelines for Evaluation of Environmental Analysis, December 1996. The data validation reports will be distributed to the TtNUS Project Manager, EPA RPM, TtNUS Lead Chemist, and project file. It is anticipated that dioxin data will be validated by EPA.

Table 17-1
QA Management Reports
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Type of Report	Frequency	Project Delivery Date	Person Responsible for Report Preparation	Report Recipients
Verbal Status Report	Daily during field activities	At the end of every day of field activities or as needed	TtNUS Field personnel TtNUS FOL: T. Dorgan TtNUS Lead Chemist: L. Guzman	TtNUS PM: S. Parker
Project Status Reports	Weekly during field activities	At the end of each week of field activities	TtNUS FOL: T. Dorgan	TtNUS PM: S. Parker EPA RPM: A. Krasko
Field Audit Report	One during field activities	10 days after audit	TtNUS QAO: L. Guzman	TtNUS PM: S. Parker
Data Validation Reports	One per data package	3 weeks after date received	Data Validators	EPA RSCC EPA RPM: A. Krasko TtNUS PM: S. Parker

18.0 VERIFICATION AND VALIDATION REQUIREMENTS

Data verification is a process of evaluating the completeness, correctness, and contractual compliance of a data set against the method standard, SOP, or contract requirements documented in this QAPP. Data validation is an analyte- and sample-specific process that extends the qualification of data beyond data verification to determine the quality of a specific data set.

The internal data verification requirements for this project include the maintenance and periodic review of field documentation (site logbooks, instrument calibration logs, chain-of-custody forms, field summary reports, and field modification records) and laboratory analytical data packages.

The data validation requirements for this project are contained in the Region I, EPA-New England Data Validation Functional Guidelines for Evaluating Environmental Analyses. Tier II level data validation will be performed for the soils, NAPL, air, wipes, and groundwater (except for water quality parameters) data from the Centredale Manor Restoration Project Site. At this level of validation, in addition to completeness verification, the results of QC checks and samples, the analytical procedures, and PE sample results are assessed and the qualifications are applied to the data results. A data package Inventory Sheet is completed and signed. PE sample results are evaluated to assess potential data quality/usability issues. A Tier II validation report is produced for each data package. Tier II provides data of known and documented quality.

A Tier I data validation will be performed for groundwater TOC, alkalinity, and sulfide analysis. During a Tier I level data validation the package is checked for completeness. The PE sample is evaluated, however, no qualifications are applied to the data. A Tier I data report is issued for each data package.

It is anticipated that all dioxin data packages will be validated by EPA using Tier III validation.

19.0 VERIFICATION AND VALIDATION PROCEDURES

This section describes the procedures that will be followed to meet the data verification and validation requirements discussed in Section 18.0.

19.1 Verification

The data verification process for this project includes the maintenance and periodic review of field documentation, including:

- Site Logbook
- Instrument Calibration Log
- Chain of Custody Form
- Field Summary Report
- Field Modification Record

Field audits and laboratory internal data reviews are important elements of the data verification process. Each of these elements is discussed in detail in Table 19-1.

19.2 Validation

TtNUS will validate the CLP and DAS analytical data at a Tier II level in accordance with the Region I, EPA-New England Data Validation Functional Guidelines for Evaluating Environmental Analyses. The DAS laboratory data results for alkalinity, sulfide, and total organic carbon analyses will be validated at a Tier I level in accordance with the Region I, EPA-New England Data Validation Functional Guidelines for Evaluating Environmental Analyses. It is anticipated that dioxin data will be validated by EPA.

Table 19-2 summarizes the required data validations by matrix and analysis. The steps to be followed by TtNUS in the data validation process are as follows:

1. The FOL gives a copy of the chain-of-custody forms to the Lead Chemist. The Lead Chemist forwards a copy to a data entry person.

2. A database specialist creates a Microsoft Access database for the project.

3. The data entry person inputs the information from the chain-of-custody records including the TtNUS sample location, CLP or DAS sample number (traffic report number), date sampled, matrix, and QC type (e.g. PE, blank, duplicate) into the database.

4. The Lead Chemist receives the data package and electronic data deliverables from the CLP and DAS laboratories. The data packages are logged into the Data Validation Tracking Log.

5. The Lead Chemist assigns a data validator for each SDG package and transfers the hard copy data package. The PE sample results are submitted to EPA Region I for evaluation.

6. The Lead Chemist gives the electronic data deliverables (EDD) to the data base specialist.

7. The Database Specialist uploads the EDD into the project database using a TtNUS developed file conversion program. The program identifies some common EDD problems (e.g., missing or incorrect SDG number, parameter naming issues) and provides an interface for their resolution. In some cases, queries are run against the EDD to find and fix minor errors. If the errors are serious, e.g. any error affecting the numerical results, the Data Specialist contacts the laboratory and requests a revised EDD. The upload program checks to see if the incoming data has a corresponding CLP or DAS sample number in the database from the chain-of-custody forms. If not, the incoming data is prevented from uploading. The upload program sequesters laboratory QC sample results in a separate table.

8. The Database Specialist prints a draft data validation table in Microsoft Excel format for distribution to the Data Validator.

9. The Data Validator checks the draft data validation tables against the data results (Form Is) in the data package and against the chain-of-custody records to ensure that the database matches the data package. The data validator notifies the database specialist immediately of any major problems (e.g., missing samples). In some cases, the data specialist may ask the laboratory to revise and resubmit the EDD.

10. The data validator performs the Tier I or Tier II validation, assessing potential data quality/usability issues, data completeness and writes the data validation report. The Data Validator marks up the draft data validation table and submits the complete data report to the Lead Chemist for review.

11. The Lead Chemist reviews the documents and returns them to the data validator for revision.

12. The Data Validator revises the documents and gives the marked-up draft data validation table to the Database Specialist.

13. The Database Specialist (or data entry person) revises the database and prints a final data validation table. The Database Specialist gives the final data validation table to the Data Validator along with the marked-up draft data validation table.

14. The Data Validator compares the final data validation table to the marked-up draft data validation table to make sure that all changes were incorporated into the database. The Data Validator assembles the data validation reports for approval and submits it for copying and distribution.

Table 19-1
Verification Tasks and Procedures
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Verification Task	Description	I – INTERNAL E - EXTERNAL	Responsible for Verification (Name, Organization)
Site Logbook	The site logbook is a hardbound, paginated, controlled-distribution record book. Entries are made for every day that onsite activities take place. Upon completion of the fieldwork, the site logbook becomes part of the project's central file. All logbook, notebook, and log sheet entries are made in indelible ink. No erasures are permitted. If an incorrect entry is made, the data is crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used are signed and dated. The Field Operations Leader signs the site logbook at the end of each day.	I	Field Operations Leader, TtNUS
Instrument Calibration Log	Field team members calibrate or check the calibration of monitoring instruments in accordance with the SOPs. The field team member completes a calibration logsheet, initials it, and dates it. Equipment, which does not calibrate properly, is taken out of service. The FOL collects and submits the calibration logsheets to the project file.	I	Field Team Members, TtNUS
Chain-of-Custody Form	The FOL designates one field team member as shipment coordinator. The shipment coordinator organizes the samples into Sample Delivery Groups by matrix, analysis, and destination and fills out the C-O-C and airbill for each SDG. The samplers sign the C-O-C. The shipping coordinator assigns each SDG to a field team member for packing in coolers. The packer checks each cooler's contents against the C-O-C before sealing it. The original C-O-C is shipped with the samples. The FOL provides a copy of the C-O-C to the Lead Chemist and submits a copy to the project file. The Lead Chemist uses the C-O-C to track the progress of the shipment.	I	Field Team Members, TtNUS
Field Summary Report	The FOL sends Field Summary Reports to the TtNUS Project Manager to document field activities. The Project Manager submits the reports to the project file and sends a copy of each month's reports to the EPA WAM.	I	Field Operations Leader, TtNUS
Field Modification Record	Changes in field operating procedures may be necessary as a result of changed field conditions or unanticipated events. If a substantial change is required, the FOL or designee notifies the TtNUS Project Manager of the need for the change. If necessary, the Project Manager will discuss the change with pertinent individuals, e.g., the EPA Region I WAM, and will provide verbal approval or denial to the FOL or assistant FOL for the proposed change. The FOL will document the change on a Field Modification Record form and forward the form to the TtNUS Project Manager at the earliest convenient time. The Project Manager will sign the form and distribute copies to the TtNUS Program Manager, Quality Assurance Officer, FOL, EPA and the project file. A copy of the completed Field Modification Record form will also be attached to the field copy of the QAPP.	I	Field Operations Leader, TtNUS

Table 19-1 (cont'd)
Verification Tasks and Procedures
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Verification Task	Description	I – INTERNAL E - EXTERNAL	Responsible for Verification (Name, Organization)
Field Audit	The Quality Assurance Officer or designated representative audits fieldwork according to audit checklists or audit guides. The QAO immediately informs the FOL and Project Manager of any findings that require immediate corrective action. The audits verify adherence to the QAPP and all applicable SOPs. The QAO records each finding of nonconformance on a Quality Notice report and submits it to the Project Manager. The QAO prepares an audit report summarizing the findings, which is distributed to the RAC Program Manager, the Project Manager, the FOL, and the Program and Project QA/QC files.	I	Quality Assurance Officer, TtNUS
Laboratory Internal Data Review	There are five categories of review performed in the laboratory: 1. Analytical review performed by the bench chemist. It includes a review of raw data, verification of all method- and project-specific QC requirements, the addition of data qualifier flags when needed, and documentation of any unusual circumstances. 2. Technical review performed by team leader or QA-approved peer. 3. QA review performed by a quality assurance specialist emphasizing overall quality of the data. 4. Data report review by the Reporting Manager, Team Leader, or approved peer to ensure the accuracy of the final report. 5. Electronic deliverable review to ensure the accuracy of the final electronic report.	I	Laboratory Manager or designee, DAS Laboratory
CLP/DAS Laboratory Internal Data Review	All data packages are verified internally by the laboratory according the applicable CLP SOW or TtNUS technical specification S99-RAC1-118. The laboratory completes DC-2 forms documenting the organization and completeness of each data package.	I	Laboratory Manager or designee, CLP/DAS Laboratory

Table 19-2
Data Validation Summary
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island

Medium/ Matrix	Analytical Parameter	Concentration Level	Validation Criteria	Validation Criteria Modified	Data Validation Tier Level Used	Modified Tier Level Used	Data Validator (Name, Title, and Organizational Affiliation)	Responsibility for Data Validations (Name, Title, and Organizational Affiliation)
Soil/NAPL	VOCs	M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses	N	Tier II	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870
Soil/NAPL	SVOCs Pesticides PCBs	L/M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses	N	Tier II	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870
Soil/GW/ NAPL	Metals	L/M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Inorganic Analyses	N	Tier II	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870
Soil/GW Air/Wipe NAPL	Dioxins	L/M		N	Tier III	N	ESAT Subcontractor to EPA	EPA Region I
GW	VOCs SVOCs Pesticides/ PCBs	L/M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses	N	Tier II	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870
GW	Alkalinity Sulfide TOC	L/M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses	N	Tier I	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870

Table 19-2 (cont'd)
Data Validation Summary
Quality Assurance Project Plan
Centredale Manor Restoration Project
North Providence, Rhode Island
Page 2 of 2

Medium/ Matrix	Analytical Parameter	Concentration Level	Validation Criteria	Validation Criteria Modified	Data Validation Tier Level Used	Modified Tier Level Used	Data Validator (Name, Title, and Organizational Affiliation)	Responsibility for Data Validations (Name, Title, and Organizational Affiliation)
Air	VOCs	L/M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses	N	Tier II	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870
Air	PCBs	L/M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses	N	Tier II	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870
Wipe	Metals	L/M	Region I, EPA-NE Data Validation Functional Guidelines for Evaluating Inorganic Analyses	N	Tier II	N	Linda Terzis, Maureen Parker, or Anne Franke, Data Validator, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870	Lucy Guzman, Lead Chemist, TtNUS Voice: (978) 658-7899 Fax: (978) 658-7870

20.0 DATA USABILITY/RECONCILIATION WITH PROJECT QUALITY OBJECTIVES

This section describes how project data will be reconciled with the project quality objectives, how data quality issues will be addressed, and how limitations on the use of the data will be reported and handled.

TtNUS will perform data quality assessment including:

- Review of the DQOs and sampling design, review of the proper validation level.
- Review of the data validation criteria, measurement performance criteria, and method QC/QL requirements.
- Correlation of data results to expected values, comparison to historical data results if available or applicable.
- If the data results meet the quality objectives, the data will be used to perform a human health risk assessment and an ecological risk assessment.

The following data quality indicator will be evaluated:

Completeness

The data validator performs a Completeness Evidence Audit in accordance with the Region I CSF Completeness Evidence Audit Program. During this audit, the validator checks that the laboratory has provided all of the documentation required to support the reported analytical results. If any documentation is missing from the data package, the data validator contacts the laboratory and requests a resubmittal. If the laboratory fails to resubmit a requested document, the data validator notes this on the CSF Inventory Sheet (DC-2) and in the data validation cover letter. The Lead Chemist determines if the missing information makes the data unusable. The Project Manager and data user determine if any missing data is crucial to achieve the data quality objectives.

Precision

The precision goal described in Section 7.0 will be evaluated. Field duplicated sample results, laboratory duplicate results, instrument variation, poor sampling techniques, sample transport

problems, sample matrix problems, sample heterogeneity will be assessed to determine the overall data precision. If the project goals for precision are not met the potential need for re-sampling will be evaluated.

Accuracy

The data validator evaluates the accuracy of the data using the laboratory and field blanks, laboratory control samples, check standards, and the results of the Performance Evaluation (PE) Samples.

The laboratory and field blanks will indicate accuracy and potential contamination bias of the data results. The analytical accuracy and bias will be evaluated based on the analysis of check standards, matrix spike recoveries, surrogate recoveries, laboratory control samples, calibration linearity, calibration verification results, and PE sample results. The PE Score Report provided by EPA is evaluated. If PE results indicate poor laboratory performance, the data validator notes the specific laboratory performance problems and their impact on data quality in the data validation report.

The data assessment will compare overall contamination and accuracy/bias of the groundwater, soil, NAPL, air and wipe sample data from the Centredale Manor site. The impact of any qualitative and /or quantitative data trend will be evaluated. Limitations on the use of the data will be evaluated as well as assessment of the potential need for re-sampling.

Sample Representativeness

The overall and specific sampling group representativeness for the samples will be evaluated. If the data are usable to address and answer the environmental questions and or to support the project decision making requirements due to problems with sampling techniques, sampling preservation, analysis holding times, field duplicate results, the need for additional sampling, scoping meetings will be evaluated.

Sensitivity and Quantitation Limits

The required quantitation limits to meet the project action levels specified in section 6.0 will be evaluated. The sample quantitation limits, the low point instrument calibration standard, matrix interferences, and sample dilutions will be evaluated to assess if the sensitivity goals were met. The specific sensitivity of the data packages results will be evaluated for the groundwater, soil, NAPL, air, and wipe samples in order to clearly differentiate between usable and unusable data for the various data users.

Comparability

Standard methods of sample collection and analysis will produce comparable data. Data from each matrix collected at the site will be compared with historical and expected data results based on the geology and hydrogeology of the site. Limitation of the data use by matrix and or specific sampling locations will be identified.

APPENDIX A

CORRECTIVE ACTIONS FORMS

TETRA TECH NUS INC.

FIELD MODIFICATION RECORD

Site Name: _____ Location: _____

Project Number: _____ Task Assignment: _____

To: _____ Location: _____ Date: _____

Description: _____

_____

_____

_____

Reason for Change: _____

_____

_____

Recommended Action: _____

_____

_____

Field Operations Leader (Signature): _____ Date: _____

Disposition/Action:

_____

_____

_____

Project Manager (Signature): _____ Date: _____

Distribution:

		Others as Required:
Program Manager:	_____	
Project Manager:	_____	_____
Quality Assurance Officer:	_____	_____
Field Operations Leader:	_____	_____
Project File:	_____	_____

Tt NUS Form GC03

TETRA TECH NUS, INC.

RECORD OF FIELD WORK ORIENTATION

Page ___ of ___

SITE: _____ JOB NO.: _____

WORK ASSIGNMENT NO.: _____

TASK OR ACTIVITY: _____ DATE OF ORIENTATION: _____

PERSONNEL ATTENDING MGR.	TRAINERS	FOL	PROJECT
1.	1.	1.	1.
2.	2.		
3.	3.		
4.			
5.			
6.			
7.			

VERIFICATIONS (CHECK AND INITIAL BY ATTENDEES)

	WORK PLAN REVIEWED	SAP/QAPP REVIEWED	SOGs REVIEWED	SITE/EQUIP. SECURITY REVIEWED	EQUIPMENT OPERATION	H&S PLAN REVIEWED	PURCHASING	INITIALS
1.								
2.								
3.								
4.								
5.								
6.								
7.								

RETURN ORIGINAL TO THE QUALITY ASSURANCE OFFICER

Copies to: PROJECT FILE: _____

PROJECT MANAGER: _____

PROGRAM MANAGER: _____

Tt NUS Form 0029

TETRA TECH NUS, INC.

QUALITY ASSURANCE QUALITY NOTICE

PROJECT/PROGRAM:		PROCEDURE/PROGRAM/DOCUMENT REFERENCE:	
RESPONSE ASSIGNED TO:	DUE DATE:	REPORTED BY:	DATE:
QN CATEGORY: __ DEFICIENCY __ OBSERVATION __ CONCERN	ACTIVITY:	QUALITY NOTICE NO.:	

REQUIREMENT:

__ SEE ATTACHMENT

CONDITION OBSERVED:

__ SEE ATTACHMENT

RESPONDER TO COMPLETE REVERSE SIDE

TO BE COMPLETED BY THE RESPONDER

AUDITED PROJECT RESPONSE:

1. ROOT CAUSE ASSESSMENT

2. CORRECTIVE ACTION FOR IMMEDIATE PROBLEM(S)

3. CORRECTIVE ACTION TO PRECLUDE PROBLEM RECURRENCE

4. FIRM SCHEDULE (DATES) FOR CORRECTIVE ACTION COMPLETION

RESPONSE SUBMITTED BY:	DATE:

RESPONSE EVALUATION TO BE COMPLETED BY QUALITY ASSURANCE:

FIRST RESPONSE: ___ SATISFACTORY ___ UNSATISFACTORY	___ QN OPEN ___ QN CLOSED
SECOND RESPONSE: ___ SATISFACTORY ___ UNSATISFACTORY	___ QN OPEN ___ QN CLOSED

REMARKS:

C/A VERIFIED: ___ YES ___ N/A	REVIEWED/APPROVED:	DATE:

APPENDIX B

PROJECT PERSONNEL RESUMES

TRACY H. DORGAN
GEOLOGIST
BOSTON, MASSACHUSETTS

EDUCATION: B.S. Geology, Keene State College, 1991

CERTIFICATIONS/ REGISTRATIONS: None

TRAINING:
OSHA 1910.120 40-Hour HAZWOPER Training; June 1994
OSHA 1910.120 8-Hour Supervisory Training; October 1994
OSHA 1910.146 Confined Space Entry Training; February 1995
OSHA 1910.120 8-Hour Annual Refresher Training; December 1999

EXPERIENCE SUMMARY:

Mr. Dorgan has over eight years experience as a Geologist, Field Operations Leader (FOL), and occasionally Site Safety Officer (SSO) conducting environmental investigations, remediation, and report preparation for both government and private clients. Mr. Dorgan has conducted numerous investigations and remedial activities including but not limited to Remedial Investigations/Feasibility Studies, Pre-Design Investigations and UST/Buried Drum Removal & Investigations, at CERCLA, RCRA, and Brownfields Sites for USEPA Region 1 and at US Naval facilities throughout New England and Texas. He has a wide range of multi-media environmental sampling techniques including air, groundwater, surface water, surface soil, subsurface soil, and sediment. Mr. Dorgan is responsible for assisting with project planning and subcontractor procurement, preparation of Sampling and Analysis Plans, directing field activities, compilation and analysis of data, and report preparation. Supervised and trained personnel in the use of environmental sampling equipment, drilling and sampling methods, geologic logging, and health and safety monitoring. Mr. Dorgan is experienced with drilling and well construction and design and has experience in both unconsolidated sediments and bedrock using numerous methods including Hollow-Stem Auger, Drive & Wash Casing, Vibra-core, Roto/vibra-Sonic, and NX/NQ diamond coring. He has conducted various aquifer tests such as slug tests, short and long-term pump tests, and packer tests. Evaluates geologic/hydrogeologic data generated in the field and prepares reports on findings. Prior to joining Tetra Tech NUS, Inc. Mr. Dorgan served with the U.S. Geological Survey for two years, as a geologist/field technician performing hazardous waste site field investigations and report preparation. Conducted geophysical surveys using Ground-Penetrating Radar and Seismic Refraction methods as well as produced regional aquifer mapping reports for the State of New Hampshire.

PROJECT EXPERIENCE:

Site Geologist/FOL/SSO; Raymark Industries Superfund Site; U.S.EPA/ARC & RAC; Stratford, CT; RI/FS for Multiple Operable Units, EE/CA, and Environmental Media Sampling.
Field direction of multi-phase drilling & test pitting programs for waste distribution and characterization, a study area groundwater investigation, and a geotechnical drilling investigation of Ferry Creek from a barge & platform. Drilling methods used include direct-push,

drive & wash casing, roto/vibra-sonic, and vibra-core. Assisted in organizing and performing multiple rounds of extensive surface water, soil, sediment, and groundwater, sampling to characterize the nature and extent of contamination from a brake-pad manufacturing facility. Site contaminants include PCB's, dioxin, solvents, acids, asbestos, and lead that were distributed throughout the town as fill during the 70 years that Raymark Ind. was in operation. Sampling efforts conducted in varied terrain including coastal wetlands, residential and commercial properties, ponds, rivers, and streams. Conducted numerous groundwater sampling rounds at over 150 wells using U.S. EPA Region I low-stress method. Built and operated a barge-mounted Vibra-core unit to conduct sediment investigation in Selby Pond. Conducted thermal mapping of Ferry Creek and seepage meter sampling to determine groundwater discharge rates into the surface water. Responsible for geologic and hydrogeologic data reduction and interpretation for multiple study area RI/FS and PDI reports.

Site Geologist/FOL/SSO; Eastern Surplus Co. Site; U.S.EPA/RAC; Meddybemps, ME; Non-Time Critical Removal Action and Remedial Investigation.
Supervised subcontractors in segregating, characterizing, and disposing several hundred tons of military surplus hardware, solid and liquid wastes, and metal debris in conjunction with site preparation, clearing and grubbing activities. Coordinated and oversaw site Health & Safety activities including the identification and onsite explosive disposal of unexploded military surplus ordinance and the segregation of unidentified compressed gas cylinders. Conducted and directed field operations for the Remedial Investigation including advancing over 100 direct-push soil borings, product/unidentified materials sampling, coordination with on-site mobile laboratory, monitoring well installation, surface soil and subsurface soil sampling. Direction and coordination of all field activities with U.S. EPA, U.S. Army (EOD), U.S. Army Corps of Engineers, Maine DEP, and other Remediation contractors.

Site Geologist/FOL/SSO; Wells G & H – Olympia Nominee Trust Property Site; U.S.EPA/RAC; Woburn, MA; Pre-Design Investigation.
Responsible for production of the Sampling and Analysis Plan and Technical Specifications. Coordinated all pre-field activities including mobilization/demobilization of personnel and equipment. Supervised and conducted the reconnaissance of the existing monitoring well network, low-stress groundwater sampling, surface and subsurface soil sampling, clearing and surveying operations. Collected hydraulic conductivity data using single well pump tests. Responsible for data compilation, and report preparation.

Site Geologist/FOL/SSO; Beede Waste Oil Site; U.S.EPA/RAC; Plaistow, NH; Field Investigation and Non-Time Critical Removal Action.
Conducted geo-probe soil sampling and micro-well installation program to delineate extent of multiple petroleum plumes. Conducted LNAPL measurement tests and sampling. Supervised the installation of 142 four-inch extraction wells using hollow-stem auger drilling as part of site remedial activities. Used angle drilling to place extraction well screens at target depths and locations beneath large soil/debris stockpiles. Site contaminants include waste oil, solvents, and PCB's.

Site Geologist/SSO; McKin Site; U.S.EPA/RAC; Grey, ME; Pre-Design Investigation.

Conducted a 72 hour pump test for use in the design of a groundwater remediation system to capture chlorinated solvent contamination, which is discharging into the Royal River. Collected surface water samples throughout the duration of the test to gauge impact on discharge concentrations. Conducted site reconnaissance to locate groundwater seeps and springs.

Site Geologist/FOL; Loring Air Force Base; U.S.EPA/ARC; Limestone, ME; Groundwater Sampling.
Coordinated the mobilization/demobilization of personnel and equipment for low-stress groundwater sampling at a 9,000-acre former Strategic Air Command Base. Coordinated sampling operations with Air Force Base Closure Agency personnel around other remedial activities.

Site Geologist/Site Safety Officer; Saco Tannery Waste Pits Site; U.S.EPA/ARC; Saco, ME; Groundwater Sampling Program.
Assisted in organizing and performing multiple quarterly rounds of groundwater, surface water, and sediment sampling to characterize the nature and extent of contamination from two 2-acre chromium lagoons and 53 waste pits containing tannery waste.

Site Geologist/FOL/Site Safety Officer; Roto-Print Machine Corporation Site; U.S.EPA/RAC; Norwich, CT.; Brownfields Targeted Site Assessment.
Supervised and conducted all field activities at this five acre former mill and print shop. Site contaminants included inorganics, solvents, petroleum, and asbestos. Advanced soil borings and installed monitoring wells using a Geoprobe drill rig, excavated numerous test pits to determine the nature and extent of fill debris used to fill site depressions and former mill race way. Excavated and overpacked buried drum. Developed and sampled monitoring wells. Collected surface and subsurface soil samples.

Site Geologist/FOL/Site Safety Officer; Lewiston-Auburn Railroad Company Site; U.S.EPA/RAC; Lewiston, ME.; Brownfields Targeted Site Assessment.
Supervised and conducted all field activities at this 1.28 acre former warehouse and storage property along the banks of the Androscoggin River. Advanced soil borings and installed monitoring wells using a Geoprobe drill rig. Developed and sampled monitoring wells using U.S. EPA Region I Low-Stress Sampling method. Collected Investigation Derived Waste samples and conducted site location survey.

Site Geologist; Watertown Landfill Site; U.S.EPA/RAC; Watertown, MA.; Site Inspection.
Conducted field activities beside and in the Charles River at this uncontrolled former landfill. Conducted seepage meter sampling to determine groundwater discharge rates into the surface water. Collected surface water and sediment samples. Collected groundwater samples from both driven well points and the seepage meters. Collected product samples after identifying a large tar/petroleum flow leading into the river. Calculated groundwater discharge rates into the surface water.

Site Geologist; New Hampshire Plating Company Site; U.S.EPA/ARC; Merrimack, NH; Concrete Characterization/UST Sampling.
Collected numerous concrete foundation samples from a former metal plating facility to determine the volume of contaminated concrete for disposal during the building demolition. Sampled an UST to determine the nature of its contents.

Site Geologist/FOL/SSO; U.S. Navy/CLEAN; Naval Station Newport; Tank Farms 4 & 5; Newport, RI; October 1994 to Present; Underground Storage Tank (UST) Preliminary Closure Assessment, Treatability Study, and Site Investigations.
Supervised the drilling of more than 120 soil borings, and constructing more than 50 monitoring wells at these sites containing 23 - 2.5-million gallon concrete USTs used to store virgin No. 6 fuel oil. Supervised the site characterization through the use of a laser-enhanced cone penetrometer. Directed subcontractors performing geophysical and topographic surveys. Performed extensive soil and groundwater sampling. Performed permitted confined space entries to estimate the product/liquid/sludge volumes in 11 USTs.

Site Geologist/SSO; U.S. Navy/CLEAN; Naval Station Newport; Melville North Landfill; Newport, RI; Site Investigation.
Conducted the Site Investigation of an 8-acre coastal landfill on the shore of Narragansett Bay. Site Contaminants included waste oil, PCB's, paints, solvents, and asbestos. Conducted passive soil-gas survey used to select locations for the drilling of soil borings, and construction of monitoring wells. Directed subcontractors performing drilling, test pit excavation, and topographic surveys. Performed extensive soil, sediment, leachate and groundwater sampling as well as hydraulic conductivity testing and a tidal influence study. Assisted in the data evaluation and report preparation.

Site Geologist; U.S. Navy/CLEAN; Naval Station Newport; Former Derecktor Shipyard Site; Newport, RI; June – August 1996; Site Assessment Screening Evaluation.
Conducted the Site Assessment Screening Evaluation of 41-acre shipyard on the shore of Narragansett Bay. Conducted the drilling operations, soil sampling and construction of monitoring wells. Completed test pit excavation and sampling. Conducted underground and building drainage system reconnaissance and sampling. Investigated and cleaned all mechanical Pits and trenches, catch basins and sumps. Contaminants included waste oil, paints, solvents, spent sand-blast grit, mercury, and asbestos. Assisted in the data evaluation and report preparation.

Site Geologist; U.S. Navy/CLEAN; Naval Air Station Brunswick, Site 11-Fire Fighting Training Pit; Brunswick, ME; November 1995; Emergency Drum Removal and UST Closure.
Directed subcontractors in the excavation, consolidation, and disposal of 65 drums of hazardous waste and visually contaminated soils removed from 14 test pits in this 4-acre site. Other duties included assisting in the closure and removal of a 6,000-gallon hazardous substance UST. Work was performed in Level B respiratory protection.

Site Geologist/FOL; U.S. Navy/CLEAN; Squantum Gardens Naval Housing Facility; Quincy, MA; Immediate Response Action and UST Closure.
Conducted mobilization activities including writing technical specifications and procuring subcontractors. Performed field activities including removal of two leaking petroleum USTs, decontamination and closure of a heating plant containing asbestos, mercury, and No. 6 Oil, excavation, and disposal of 300 cubic yards of petroleum-contaminated soils. Conducted the subsequent site investigation field activities that consisted of a wetland delineation, surface water & sediment sampling, drilling effort to collect soil samples and construct monitoring wells. Performed test pit excavation, soil and groundwater sampling, and characterized the affected aquifer.

Site Geologist; U.S. Navy/CLEAN(Southdiv); Naval Air Station Dallas; Dallas, Texas; RCRA Facility Investigation.
As part of a large team conducting a RCRA Facility Investigation at this 850 acre Naval Air Station containing approximately 150 Solid Waste Management Units Mr. Dorgan conducted drilling operations using hollow-stem auger and direct-push (Geoprobe) methods. Responsible for conducting drilling operations on and surrounding an active military flightline, soil sampling, monitoring well construction and geologic interpretation. Work conducted in concurrence with Texas Natural Resources Conservation Commission and U.S.EPA Region VI Guidance.

Site Geologist/FOL/SSO; U.S. Navy/CLEAN; Naval Station Newport; Old Fire Fighting Training Area; Newport, RI; Source Removal Evaluation and Remedial Investigation.
Conducted subsurface investigation for defunct underground oil and fuel storage tanks, piping, drains, and oil/water separators. Completed test pit excavation and soil sampling for NAPL delineation. Conducted aerial photo interpretation to guide test pit locations. Conducted background surface and subsurface soil sampling using direct-push (Geoprobe) method. Responsible for background soil data evaluation, interpretation, and report preparation.

Site Geologist/FOL/SSO; U.S. Navy/CLEAN; Naval Submarine Base New London; Groton, CT; DRMO Site Investigation.
Conducted monitoring well network repair and replacement. Collected groundwater samples using U.S. EPA Region I Low-Stress Sampling method. Supervised site survey and IDW Characterization and Disposal.

Site Geologist; U.S. Navy/CLEAN; Portsmouth Naval Shipyard; Kittery, ME/ Portsmouth, NH; Basewide Groundwater Investigation.
Installation of dedicated bladder-type pumps and tubing at 67 monitoring wells across the base. Collected groundwater samples using U.S. EPA Region I Low-Stress Sampling method in coordination with tide cycles. Conducted multiple synoptic water level measurement rounds.

Site Geologist/Site Safety Officer; U.S. Navy/CLEAN; Naval Construction Battalion Center; Davisville, RI; UST Investigation.
Supervised drilling subcontractors during the installation of 58 soil borings, 26 of which were completed as monitoring wells, as part of the UST RI for 30 former heating oil UST locations. Other duties included health and safety monitoring, and reporting.

Site Geologist/FOL; U.S. Navy/CLEAN; Naval Construction Battalion Center and Camp Fogarty; Davisville and North Kingstown, RI; November 1995 - January 1996; Investigation Derived Waste Removal.
Responsible for the collection, consolidation, and disposal of more than 360 drums of solid and liquid investigation-derived waste at numerous remote sites on the two bases. Supervised the cleaning of a 7,500 gallon tanker trailer used for decontamination fluids storage.

Site Geologist/FOL; Steel Mill Waste Storage Area; Lemont, IL; Private Sector Client; Groundwater Investigation.
Organized and performed two low flow groundwater sampling rounds, to determine the extent of metals contamination surrounding a permanent repository for electric-arc furnace emission control dust. Performed data reduction and report preparation.

Site Geologist/Field Technician; Gilson Road Superfund Site; U.S. Geological Survey; Nashua, NH; Geophysical Investigation.
Performed ground penetrating radar and seismic refraction surveys over a ten-mile area to determine thickness and type of glacial sediments as well as the depth and relief of bedrock surrounding the site. Conducted data analysis, and prepared an open-file report for the USGS and State of New Hampshire.

Site Geologist/Field Technician; Savage Municipal Water Supply Well & Key's Municipal Water Supply Well Superfund Sites; U.S. Geological Survey; Milford, NH; Geophysical Investigation.
Performed ground penetrating radar surveys using experimental antennas throughout the study area to determine thickness and type of glacial sediments as well as the depth and relief of bedrock surrounding the site. Conducted hydraulic conductivity slug-tests in monitoring wells and piezometers at both sites. Conducted grain size sieve analysis of soil and sediment samples from both sites for use in determining transmissivity rates for groundwater flow models.

Site Geologist/Field Technician; Flints Pond; U.S. Geological Survey; Hollis, NH; Geohydrolgic Investigation of the Flints Pond Aquifer.

Conducted field investigations and data analysis to study the accelerated eutrophication of the Flints Pond Aquifer for the State of New Hampshire. Conducted ground-penetrating radar surveys of the water body and surroundings. Advanced soil borings and constructed a monitoring well network to monitor groundwater fluctuations. Assisted in the production of an Open-File Report summarizing the findings of the investigation for the USGS Water Resources Division.

CHRONOLOGICAL WORK HISTORY:

Geologist & Field Operations Leader; Tetra Tech NUS, Inc.; Boston, MA; June 1994 to Present.

Geologist/Field Technician; U.S. Geological Survey; Concord, NH; December 1992 to June 1994. Conducted geologic, geophysical and hydrogeological field investigations throughout southern New Hampshire for the State of New Hampshire Dept. of Environmental Services and the U.S. EPA. Compiled data and created maps of the water table, saturated thickness, and transmissivity for stratified drift aquifers throughout the state. Wrote and published two Open File Reports on studies completed for State and Federal agencies.

PROFESSIONAL AFFILIATIONS:

New Hampshire Geological Association – 1994 To Present

Association of Engineering Geologists – New England Section – 1995 To Present

PUBLICATIONS:

Ayotte, Joseph D. and Dorgan, Tracy H.; **RESULTS OF GEOPHYSICAL SURVEYS OF GLACIAL DEPOSITS NEAR A FORMER WASTE-DISPOSAL SITE, NASHUA, NEW HAMPSHIRE;**; U.S. Geological Survey Open-File report 95-142; 1995

Ayotte, Joseph D. and Dorgan, Tracy H.; **GEOHYDROLOGY OF THE FLINTS POND AQUIFER, HOLLIS, NEW HAMPSHIRE**; U.S. Geological Survey Open-File report 95-363; 1995

LUCY GUZMAN
SENIOR CHEMIST/QUALITY ASSURANCE OFFICER
TETRA TECH NUS, INC.
WILMINGTON, MASSACHUSETTS

PROPOSED ROLE: Lead Chemist and Quality Assurance Officer

EDUCATION:
M.S. Food Science and Resource Chemistry, University of Rhode Island, 1979
M.S. (equivalent, six-year program) Chemistry and Pharmacy, University of Chile, 1970
Inductively Coupled Plasma-Mass Spectrometry Auditors Training, EPA, 1992
Quality Improvement Process, Halliburton NUS, 1990
29 CFR 1910.120 OSHA 8-Hour Annual Refresher Training, 1990 - 1998
29 CFR 1910.120 OSHA 8-Hour Supervisor Training, 1990
29 CFR 1910.120 OSHA 40-Hour Health and Safety Training, 1989
Quality Assurance Training, Halliburton NUS, 1989
Air Toxics Training, EPA, 1989
Quality Improvement Training, American Management Association, 1986
High Resolution Capillary Column GC, Fisheries Research Board of Canada, 1975

EXPERIENCE:
Tetra Tech NUS (includes predecessors), 1989 - present
Roy F. Weston, 1989
ENSECO/Erco Laboratory, 1981 - 1988
University of Rhode Island, 1977 - 1979
Fisheries Development Institute of Chile, 1971 - 1977

Ms. Guzman is an analytical chemist with more than 20 years of experience in environmental analysis, quality assurance/quality control, data validation/interpretation, and data management. For the past 9 years, she has served in a dual role as lead chemist and quality assurance officer for the Tetra Tech NUS office in Wilmington, MA. She has extensive experience developing Quality Assurance Project Plans (QAPPs) and scoping sampling and chemical analysis needs to develop Sampling and Analysis Plans.

Lead Chemist: Responsible for developing Data Quality Objectives (DQOs) for field sampling activities in support of remedial investigations, remedial actions, remedial investigation oversight, and technical assistance projects; developing sampling and analysis plans; and developing method specifications for requests of analytical services of air, fish, waste, water, and solid samples for organic and inorganic analyses. Ms. Guzman is responsible for oversight of field screening of volatile compounds, PCBs, and metals using gas chromatography, x-ray fluorescence, and immunoassay techniques. She coordinates sample scheduling and analysis, and participates in data evaluation and interpretation in support of remedial investigations and remedial action studies.

Quality Assurance Officer: Ms. Guzman reviews and prepares Quality Assurance Project Plans for site activities and performs field audits to determine Sampling and Analysis Plan compliance to Quality Assurance/Sampling Plans. She performs laboratory audits and select laboratories. She also performs quality assurance training for Tetra Tech NUS personnel.

Project Manager: Ms. Guzman is responsible for technical issues, costs, and scheduling laboratory subcontracting activities.

Senior Data Validator: Responsible for the data validation of hundreds of organic and inorganic data packages. Manages the data validation task, and is responsible for scheduling, reviewing the data validation reports, and controlling data validation budgets.

Organic Laboratory Director: Previously responsible for overall technical direction and management of volatile organic, gas chromatography/mass spectroscopy, and hydrocarbon laboratories with more than 50 technical personnel.

PROJECT EXPERIENCE:

Lead Chemist/QA Officer; numerous Superfund sites for U. S. EPA Region I - Participates as lead chemist, senior data validator, and quality assurance officer for numerous projects. Provides technical assistance on Sampling and Analysis Plans and advises on data usability and interpretation. Reviews project activities to ensure that the standards of performance comply with the QAPP.

Senior Organic Data Validator; Superfund and Resource Conservation and Recovery Act (RCRA) sites for U.S. EPA Region I - Performed organic data validation for dioxins, Special Analytical Services (SAS) and Routine Analytical Services (RAS) protocols for Superfund and RCRA projects.

Laboratory Program Manager; EPA Contract Laboratory Program - Responsible for the analysis of hazardous substances at potential hazardous waste sites, according to CLP protocols and requirements.

Expert Witness; New York Department of Environmental Conservation - Provided expert testimony on the hazardous waste testing of waste samples at White Plains, New York.

MICHAEL S. HEALEY
SENIOR HYDROGEOLOGIST
WILMINGTON, MASSACHUSETTS

EDUCATION: B.A., Earth Sciences, Bridgewater State College, 1979
M.A., Geology, Boston University, 1986

29 CFR 1910.120 OSHA 8-Hour Refresher Training, 1995
29 CFR 1910.120 OSHA 8-Hour Supervisory Training, 1992
29 CFR 1910.120 OSHA 40 Hour Health and Safety Training, 1990

Mr. Healey has 16 years of technical experience in the fields of hydrogeology and engineering geology for federal, municipal, and industrial projects. He currently serves as Senior Hydrogeologist/Project Manager responsible for designing and implementing remedial investigations of hazardous waste sites. Prior to joining Brown & Root Environmental, he worked for 4 years as senior hydrogeologist/Project Manager at two boston consulting firms. During that time period he was responsible for providing hydrogeologic services for private, municipal, and industrial clients regarding consisting of waste and water supply issues. Previously, Mr. Healey worked as a field geologist for an geotechnical consulting firm, supervising site investigations for deep foundations, tunnels, hazardous waste, and water supply. During this time he also provided construction oversight of many civil engineering projects that included deep excavations, tunnels, and embankment dams.

Mr. Healey has been responsible for completing site investigations for industrial and hazardous waste projects. These projects have included: a water supply for 300-megawatt power plant; a water supply for small subdivisions; subsurface disposal of treated waste water with flows from 15,000 to 120,000 gallons per day; contaminant transport of organics and inorganics in complex geologic and hydrogeologic conditions including a tidally influenced river valley with and 1,200 gallon per minute water supply well; design and implementation of aquifer tests to determine capture zones for municipal water supply wells, groundwater extractions wells, and potential for induced infiltration from adjacent surface water bodies. He has performed these tasks in both porous and fractured media.

PROJECT EXPERIENCE:

Project Manager; Industri-Plex Site, Woburn, MA; Groundwater Contamination Assessment.
Managed project to evaluate groundwater contaminant sources located upgradient of the Industri-Plex Site.

Senior Hydrogeologist; Loring Air Force Base, Limestone, ME; Remedial Investigations and Feasibility Studies (RI/FS) and Remedial Design Oversight and Technical Support.
Provided technical review of reports submitted by the Air Force for the 13 Operable units at the Base. The sites included industrial areas where chlorinated solvents were used, stored, and spilled; investigations and remediation of three landfills; and remediation of low-level radioactive wastes. The contaminants include both dissolved and immiscible contaminants in the overburden and fractured bedrock.

Senior Hydrogeologist; Raymark Industries, Stratford CT; RI/FS.
Provided technical support for the project team to investigate off-site areas which may have been impacted by that disposal and/or migration of contaminants from the Raymark facility, including organic and inorganic contaminants. The organic contaminants included non-aqueous phase liquids in both the overburden and bedrock aquifers.

Senior Hydrogeologist; Saco Tannery Waste Pits Site; Saco, Maine; Groundwater Contamination Assessment.
Provided technical support to the project team to design and implement the remedial action. This included designing and installing a monitoring well network to evaluate the potential for contaminant transport via facilitated transport. Other duties included coordinating geotechnical information generated from the monitoring well borings and collecting undisturbed tube sample for geotechnical laboratory analysis.

Senior Hydrogeologist; Kearsarge Metallurgical Corporation, Conway NH; Groundwater Contamination Assessment.
Provided technical support to plan and execute the pre-design investigation to capture dissolved organic and inorganic contaminants. This required the field design and execution of three short-term aquifer tests. These tests provide the data needed to evaluate the number, location, design, and pumping rate of the groundwater extractions wells.

Senior Hydrogeologist; Solvents Recovery Service, Southington, CT; Groundwater Contamination Assessment.
Provided technical support for the planning, budgeting, and execution of the site investigation of the nature and extent of contaminants in the overburden and bedrock aquifers. Site contaminants included inorganics, LNAPLS, and DNAPLS.

Project Manager/Senior Hydrogeologist; NEA Cogeneration Plant Bellingham, MA; Permitting.
Managed project to permit a 300-megawatt cogeneration plant, focusing on environmental issues for water supply and hazardous waste. Duties included project management, both technical and financial, and expert testimony before the Massachusetts Energy Sitting Council.

Project Manager/Senior Hydrogeologist; Shaws Plaza, Sharon, MA; Groundwater Contamination Assessment.
Managed both the technical and financial aspects of a site investigation to determine the impacts of chlorinated solvents in the groundwater within 1,000 feet of a municipal water supply well.

STEPHEN S. PARKER
PROJECT MANAGER
WILMINGTON, MASSACHUSETTS

EDUCATION: M.S. Environmental Studies, 1987, Southern Illinois University at Edwardsville
B.A. Biology, 1984, Franklin Pierce College

CERTIFICATIONS/ REGISTRATION: Massachusetts Certified Asbestos Inspector, Since 1987

TRAINING:
OSHA 1910.120 40-Hour HAZWOPER Training; October 27, 1989
OSHA 1910.120 8-Hour Supervisory Training; November 26, 1990
OSHA 1910.146 Confined Space Entry Training; February 6, 1995
OSHA 1910.120 8-Hour Refresher Training; December 29, 1999
Asbestos Inspector Refresher Training; December 17, 1999

Mr. Parker has more than fourteen years of experience in various environmental contract, research, and consulting capacities, and currently supervises the Life Sciences Group in the TtNUS Wilmington Office. He is a manager for various projects including on-shore and off-shore remedial investigations, feasibility studies and ecological risk assessments, UST removal and corrective actions, and other investigation and remedial action-related projects. He directs internal staff and subcontractors, and develops work plans, implementation plans, and subcontract specifications. He is responsible for all aspects of project work, including technical content of deliverable documents, budget maintenance and reporting, directing work efforts, and schedule compliance. Performs extensive client interaction on both managerial and technical levels.

In addition, Mr. Parker provides technical assistance and subcontractor oversight for asbestos projects, lead paint survey and industrial hygiene projects; risk assessments; risk analyses; wetlands delineation and mitigation studies; and fishery, industrial hygiene, and emergency response projects.

PROJECT EXPERIENCE:

Project Manager; Naval Education and Training Center, Gould Island Torpedo Overhaul Shop Newport, RI; Study Area Screening Evaluation, July 1999 to Present
Managed investigations at former manufacturing facility to identify contaminats present in concrete, sludge, soil, and soil gas. Closely coordinated field activities with on-site demolition contractor to assure no schedule impacts and to assure safety of all employees on site. Prepared work plans, developed and conducted investigation interpreted data, provided presentations to the public, and prepared and published report on findings.

Project Manager; Centredale Manor Site North Providence, RI; Technical Assistance for Sediment Investigations, July 1999 to Present
Managed progress and financial concerns for technical assistance work assignment for EPA Region 1 under the RAC program. Designed and implemented sediment sampling program for three mile stretch of river, including residential waterfront properties, ponds and other areas. Directed sampling crews, controled costs and schedule, prepared reports, assisted client contacts with direction of project implementation and development.

Project Manager; Naval Education and Training Center; Derecktor Shipyard; Newport, RI; Marine Investigations, Risk Assessments and Feasibility Studies, January 1997 to Present
Managed progress and financial concerns of multiple subcontractors including engineering firms, analytical laboratories, off-shore survey crews, commercial divers and others who performed the field and analytical work for the study. Coordinated preparation of Ecological and Human Health Risk Assessment reports,

responses to comments and report revisions. Prepared feasibility study evaluating remedial options for contaminated sediment. Provided public meeting presentations for all phases of these studies.

Project Manager; Naval Education and Training Center; Old Fire Training Area; Newport, RI; Off-Shore Remedial Investigation and Ecological Risk Assessment, February 1998 to Present.
Managed progress and financial concerns of subcontractors, including the University of Rhode Island Graduate School of Oceanography and others who performed the field and analytical work for the off-shore study.

Project Manager; Naval Education and Training Center; McAllister Point Landfill; Newport, RI; Off-Shore Investigations and Ecological Risk Assessment, March 1996 to Present
Managed progress and financial concerns of subcontractors, including the University of Rhode Island Graduate School of Oceanography and others who performed the field and analytical work for the off-shore study. Followed up original study with two phases of off-shore drilling operations, hot spot investigations, technical memoranda, report preparation and support to the FS for this site.

Project Manager; Naval Education and Training Center; Derecktor Shipyard; Newport, RI; On- Shore Study Area Screening Evaluation November 1995 to December 1998.
Managed in-house site assessment project in accordance with work plans and regualtory oversight at a former shipyard site in Rhode Island, Coordinated and directed multiple sampling crews, on-site analytical efforts, and multiple subcontractors including analytical services, drilling, well installation, test pit excavations, gerneral environmental cleanup. Directed report preparation, technical presentations, responses to regulatory comments, and document revisions.

Project Manager; Naval Education and Training Center, Newport, RI; Work Plans for On-Shore and Off- Shore Investigations May 1995 to December 1996.
Prepared work plans for extended program of field investigations for multiple sites. Coordinated internal preparation of work plans for on-shore field investigations of a former shipyard. Coordinated subcontractors, researched information, and prepared work plans for on-shore and off-shore remedial investigations and ecological risk assessments at multiple hazardous waste sites.

Field Operations Leader; Stratford Sites; Stratford, CT; Emergency Response Actions, October 1993 to June 1994.
Coordinated mobilization/demobilization of field equipment, personnel, and subcontractors performing sampling and generating on-site reports. Controlled sampled collection efforts and data production from three subcontracted laboratories, one subcontracted labor group, and two field sampling crews. Created and directed data transfer systems between laboratories, sampling crews, and report production staff.

Project Manager; Naval Construction Battalion Center; Davisville, RI; UST Corrective Actions and Pre-Design Investigations, April 1994 to December 1998
Secured subcontractors, and managed in-house staff and subcontract work for multiple concurrent tasks, including report preparation, field investigations, and design of remedial actions.

Project Manager; Naval Construction Battalion Center; Davisville, RI; UST Site Investigations and Corrective Action Plans, November 1996 to December 1998
Performed site investigations at multiple former UST sites, activities included securing subcontractors, managed in-house staff for field investigations and subcontract work for multiple concurrent tasks including drilling, test pit excavation, corrective action excavations, and laboratory analysis. Prepared reports of investigations with recommendations for corrective actions.

Field Operations Leader; Solvents Recovery Services of New England, Inc.; Southington, CT; RI/FS; Environmental Sampling April 1990 to December 1992.
Coordinated mobilization of field equipment, personnel, and subcontractors; controlled sample collection efforts; and monitored data production for three phases of field sampling between 1990 and 1993 with

durations between 4 and 20 weeks. Controlled data documentation and reports to project manager and technical lead personnel.

CHRONOLOGICAL WORK HISTORY:

Project Manager; Tetra Tech NUS, Inc.; Wilmington MA; September 1989 to Present

Senior Scientist, Gulf of Maine Research Center, Inc. Salem, Massachusetts
October, 1987 to September, 1989
Managed all 21E site assessment projects. Scoped and supervised tank and soil cleanup projects. Developed and executed indoor air monitoring programs in residential, office and industrial buildings. Performed business development for all aspects of company activities.

Industrial Hygienist: Hygeia, Inc. Waltham,Massachusetts May,1986 to September, 1987
Supervised and executed asbestos-related projects, including inspections/surveys, removal estimating, management planning, preparation of specifications for asbestos removal and I.H. monitoring of removal operations. Completed air quality emissions permits for leather finishing manufacturers for compliance with CAA permit requirements. Supported clients in SARA Title III reports, permit compliance, and control strategies. Designed and performed air sampling programs for formaldehyde, asbestos, and particulates in homes. Provided consultation services to homeowners for mitigation actions for various contaminant sources. Supported in-house safety personnel for lighting manufacturing plant in Lynn, Massachusetts, by developing and performing an air sampling program for mercury and sulfur dioxide.

Biologist, Union Electric Co. St. Louis, Missouri May,1985..May, 1986
Assisted environmental services staff with fisheries projects, PCB investigations, corbicula and zebra mussel investigations, radiological sampling, and other department objectives. Performed regular upkeep of inventory of sampling equipment including electrofishing boats and related equipment.