Part 2

Quality Assurance Project Plan

Part 2: Quality Assurance Project Plan

Supplemental Site Investigation (SOC 4) and Remedial Investigation (SOC 5)
UMore Mining Area
Dakota County, Minnesota

Prepared for
University of Minnesota

August 21, 2009

BARR

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Quality Assurance Project Plan
Supplemental Site Inspection (SOC 4) and Remedial Investigation (SOC 5)
UMore Mining Area
Dakota County, Minnesota

August 10, 2009

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Jim Aiken, Barr Engineering Co. Project Manager	Date
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Jim Eidem, Barr Engineering Co. Field Team Leader, Site Safety Officer	Date
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Marta Nelson, Barr Engineering Co. Quality Assurance Officer	Date
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Gary Krueger, Minnesota Pollution Control Agency Project Manager	Date
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Laboratory Project Manager — Date: 8/12/09

Erica Nastrom, Legend Technical Services
Laboratory QA Officer — Date: 8/12/09

Steve Albrecht, Braun Intertec
Project Manager — Date: 8-11-09

Karen Sellers, Test America
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A3 Distribution List

Janet Dalgleish, University of Minnesota – Project Manager

Allan Gebhard, Barr Engineering Co. – Principal-in-Charge

Jim Aiken, Barr Engineering Co. – Consultant Project Manager

Jim Eidem, Barr Engineering Co. – Consultant Field Team Leader

Marta Nelson, Barr Engineering Co. – Consultant Project Quality Assurance Officer

Gary Krueger, Minnesota Pollution Control Agency – Agency Project Manager

Dave Scheer, Minnesota Pollution Control Agency – Agency Project QA Officer/Hydrogeologist

William Scruton, Minnesota Pollution Control Agency – Agency QA Coordinator

Terri Olson, Legend Technical Services – Laboratory Project Manager

Erica Nastrom, Legend Technical Services – Laboratory QA Officer

Steve Albrecht, Braun Intertec – Laboratory Project Manager

Karen Sellers, TestAmerica – Laboratory Project Manager

Acronym List

AES	Agricultural Experiment Station
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirements
AST	Above Ground Storage Tank
bgs	Below ground surface
COC	Constituent of Concern
DBP	Di-n-butyl Phthalate
DNT	Dinitrotoluene
DNR	Department of Natural Resources
DPA	Diphenylamine
DRO	Diesel Range Organics
DQO	Data Quality Objective
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FSI	Focused Site Inspection
GPS	Global Positioning System
GOW	Gopher OrdnanceWorks
GRO	Gasoline Range Organics
HRL	Health Risk Limit
kg	Kilograms
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
mg	Milligrams
MPCA	Minnesota Pollution Control Agency
msl	Mean sea level
PA	Preliminary Assessment
PACM	Potentially Asbestos Containing Material
PAH	Polycyclic Aromatic Hydrocarbon
PID	Photoionization Detector
PPM	Parts per Million
Phase I	Phase I Environmental Site Assessment
REC	Recognized Environmental Condition
RI	Remedial Investigation

SAP	Sampling and Analysis Plan
SSI	Supplemental Site Inspection
SLV	Soil Leaching Value
SOC	Site of Concern
SRV	Soil Reference Value
SVOC	Semi-volatile Organic Compound
TBC	To-be-considered Criteria
UMA	UMore Mining Area
UMore Park	University of Minnesota Outreach, Research and Experimentation Park
ug	Micrograms
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
UST	Under Ground Storage Tank
VOC	Volatile Organic Compound

A4 Introduction

This QAPP presents the organization, objectives, functional activities and specific QA and quality control (QC) activities required for the Supplemental Site Inspection and Remedial Investigation (SSI/RI) that will be used to characterize soil and groundwater at two Sites of Concern (SOCs) located in the UMore Mining Area (UMA), Dakota County, Minnesota (the Site). This QAPP is intended to encompass the Site sampling and analysis activities associated with this investigation. This QAPP also describes the protocols that will be followed for sampling, sample handling and storage, chain of custody, laboratory analysis, and field analysis.

All QA/QC procedures will be in accordance with applicable professional technical standards, EPA requirements, government regulations and guidelines, and specific project goals and requirements. This QAPP was prepared by Barr Engineering Co. (Barr) in accordance with EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5, Quality Assurance Division, United States Environmental Protection Agency, March 2001.

A5 Project Organization

The project organization is shown on Figure 1. The qualifications of the main project team members are included in Appendix A.

A5.1 University of Minnesota Project Manager

The University of Minnesota (University) is responsible for implementing the project and has the authority to commit the resources necessary to meet project objectives and requirements. University Project Manager Janet Dalgleish will be responsible for reviewing all project deliverables and documents. She has overall authority and responsibility for technical aspects of the project. The University project manager will provide the major point of contact and control for matters concerning the project. The responsibilities of the University project manager include:

- Acquiring and applying resources as needed to ensure performance within budget and schedule constraints;
- Directing all project activities
- Reviewing all project deliverables, and oversee all project strategies
- Representing the project team at meetings and public hearings

The University project manager may delegate most of these responsibilities to competent individuals.

A5.2 Barr Engineering Co. (Barr)

At the direction of the University, Barr has responsibility for oversight of the site investigation. Overall project implementation management will be provided by Barr. The various quality assurance and management responsibilities of key project personnel are defined below.

A5.2.1 Barr Principal in Charge

Allan Gebhard is the Barr Principal in Charge. The Principal in Charge has overall responsibility for verifying that the project meets the established objectives and quality standards. The Principal in Charge is the primary contact for contractual issues and for resolving quality concerns. The Principal in Charge has responsibility for overall project implementation management and product quality.

Specific responsibilities of the Principal in Charge include:

- Leading and overseeing on behalf of Barr contract negotiations and development, including contract terms, scope, schedule, and budget
- Involvement with overall management, administration, and technical aspects of project
- Providing independent quality review and validation for technical and contractual issues
- Monitoring client satisfaction for contract work
- Resolving contractual or quality issues

A5.2.2 Barr Project Manager

Jim Aiken is the Barr Project Manager. Barr's Project Manger is the University's primary contact for technical issues and day-to-day communication of scope, schedule, and budget progress. Barr's Project Manager is the primary Barr contact for project direction. The Barr Project Manager has the day-to-day and overall responsibility for managing implementation of the project, including quality management and overall project quality. The Barr Project Manager is responsible to the University for implementing the project. The Barr Project Manager's primary function is to see that technical, financial, and scheduling objectives are achieved successfully. The Barr Project Manager will provide the major point of contact for the University on matters concerning implementation of the project. Specific responsibilities of the Barr Project Manager include:

- Involvement on behalf of Barr in contract negotiation of scope, schedule and budget
- Direct involvement in day-to-day administration, budgeting, coordination, scheduling, and other managerial tasks
- Matching project needs with staff abilities and informing all team members of the project requirements
- Overall direction of technical aspects of the project including defining project objectives and developing a detailed work plan and schedule
- Primary responsibility for project quality, including technical correctness and completeness, contract compliance, and budget and schedule compliance
- Notifying the University of necessary scope, schedule, or budget modifications
- Reviewing and recommending subcontractors

- Communicating directly with the University Project Manager

A5.2.3 Barr Quality Assurance (QA) Manager

Marta Nelson is the Barr Quality Assurance Manager. The role of the Quality Assurance Manager is to provide an independent review of the product and the process to see that the work meets quality standards. She is responsible for auditing the implementation of the QA program in conformance with the requirements of this quality assurance plan, and the demands of specific project tasks. Specific responsibilities of the QA Manager include:

- Providing QA technical assistance to project staff
- Reporting on the adequacy, status, and effectiveness of the QA program on a regular basis to the Barr Project Manager
- Data validation
- Laboratory audits
- Initiation, tracking and review of QA/QC corrective actions
- Distribution of the approved SAP and subsequent revisions

A5.2.4 Barr Field Manager

The role of the Barr Field Manager is to oversee the entire investigation and the collection of all analytical samples following the procedures outlined in this QAPP and associated work plans. The Barr Field Manager, in conjunction with the Barr project manager and with approval of the University project manager, has the authority to stop or change work activities to ensure compliance with project goals and data quality objectives.

Additional Barr Field Manager responsibilities include;

- Direct all field staff to ensure the data collection and field activities meet the objectives of the SSI/RI.
- Along with the Barr Project Manager, make field decisions related to the scope and schedule of the SSI/RI.

A5.2.5 Barr Field Staff

The role of the field staff is to collect all analytical samples following the procedures outlined in this QAPP and associated work plans. Additional field staff responsibilities include;

- Collect and calibrate all necessary field equipment prior to beginning an assessment
- Oversee investigation contractors to ensure proper techniques are being followed and the desired information is being collected
- Assure quality objectives are met during sample collection, packaging, documentation, and shipping
- Documenting field activities to assist subsequent data analysis interpretation and reporting
- Complete and submit all necessary paperwork and forms to the project team

A5.2.6 Barr Health and Safety

Karen Stoller, an industrial hygienist, is the Barr Health and Safety Manager. The role of the Health and Safety Manager is to oversee all aspects of job safety and develop Project Health and Safety Plans (PHASP) which provide guidelines, requirements, and procedures intended to help protect the health and safety of all employees of Barr and Barr's subcontractors who will participate in the field work in accordance with the provisions of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

A5.3 Legend Technical Services, Inc.

Legend Technical Services, Inc. (Legend) located in St. Paul, Minnesota will conduct the physical preparation and chemical analyses of the majority of the analytical samples specified in the associated work plan. Independent quality assurance will be provided by the Legend Project Manager and QA Officer prior to release of all data to Barr. A copy of Legend's Quality Assurance Manual (QAM) is provided in Appendix B.

Other qualified analytical laboratories will be subcontracted through Legend to perform routine analytical work which may be undertaken at the site. Legend will coordinate shipment of samples to the identified subcontracted laboratories (Test America for perchlorate and nitrocellulose analyses and Braun Intertec for the Minnesota Department of Agriculture (MDA) List 1 and 2 pesticides, Nitrate + Nitrate as N, and Total Kjeldahl Nitrogen (TKN)).

Legend is certified though the Minnesota Department of Health's (MDH) Environmental Laboratory Certification Program (when applicable for the target analytical list in Table 1) Braun is certified by MDA for the List 1 and 2 pesticide analysis and by the MDH for Nitrate + Nitrite as N and TKN analysis. The perchlorate and nitrocellulose are not certifiable tests under the MDH program. Any additional subcontracted laboratories will be certified by the MDH to perform analysis in Minnesota, where applicable, and will follow the processes and procedures as outlined in this QAPP.

All laboratory reports will be prepared and submitted to Barr following each sampling event electronically. Specific roles of the Legend personnel are outlined below.

A5.3.1 Legend Project Manager

Terri Olson is the Legend project manager. The Legend Project Manager is responsible for verifying that the assessment data meets the established objectives and Legend's quality standards. The Legend Project Manager is responsible for technical quality control and project oversight. The Legend Project Manager's primary function is to see that technical, financial and scheduling objectives are achieved successfully. The Legend Project Manager will be the primary laboratory contact for administrative, financial and scheduling considerations. Specific responsibilities include:

- Acquiring and applying technical and corporate resources as needed to perform the work within budget and schedule constraints
- Developing and meeting on-going project and staffing requirements
- Reviewing all work performed by Legend to verify its quality and completeness and review subcontractors data to verify its completeness, responsiveness and timeliness

A5.3.2 Legend Project QA Officer

Erica Nastrom is the Legend QA Officer for the laboratory. The Legend project QA Officer will remain separate and distinct from other project-related duties. The QA Officer is responsible for maintaining conformance to project QA requirements, Legend's Corporate QA/QC Plan, EPA and related methodologies. The following lists several specific duties of the Legend QA Officer:

- Tracking validation data and ensuring adherence to published guidelines
- Determining if the levels of QA/QC are being achieved
- Certifying the level of QA/QC for each analytical project

- Maintaining QA/QC procedures
- Initiating and overseeing internal audits
- Initiation and implementation of corrective actions

A5.4 Test America, Inc.

Test America, Inc. (TestAmerica) located in Sacrament, California will conduct the physical preparation and chemical analyses of the majority of the analytical samples specified in the associated work plan. Independent quality assurance will be provided by the TestAmerica Project Manager prior to release of all data to Barr. A copy of TestAmerica's Quality Assurance Manual (QAM) is provided in Appendix B. Specific roles of the TestAmerica personnel are outlined below.

A5.4.1 TestAmerica Project Manager

Karen Sellers is the TestAmerica project manager. The TestAmerica Project Manager is responsible for verifying that the assessment data meets the established objectives and TestAmerica's quality standards. The TestAmerica Project Manager is responsible for technical quality control and project oversight. The TestAmerica Project Manager's primary function is to see that technical, financial and scheduling objectives are achieved successfully. The TestAmerica Project Manager will be the primary laboratory contact for administrative, financial and scheduling considerations. Specific responsibilities include:

- Acquiring and applying technical and corporate resources as needed to perform the work within budget and schedule constraints
- Developing and meeting on-going project and staffing requirements
- Reviewing all work performed by TestAmerica to verify its quality and completeness and review subcontractors data to verify its completeness, responsiveness and timeliness

A5.5 Braun Intertec Corporation

Braun Intertec Corporation (Braun) located in Minneapolis, Minnesota will conduct the physical preparation and chemical analyses of the majority of the analytical samples specified in the associated work plan. Independent quality assurance will be provided by the Braun Project Manager prior to release of all data to Barr. A copy of Braun's Quality Assurance Manual (QAM) is provided in Appendix B. Specific roles of the Braun personnel are outlined below.

A5.4.1 Braun Project Manager

Steve Albrecht is the Braun project manager. The Braun Project Manager is responsible for verifying that the assessment data meets the established objectives and Braun's quality standards. The Braun Project Manager is responsible for technical quality control and project oversight. The Braun Project Manager's primary function is to see that technical, financial and scheduling objectives are achieved successfully. The Braun Project Manager will be the primary laboratory contact for administrative, financial and scheduling considerations. Specific responsibilities include:

- Acquiring and applying technical and corporate resources as needed to perform the work within budget and schedule constraints
- Developing and meeting on-going project and staffing requirements
- Reviewing all work performed by Braun to verify its quality and completeness and review subcontractors data to verify its completeness, responsiveness and timeliness

A5.6 Minnesota Pollution Control Agency (MPCA)

The MPCA project manager and quality assurance reviewer must approve all quality documents prior to beginning any field work. Specific responsibilities for the MPCA project manager and the MPCA quality assurance reviewer are addressed in the following sections.

A5.6.1 MPCA Project Manager

Gary Krueger is the MPCA Project Manager. Specific responsibilities include;

- Direct review and approval of the QAPP and work plans
- Technical consultation with the University Project Manager and/or the Barr Project Manager
- Review all progress reports detailing completed work
- Review all final reports

A5.6.2 MPCA Quality Assurance Coordinator

William Scruton is the MPCA QA Coordinator. Specific responsibilities include;

- Review and approve QAPP

- Assist in review of all sampling protocols
- Conducting external performance and system audits of laboratory and field activities.
- Reviewing and evaluating analytical field and laboratory procedures

A6 Project Definition and Background

This QAPP has been prepared on behalf of the University by Barr to describe the continuation of environmental investigations at two Sites of Concern (SOCs) in the UMore Mining Area (UMA), located in Dakota County, Minnesota (Figure 2). The UMA consists of the approximate western one-third of the University of Minnesota Outreach, Research, and Experimental Park (UMore Park) property. The UMA is being proposed for future sand and gravel mining and is the subject of an Environmental Impact Statement (EIS) currently in preparation by the University.

The two subject SOCs, referred to as the Former DNT Loading Platform and Drainage Ditch (SOC 4) and the Central Services Station/Former DNT Storage Bunkers (SOC 5), were ancillary (non-production) areas for the Gopher Ordnance Works (GOW), a smokeless gunpowder production facility that was operated briefly during World War II. A portion of SOC 4 and all of SOC 5 were identified as Areas of Concern (AOCs) 3 DA-1 and AOC 5, respectively, in a Preliminary Assessment (PA) conducted by the U.S. Army Corps of Engineers (Army; USACE, 2006). Both AOC 3 DA-1 and AOC 5 were carried forward for further investigation in a Focused Site Inspection (FSI; Bay West, 2009). The FSI included the collection and analysis of four soil samples and one groundwater sample in AOC 3 DA-1 and twenty-four soil samples and one groundwater sample in AOC 5. Based on the result of the FSI, the Army concluded that releases of hazardous substances to soil occurred in AOC 5.

A6.1 Historical Site Assessments

A6.1.1 Assessment

A Phase I Environmental Site Assessment (Phase I) was prepared for UMore Park in 2006 (Peer, 2006). Barr updated the Phase I components that related to the UMA in 2008. In the updated Phase I, seven SOCs that had at least a potential for release or threatened release of petroleum products or hazardous substances were identified in the UMA. Based on comments from Dakota County, an eighth SOC (Undetermined Use Area) was considered for investigation.

Barr submitted a draft Work Plan to the Minnesota Pollution Control Agency (MPCA) describing the proposed investigation of the eight SOCs in the UMA (Barr, 2008b). Based on comments issued by the MPCA, SOCs 1-3 and 6-8 were separated from SOCs 4 and 5 and became the subject of a separate investigation to determine if a release of a hazardous substance or petroleum has occurred within the SOCs 1-3 and 6-8. The Phase II Investigation Work Plan for SOCs 1-3 and 6-8 has been

submitted to the MPCA under separate cover (Barr, 2009a). SOCs 4 and 5 are being investigated in accordance with the Work Plan for Supplemental Site Inspection (SOC 4) and Remedial Investigation (SOC 5) because previous investigations have identified previous releases from GOW and post-GOW site operations that were either confirmed by the Army (SOC 5) or lacked sufficient data (SOC 4) to adequately assess presence or absence of a release.

A7 Project Description

This SSI/RI builds upon the results of the FSI and other previous investigations so that the University can assess the nature and extent of releases of hazardous substances or petroleum within SOCs 4 and 5. The planned investigation includes conducting a SSI of SOC 4 and a RI of SOC 5. The primary objective of the SSI is to collect and analyze soil and groundwater samples from SOC 4 to determine if there is evidence of a release and, if contamination is present, evaluate risks to human health and the environment. The objective of the RI for SOC 5 is to collect sufficient data characterize the nature and extent of environmental impacts and to support the development of response actions (if needed) to prepare for future sand and gravel mining operations.

The University maintains that the Army is responsible for releases of hazardous substances and petroleum that occurred in UMA as a result of the GOW. However, to properly prepare for the planned sand and gravel mining operations, the University is moving forward to conduct this SSI/RI of SOCs 4 and 5 in order to provide information for the Environmental Impact Statement (EIS) that is currently in preparation.

This project will involve both soil and groundwater sampling and characterization. The soil and groundwater samples will be analyzed for parameters that have been selected based on past Site uses. Sampling and analysis plan details, analytical methodologies, quality assurance sampling frequency, and sample container, preservative, and hold times are summarized in Tables 1 through 4 of the Field Sampling Plan.

Field screening and analytical results will be used to determine if past land use has impacted soil or groundwater at the Site. Soil analytical results will be compared to Minnesota Pollution Control Agency Tier I and II Soil Reference Values (SRVs), considering the human-soil pathway for residential and industrial chronic risk scenarios. Groundwater results will be compared to Minnesota Department of Health Health Risk Limits (HRLs) and Health Based Values (HBVs), and EPA Maximum Contaminant Levels (MCLs). Soil and groundwater data will be compared to regulatory criteria to determine if, and the extent to which, past land use has impacted the site.

Sample collection is scheduled to begin in September 2009 and will take approximately four weeks. Laboratory analyses will be completed and data will be provided within 45 days of sample receipt at the laboratory. A report describing the results of the investigation will be prepared in December 2009.

A8 Special Training Requirements/Certification

A8.1 Field Personnel

All field personnel will be under the supervision of the Project Manager. The personnel conducting the on-site activities will be experienced in conducting proper quality procedures as outlined in this QAPP. All field personnel will be trained to follow all health and safety procedures as outlined in the project health and safety plan, as well as in the operation of all field monitoring equipment. All project field staff will have been 40 hour OSHA HAZWOPER trained.

A8.2 Laboratory

The laboratories utilized for this project will have all appropriate certifications necessary to perform analysis in the state of Minnesota, where applicable. A summary of the laboratories certification documentation is included in Appendix D. The laboratory personnel training will be conducted by appropriate trainers and monitored by the laboratory personnel as outlined in the Laboratory QAM included in Appendix B.

A8.3 Training Records

Barr's Health and Safety Manager, Karen Stoller, is responsible for maintaining the OSHA health and Safety Training Records.

A9 Data Quality Objectives and Criteria for Measurement Data

A9.1 Data Quality Objectives

A9.1.1 Project Quality Objectives

Project data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the analytical data needed to support decisions made during project investigations. DQOs are established to ensure that the data collected are sufficient and of adequate level of quality for their intended uses. A summary of the project data quality objectives is included in Table 2.

The specific options for the program were developed in conformance with the U.S. EPA document QA/G5 guidance document (EPA, 2002). The following subsections describe the DQO process followed according to QA/G5.

The seven-step DQO process (EPA 2000a) was used to identify the adequacy of existing data and the need for additional data, to develop the overall approach to each study element, and ultimately to design the various field and laboratory investigations.

DQOs are designed to ensure that the type, quality, and quantity of environmental data used in decision-making are appropriate for their intended application. DQOs are qualitative and quantitative statements that: (1) clarify the study objective; (2) define the most appropriate type of data to collect; and (3) determine the most appropriate conditions under which to collect the data. The elements of the seven step DQO process for this sampling effort are described in the following sections and in Table 2 of this QAPP.

A9.1.1.1 Step 1: Identify the Problem

The first step of the DQO process is to develop a concise and complete description of the problem. This problem statement provides the basis for the rest of the DQO development. To do this, technical representatives from the University and Barr worked in consultation with representatives from the MPCA and laboratories. Concise problem statement descriptions are presented in Table 2, broken down by environmental media and area.

A9.1.1.2 Step 2: Identify the Decision

The purpose of this step is to define the decision statement and alternative actions that may be taken depending on the findings of the sampling program. Output from this step will be used to identify decision rules (Step 5) and define tolerable limits on decision errors (Step 6) later in the process. These statements are presented in Table 2.

A9.1.1.3 Step 3: Identify Inputs to the Decision

In this step, the different types of information needed to resolve the decision statement are identified. The inputs to the decisions defined in Step 2 are specified in Table 2 for each medium. In general, decision inputs will consist of historical sampling data, new data generated through the sampling program described in the associated Field Sampling Plan and work plan, background/reference area concentrations and screening levels. Project data needs were identified based on a review of available historical data and consideration of the type, quality, and quantity of data needed.

A9.1.1.4 Step 4: Define the Study Boundaries

Study boundaries are both spatial and temporal. The MPCA approved work plans describe the spatial and temporal boundaries (including overall study area boundaries, sampling areas, specific sampling locations, and project schedule) in sufficient detail to perform the investigation. Spatial and temporal boundaries are also described in general terms in Table 2.

A9.1.1.5 Step 5: Develop a Decision Rule

The decision rule is a synthesis of the output from the previous DQO steps into “if... then...” statements that define the response(s) to the study outcome. In this case, the “if” portion of the statements assesses the sampling results of hazardous constituents and other analytical parameters relative to background/reference area concentrations, human health screening levels, and/or ecological screening levels (whichever is specified as appropriate). The “then” portion of the statement indicates the further action, if required (e.g., further investigation or evaluation in a risk assessment). Decision rules for each element of the investigation are provided in Table 2.

A9.1.1.6 Step 6: Specify Limits on Decision Errors

Decision errors can arise from sampling design error and/or measurement error. It is important to limit the likelihood of decision errors so that risk management and remediation decisions will be

protective of public health and the environment and that project resources will be used appropriately and efficiently.

Sampling design error occurs when the data collection design does not capture the characteristics of the study area to the extent appropriate to answer the principal study questions. This error is influenced by the inherent variability of the population over space and time, the sample collection design, the number of samples, and the uncertainty that is inherent in using sample data to represent the characteristics of the entire target population or environmental medium of interest. It is usually impractical to measure the entire decision unit, and limited sampling may miss some features of the natural variation of the measurement of interest. Sampling design error can lead to random error (i.e., variability or imprecision) and systematic error (bias) in estimates of population parameters. This is reflected in the sampling design by: 1) appropriate selection of sampling locations and analytes, and 2) identification of appropriate sample collection methods.

Measurement errors are defined as the combination of random and systematic errors that inevitably arise during the various steps of the measurement process. This type of error is minimized at this site through the systematic uniform management of each of the steps of the measurement process. Each of the measurement process steps and the overall management plan are outlined in this QAPP for laboratory procedures and in the associated work plan for sampling protocols.

The sampling program and QA procedures for this project were designed based on site-specific information, MPCA guidance, and professional experience with the goal of providing a data set that will limit decision errors to acceptable levels. Potential sources of decision error, along with the potential consequences of any such error, will be identified on a case-by-case basis during the data evaluation phase of the project. The planning team will apply professional judgment to weigh the likelihood of potential decision errors against the risks of incorrect decisions. In the event that the risk of decision error is unacceptably high, the planning team will determine an appropriate course of action (e.g., additional sampling and analysis) to reduce the probability of decision error to an acceptable level.

A9.1.1.7 Step 7: Optimize the Design for Obtaining Data.

The study design for obtaining data to support the work plan objectives was developed through an intensive planning process. Key considerations in the study design were review of information on

site history and material disposal practices, review of previous environmental sampling results, and identification of data gaps.

The sampling program was developed using both quantitative and qualitative approaches to determine the number, type, and locations of sampling locations, to identify analytical parameters, and to establish QA standards and procedures for the project.

Details of the study design and its underlying rationale are provided in the MPCA approved work plans. Study design elements are also summarized under Step 7 in Table 2 of this QAPP.

A9.1.1.8 Project Data Quality Objectives

Project data quality objectives (DQOs) are qualitative and quantitative statements which specify the quality of the analytical data needed to support decisions made during project investigations. DQOs are established to ensure that the data collected are sufficient and of adequate level of quality for their intended uses. Four Site data quality objectives have been identified and are presented below along with brief descriptions of steps that will be taken to address these objectives. The data must satisfy the site data quality objectives presented below.

1. Analytical results must accurately represent groundwater and soil quality: Chemical analyses will be performed to confirm the target analytes present and their concentrations at each SOC.

2. Analytical results must satisfy quality control requirements for: accuracy, precision, representativeness, completeness and comparability (see the following section).

3. Field data requires an intermediate level of data quality compared to laboratory analysis done in a controlled environment: field data provides real-time data that may be necessary to make field decisions. Field data includes volatile organic headspace monitoring with a photo ionization detector (PID) (MPCA Method) and soil classification (ASTM D 2488).

4. The laboratory analyses will require a high level of data quality and will be used to determine the type and concentrations of chemical constituents present at the property. These analyses are characterized by established QA/QC protocols and documentation and provide qualitative and quantitative data. These methods are based on EPA or other regulatory method protocols and are presented in Table 1. Analytical and data review procedures must be in accordance with recognized protocols to ensure the data is valid.

A9.2 Quality Assurance Objectives and Criteria

The overall quality assurance objectives (QAOs) are to develop and implement procedures for field sampling, chain of custody, laboratory analysis, and reporting that will provide the level of data required for determining the characteristics of the various environmental media. Specific procedures for sampling, chain-of-custody, laboratory instruments calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QAPP. The purpose of this section is to address the specific objectives for accuracy, precision, completeness, representativeness, and comparability. The fundamental QA objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical protocols.

Quality control checks available for use in each project include the following measures:

- Field blank samples are analyzed to check for procedural contamination that may cause sample contamination.
- Duplicate samples are analyzed to check for sampling and analytical reproducibility.
- Matrix spikes (MS) provide information about the effect of the sample matrix on the digestion or preparation and measurement methodology. Matrix spikes are sometimes performed in duplicate and are referred to as MSD samples.

The general level of the QC effort will be a minimum of one field duplicate and field blank for each batch of 20 samples during the investigation. MS/MSD samples are analyzed as required by the methodology in accordance with the laboratory SOPs, but are typically analyzed with every batch of 20 samples, The level of QC effort provided by the laboratory will be equivalent to the level specified within the SOPs for the parameters to be tested (Appendix C).

The five individual QAOs are defined below, along with the means by which they are measured to monitor the compliance to the project needs.

A9.2.1 Precision

Precision measures the reproducibility of measurements under a given set of conditions. Precision of analytical laboratory data may be assessed by comparing the analytical results between matrix spike/matrix spike duplicates (MS/MSD), laboratory control sample/laboratory control sample duplicates, laboratory duplicates (non-spiked), or masked field duplicate samples. Duplicate

samples, when collected, processed and analyzed by the same organization, provide intra-laboratory precision information for the entire measurement system, including sample acquisition, handling, shipping, storage, preparation, and analysis. Field duplicate samples are submitted to the laboratory as blind or mask samples. Relative percent differences (%RPD) will be calculated for each pair of duplicate results using the following equation:

$$\%\,\mathrm{RPD} = \left| \frac{S - D}{(S + D)/2} \times 100 \right|$$

Where: S = First sample value

D = Second sample value

RPD calculations of MS/MSD, LCS/LCSD will be performed on the final concentration (not the percent recoveries). The RPD limits for MS/MSD, LCS/LCSD and non-spiked laboratory duplicates are set by the laboratory and are subject to change. For this investigation RPDs falling beyond the laboratory published for MS/MSD, LCS/LCSD and/or non-spiked laboratory duplicates will be evaluated as detailed in the data review SOPs included in Appendix F. The differences between duplicates must be less than the action level for evaluation. All duplicates greater than five times the reporting level must possess an RPD less than 25% for liquid samples and 50% for soil samples.

A9.2.1.1 Field Precision Objectives

Field precision is assessed through the collection and measurement of replicate field samples with the field equipment at a rate of one per 20 analytical samples to ensure the precision of the field equipment and to demonstrate precision in the field collection procedures. These replicates will be collected and analyzed in the field only. Table 3 outlines the field instrumentation's precision, accuracy limits and preventative maintenance procedures.

Field duplicate samples will be collected and sent to the laboratory at the frequency presented in Table 4. The RPD limits for field duplicate soil samples will be 40% and 30% for field duplicate groundwater samples. Native and duplicate sample results at or near the reporting limits can exaggerate RPD values therefore, these higher RPD values do not always indicate poor precision. Duplicate samples should be collected from locations where target analytes are expected to be present.

A9.2.1.2 Laboratory Precision Objectives

Precision in the laboratory is assessed through the calculation of relative percent difference (RPD) for laboratory duplicates, MS/MSD and LCS/LCSD samples. These quality control samples will be analyzed at a rate of one per twenty samples as required by the laboratory SOPs. This data allows for evaluation of the laboratory's ability to satisfactorily replicate specific sample results. The Laboratory precision and accuracy criteria are published in each laboratory report and will be used as the final acceptance criteria during data review.

A9.2.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy measures the bias in a measurement system. Accuracy of laboratory results may be assessed using the analytical results of method blanks, reagent/preparation blank, matrix spike/matrix spike duplicate samples and laboratory control samples. The percent recovery for (%R) matrix spikes and laboratory control samples will be calculated.

Percent recoveries for surrogate standards (for organic analyses only), LCS samples, and MS samples are established by the laboratory and are subject to change. In general, surrogate standard percent recovery limits for VOCs are 75-125%, for the semivolatile and/or PAH analyses the surrogate recoveries vary depending on the class of compound, but for purposes of this investigation acceptable limits will not exceed 30-150% (including pesticides). In general, for MS and LCS samples, percent recovery limits are 80-120% for VOCs and 75-125% metals, for semivolatile and/or PAH analyses, the recoveries vary widely depending on the class of compounds, but for purposes of this investigation, acceptable limits will not exceed 30-150%. Typical percent recoveries for pesticides in MS and LCS samples are 70-130%.

These percent recoveries are subject to change. The current limits will be present along with all sample results within the laboratory reports and will be used as the final acceptance criteria during data review.

Results of method blanks will be evaluated to determine the presence of any gross systematic contamination issues to identify potential false positive results.

A9.2.2.1 Field Accuracy Objectives

Accuracy in the field is assessed through the use of field and trip blanks (for VOC analyses only) and through the adherence to all sample handling, preservation and holding times.

SOPs for the field equipment to measure organic vapors, pH, conductivity, Eh, and temperature are outlined in Appendix E. Accuracy and precision requirements for field screening analyses are included in Table 3.

A9.2.2.2 Laboratory Accuracy Objectives

Laboratory accuracy is assessed through determination of percent recoveries in the analysis of MS/MSD's, LCS/LCSDs and surrogate spikes (for organic analyses only). Accuracy control limits are included in each laboratory report and will be used as the final acceptance criteria during data review. The frequency of sample spikes being analyzed will be at least 5 percent as outlined in the laboratory SOPs and/or EPA or other regulatory methodology. Corrective actions are discussed in more detail in Section C2 of this QAPP for laboratory content, and Appendix F for potential data qualification.

A9.2.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions. Field completeness goals for each project will be greater than 95 percent. It is expected that Legend will provide data meeting QC acceptance criteria for 95 percent or more of all samples tested. However, other factors may affect the decision to resample for lost or otherwise invalid data, such as if the sample was collected for confirmation of an earlier detection, or if the same parameter at the same well was somehow invalidated during consecutive sampling events. Following completion of analytical testing, completeness will be calculated as a percent using the following equations:

$$Completeness\ (\%) = \frac{(Number\ of\ \ valid\ \ data)}{(Number\ of\ \ samples\ collected\ \ for\ each\ \ parameter\ analyzed)}\ x\ 100$$

A9.2.4 Representativeness

Representativeness is defined as a measure of the degree to which data accurately and precisely represents a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that is dependent upon the proper design of the sampling program and proper laboratory protocol. As described in the work plans, the sampling network will be designed to provide samples representative of site conditions. During development of this network, consideration will be given to available

information regarding the site, and any future remedial action. The representativeness criteria will be satisfied by following the associated work plan and by the use of proper sampling techniques and appropriate analytical procedures. Sample collection procedures (included in Appendix E) will describe proper sample homogenization techniques for soil samples and stabilization procedures for water samples that will aid in ensuring a sample is representative of site conditions. This will be measured on this project through the use of matrix spikes, matrix spike duplicates, field blanks, method blanks, and field duplicates as described in Section A9.3.

A9.2.5 Comparability

Comparability is defined as the confidence with which one set of data can be compared with another. The extent to which existing and planned analytical data will be comparable depends on the similarity of sampling and analytical methods. Comparability will be satisfied by ensuring that the sample plan is followed. This will be accomplished by the project team with the use of matrix spikes, field blanks, method blanks and field duplicates as described in Section A9.3.

A9.2.6 Sensitivity

Sensitivity expresses the methodology's and laboratory instrumentation's ability to meet or exceed the associated screening levels. In some cases, laboratory instrumentation limitations result in final reporting limits greater than the associated screening level. In these cases, the laboratory will report estimated concentrations below the final reporting limit but above the method detection limit. These results will be qualified with a "J"

A9.3 Field Sampling QA/QC

Field blanks will be prepared and submitted to the analytical laboratories to check for procedural contamination at the site which may cause sample contamination.

Accuracy of the field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks. Precision will be assessed on the basis of reproducibility by multiple analyses of a single sample. Data completeness may be determined upon project completion and receipt of all data. The quality control program consists of collecting and analyzing field blank and field duplicate samples.

A9.3.1 Field Blanks

Field blanks are defined as samples which are obtained by pouring analyte-free, deionized water into the appropriate sample containers for analysis.

Field blanks will be collected and submitted at the frequency of one field blank per 20 investigative samples. Field blank samples will be identified with the prefix FB followed by a sequential number (FB-1, FB-2....).

The results of field blanks will be evaluated to determine the presence of any potential false positive results. The results of the field blanks should not have reportable concentrations of any target analyte above its reporting limit. Data qualifications relating to field blanks are discussed in Appendix F.

A9.3.2 Field Duplicate Samples

Field duplicate samples are independent samples collected in such a manner that they are equally representative of the parameter(s) of interest at a given point in space and time. Field duplicate samples, when collected, processed, and analyzed by the same organization, provide intralaboratory precision information for the entire measurement system, including sample acquisition, homogeneity, handling, shipping, storage, preparation, and analysis. Field duplicate samples are submitted to the laboratory as blind or mask samples.

One out of every 20 investigative samples will be collected in duplicate, with a minimum of one per event. These samples should be collected at locations where contaminants are expected to be present. Field duplicate samples will be identified with the SOC number, a prefix Dup (Duplicate) followed by a sequential number (Dup-1, DUP-2 ....).

A10 Documentation and Records

The following is a list of information that must be documented and records that must be reported or available for review. The list is not intended to be a complete list of every item, rather general guidance on required information.

A10.1 Field Records

Field records should include:

- Sample collection records
- Chain of custody
- QC sample records, if applicable
- Field procedures
- Field measurement results
- Equipment calibration documentation
- Corrective action reports
- Observation notes
- Weather Conditions
- Results of field testing
- Names of all personnel on site

A10.2 Laboratory Records

Laboratory records should include:

- Date of sample analysis
- Sample management information (e.g., receipt, numbering, handling)
- Analytical procedures
- Notes of deviations from procedures
- Sample preparation and analysis information
- Results of analytical testing
- Detection limits and reporting limits
- QC criteria and results
- Data handling information

A10.3 Storage and Retention

Field files are stored in the Barr project files which are retained on or off-site indefinitely.

Laboratory report retention is discussed in Section B10.5.

B Measurement Data Acquisition

B1 Sampling Process Design

Samples locations, parameters, and rationale will be specified in the associated work plans.

Tables 1 present a summary of the analytical constituents and methods that may be required for laboratory analysis at the Site. The following table presents a summary of the laboratories and associated analyses to be performed.

Laboratory	Analyses **
Legend – St. Paul, MN	Soil, groundwater analyses of volatiles, semi-volatiles, metals and general chemistry parameters
Braun Intertec – Minneapolis, MN	Soil and groundwater analysis of MDA List 1 and List 2 pesticides and groundwater analysis of Nitrate + Nitrite as N and TKN
TestAmerica – West Sacramento, CA	Perchlorate and nitrocellulose

**Specific methods for these analyses are contained in Table 1.

B2 Field Sampling Method Requirements

Sample collection procedures are described in the Field Sampling Plan and the Work plan. A short summary of the Site activities is described in the following paragraphs.

B2.1 Field Sampling Equipment and Procedures

Sample collection equipment and procedures are described in Appendix E of this QAPP.

The following is a brief overview of procedures related to the correct acquisition of surface and groundwater levels and samples. It is assumed that the reader has a firm knowledge of environmental sampling, and procedures related to environmental fieldwork.

There are four general types of sampling conducted at the Site; groundwater sample collection, surface soil collection, subsurface soil collection, and composite soil sample collection. Specific numbers of samples to be collected and locations are included in the Field Sampling Plan.

B2.1.1 Sample Collection

A direct push sampling unit, drilling rig, or hand sampling equipment will most likely be used to collect any required sub-surface soil samples using coring, split-spoon sampling and hand sampling gear. In addition, bailers and pumps (submersible or peristaltic) may be used to perform groundwater sampling.

Additional information on the Barr field sampling techniques can be found in the Barr SOPs located in Appendix E. All subcontractors performing work under the direction of Barr will adhere to these SOPs.

B2.2 Field Sample Handling and Analysis

All analytical samples will be collected in the field in accordance with an approved work plan and QAPP.

Each laboratory sample to be transported will be marked with a permanent marker directly on the container or on adhesive labels that will remain on the container. Each shipping container will be marked with a proper U.S. DOT transportation description, the sample designation and the names and addresses of the senders and receivers. Proper shipping papers will accompany each shipment of samples.

All samples will be shipped to the laboratory(s) at the following location except for MDA List 1 and List 2, Nitrate + Nitrite as N, and TKN samples which may be shipped directly to Braun:

Legend Technical Services, Inc.
Attn: Sample Receiving
88 Empire Drive
St. Paul, MN 55103
(651) 642-1150

Braun Intertec
Attn: Sample Receiving
11001 Hampshire Avenue South
Minneapolis, MN 55438
952-995-2622

All samples will be shipped for delivery within four days of sample collection unless sample holding times dictate shorter delivery. All analytical samples will be shipped via an over-night delivery or messenger service.

B2.3 Field Logbooks/Documentation

Field logbooks will provide the means of recording data collecting activities. As such, entries will be described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory.

Field logbooks will be bound, field survey books, or notebooks. Each logbook will be identified by the project-specific document number.

The title page of each logbook will contain the following:

- Person to whom the logbook is assigned
- Project name
- Project start date
- End date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling, or investigation team personnel and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected or a measurement is made, a detailed description of the location of the station shall be recorded. The number of the photographs taken of the station, if any,

will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the QAPP, the Field Sampling Plan and approved work plans. The equipment used to collect samples will be noted, along with the time of sampling, sample description, volume, and number of containers. A sample identification number will be assigned prior to sample collection. Duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

The following nomenclature will be followed for sample identification.

Soil samples will be represented by the SOC the sample is collected from, a letter designator representing the type of investigative method, a unique location number indicated in the Work Plan, and, in the case of soil samples, the sample bottom depth. Standard investigative designators are as follows:

- **SS (Surface Soil)**: Surface soil samples will be collected beneath the surface vegetation and the rooting zone, approximately from an interval of 2 to 6 inches below the ground surface. (Example: SOC1_SS1_2-6", etc.)
- **GP (Geoprobe Boring)**: Represents any direct-push boring installed for the purpose of collecting information on the stratigraphy or for collecting soil or groundwater samples collected from the drill stem or a temporary well installed in the geoprobe borehole. (Example: SOC1_GP1_0-6", etc.)
- **TT (Test Trench):** Represents any test pit excavated for the purpose of observing subsurface conditions or for collecting soil samples. (Example: SOC1_TT1_2-4', etc)

QA/QC samples will be identified with the following prefixes followed by a sequential number:

- **FB** (Field Blank): Represents a sample collected for QA/QC procedures.
- **DUP** (Duplicate): Represents a duplicate soil or groundwater sample collected for QA/QC procedures. (Example: SOC1_DUP1, or for groundwater: MW_DUP1)
- **TB** (Trip Blank): Represents a blank container filled by the laboratory with ultra clean test water or methanol and are employed for VOC sample analysis.

B2.4 Sample Containers, Preservation Techniques, and Holding Times

The sample containers associated with the anticipated analytical tests are listed in Tables 1 and their proper preservation techniques are detailed in Table 5.

B3 Sample Handling and Custody Requirements

It is U.S. EPA Policy to follow the sample custody (chain-of-custody) protocols as described in "NEIC Policies and Procedures," EPA-330/9-78DDI-R, Revised June 1991. This custody is in three parts: sample collection, laboratory analysis, and final evidence files. A sample or evidence file is under your custody if they:

- Are in your possession;
- Are in your view, after being in your possession;
- Are in your possession and you place them in a secured location; or
- Are in a designated secure area.

Barr will follow this EPA policy for this project.

B3.1 Field Chain-of-Custody Procedures

The sample packaging and shipment procedures summarized below will insure that the samples will arrive at the laboratory with the chain-of-custody intact.

1. The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples.
2. All containers will be labeled with sample description and location.
3. Sample labels are to be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample tag because the ballpoint pen would not function in freezing weather.
4. The Barr QA Manager will review field activities to determine whether proper custody procedures were followed during the field work and decide if additional samples are required.

B3.2 Transfer of Custody and Shipment Procedures

Samples are accompanied by a properly completed chain-of-custody form. An example of the chain-of-custody form is provided on Figure 3. The sample numbers and locations will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to the laboratory, or to/from a secure storage area.

Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be sealed and secured with tape for shipment to the laboratory. The cooler is strapped shut with strapping tape in at least two locations. At least one custody seal will be signed and placed over the cooler opening to verify that the samples have not been disturbed.

Whenever samples are co-located with a source or split with a government agency, a separate chain-of-custody form is prepared for those samples and marked to indicate with whom the samples are being co-located. The person relinquishing the samples to the facility or agency should request the representative's signature acknowledging sample receipt. If the representative is unavailable or refuses, this is noted in the "Received By" space.

All shipments will be accompanied by the Chain of Custody Record identifying the contents. The original record will accompany the shipment, and the pink and gold copies will be retained by the sampler for returning to the sampling office.

B3.3 Chain-of-Custody Samples in the Laboratory

The laboratory sample custodian will be responsible for maintaining proper chain-of-custody from the time that the samples are received by the laboratory for the project. All facility entrances are secured or monitored at all times; all visitors to the laboratory portion of the facility are documented in the visitor's log book. The laboratories document receipt of samples into the laboratory using preprinted chain-of-custody records (client chain-of-custody forms are acceptable). When samples are received in the laboratory, the chain-of-custody documents are signed and dated by the sample custodian. The samples are then assigned an identification number by the sample custodian. Samples do not remain outside refrigeration for more than 4 hours from the time of receipt. Samples are transferred after log-in to the sample refrigerators by the Sample Custodian. The internal analytical request forms, chain-of-custody forms, and any related paperwork are put into the project

folder. The analysts are responsible for the custody of the samples until they are returned to the sample refrigerators.

B3.4 Custody of Evidence File

Until completion of the project, all correspondence, laboratory reports, and data will be maintained in Barr project files. All original laboratory reports and field data are maintained in their original format and stored separately from working copies of these reports. The Barr Project Manager will direct maintenance of the project file. Following completion of the project, the evidence file will be stored in the Barr project file storage area or transferred to a secure document storage facility. The files will be maintained for a minimum of 5 years.

B4 Analytical Methods Requirements

Trained Barr personnel (or Barr's subcontractor) will perform all field analytical methods. Table 1 presents the required methods for each of the target compounds identified for this project.

B4.1 Laboratory Samples

All laboratory samples will be collected following all applicable EPA and other regulatory methods as described in the laboratory SOPs included in Appendix C.

B4.2 Laboratory Analysis

Analytical methods will be selected to provide adequate detection limits for compounds of interest, and for the final intended data usage. A list of anticipated laboratory methods and their corresponding reporting limits and minimum detection limits can be found in Table 1. All solid sample results will be provided on a dry weight basis as the methodology specifies. SOPs have been prepared for all methods used for analysis of samples for this project. Laboratories project-required SOPs are included in Appendix C. Each of these SOPs is based on an analytical method published by the U.S. EPA, Standard Methods or other recognized sources as available.

A few compounds (including some metals, pesticides, VOCs and SVOCs) listed in Table 1 have reporting limits that do not achieve regulatory criteria. For these compounds, the laboratories will quantitate down to the method detection limit to achieve the lowest possible levels. This will result in the majority of the compounds meeting their respective regulatory limits.

There are a relatively small number of compounds that will not be able to be quantified below the regulatory criteria using approved analytical methods. It is possible that these compounds will be present above regulatory criteria in samples with results reported as non-detect. Barr will evaluate each compound on an individual basis at each investigation area to determine what potential risks may be involved with not being able to quantify to the regulatory criteria.

B4.3 Field Analysis

Barr personnel will perform analytical screening in the field which may include soils identification, headspace, pH, Eh, temperature, conductivity. All field screening methods will be selected to allow for real time data, while meeting data quality objectives. SOPs for the field methods are included in Appendix E.

B5 Quality Control Requirements

B5.1 Field Quality Control Requirements

QC procedures for pH, Eh, specific conductance, temperature of water samples, flame ionization detector (FID), photoionization detector (PID), and organic vapor measurement for soils will include calibrating the instruments as described in Section B7.2 of the QAPP, measuring duplicate samples and checking the reproducibility of the measurements by taking multiple readings on a single sample or reference standard. The thermometer used will be compared to a NIST traceable thermometer (or equivalent). Assessment of field sampling precision and bias will be accomplished through collecting field duplicates and field blanks for laboratory analysis. Collection of the samples will be in accordance with the applicable procedures in the SOPs located in Appendix E. Frequency of the collection of quality assurance samples is presented in Table 4. Field collection techniques must be conducted to ensure that samples will not be field filtered or otherwise transferred from one sample container to another (with the exception of field filtered metal samples) and that whenever possible, samples will be collected from the dirtiest location to the cleanest whenever the nature of the contamination is known. Field collection techniques must also ensure that water samples for volatile analysis are not collected in a manner which allows for headspace within the sample vials.

B5.2 Laboratory Quality Control Requirements

The laboratories proposed for use on this project ensure the production of quality analytical data through the use of overall quality assurance systems that are supported by documented quality control checks.

B5.2.1 Quality Assurance Program

The main objectives of Legend's QA Programs are to assure that the laboratory generates data of known quality, that data meets or exceeds all QA/QC criteria, and that records necessary to document laboratory performance are maintained. QA oversight is performed throughout sample processing from initial order/entry, through the analytical system, to the final report. The QA Officer is responsible for monitoring compliance with the laboratory Standard Operating Procedures, and established Good Laboratory Practices (GLPs). Additionally, the QA/QC Officer has the responsibility of providing feedback to management and identifying and implementing policies to improve quality.

All laboratory procedures are documented in writing as SOPs. Internal quality control procedures for analytical services will be conducted in accordance with their standard operating procedures and the individual method requirements in a manner consistent with appropriate U.S. EPA procedures, 40 CFR Part 136 and SW846. The analytical SOPs are presented in Appendix C.

B5.2.2 Quality Control Checks

The particular types and frequencies of quality control checks analyzed with each sample are defined in the laboratory SOPs and QAM. All analytical procedures are documented in writing as SOPs and each SOP includes a QC section, which addresses the minimum QC requirements for the procedure. The internal quality control checks might differ slightly for each individual procedure but in general the QC requirements include the following:

- Method blanks
- Reagent/preparation blanks (applicable to inorganic analysis)
- Instrument blanks
- Matrix spikes/matrix spike duplicates (MS/MSDs)
- Surrogate spikes (applicable to organic analysis)
- Field duplicates
- Laboratory duplicates
- Laboratory control standards
- Internal standard areas for GC/MS analysis
- Mass tuning for GC/MS analysis
- Proficiency Testing Blind Standard

Refer to the submitted SOPs (Appendix C), and the Laboratory Quality Assurance Manual in Appendix B for a description of the specific QC requirements and the frequency of internal and external audits.

All data obtained will be properly recorded. The data package will include summary QC data to allow the recipient to evaluate QC results and compare it to applicable criteria. All samples analyzed and appearing in nonconformance with the QC criteria, will be reanalyzed by the laboratory, if sufficient volume is available. It is expected that sufficient volumes/weights of samples will be collected to allow for reanalysis when necessary.

B5.3 Field Quality Control Requirements

Barr ensures the production of quality field data through the use of overall quality assurance systems that are supported by documented quality control checks. These checks include instrument calibration standards and field blanks.

B6 Instrument/Equipment Testing, Inspection and Maintenance Requirements

B6.1 Field Equipment

Barr staff and/or subcontractors perform routine preventive maintenance of instruments based on manufacturers' recommendations and schedules. Equipment usage and calibration standards are obtained from the manufacturer of that equipment or from a recognized standard source. Field equipment maintenance information is provided in the SOPs (Appendix E).

B6.2 Laboratory Equipment

Legend performs routine preventive maintenance of instruments based on manufacturer's recommendations. Maintenance of the laboratory instruments is the responsibility of the analyst. Laboratory equipment maintenance information is provided in Section 8 in Legend's QAM.

B7 Instrument Calibration and Frequency

This section describes procedures for maintaining the accuracy of all the instruments and measuring equipment which are used for conducting field and laboratory analyses. These instruments and equipment are calibrated prior to each use or on a scheduled, periodic basis.

B7.1 Laboratory Instruments

Procedures for initial calibration and continuing calibration verification are in place for all instruments within the laboratory. The calibrations generally involve checking instrument response to standards for each target compound to be analyzed. The source and accuracy of standards used for this purpose are integral to obtaining the best quality data. Standards used at the laboratories are prepared from pure standard materials or purchased. All standards in solution are stored in a discrete freezer or refrigerator in the applicable laboratory section. Each standard is discretely designated. The information is stored in a standards book and/or electronically within the laboratory database. .

Instruments are calibrated and recalibrated at regular intervals as specified in the applicable SOP, and consistent with EPA or Standard Methods methodology.

The frequency of calibration and calibration verification, number of points calibrated, and acceptance criteria for each of the instruments to be used are provided in the SOPs.

Additional information on laboratory calibration procedures is included in laboratory SOPs located in Appendix C.

B7.2 Field Equipment

All field equipment is tested and maintained when needed using manufacturers' recommendations and labeled with most recent calibration date.

B7.3 Field Instrument Calibration

The field instruments will be calibrated as described in the manual provided by the manufacturer. Field instruments include an organic vapor analyzer (PID), water quality meter (to measure pH, temperature, conductance, and dissolved oxygen), and a balance. As a rule, instruments will be calibrated daily prior to use.

The calibration procedures performed will be documented in the field report and will include the date/time of calibration, name of person performing the calibration, reference standard used, and readings taken on the standard. Multiple readings on one sample or standard or on replicate samples will also be documented.

B8 Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables that will be used for the projects include, sample jars, sampling equipment and various analytical reagents and gasses.

All sample jars and analytical reagents will be supplied by each laboratory and be acquired from approved vendor sources. The laboratory will acquire only pre-cleaned, certified sample jars approved for the analytes/methods cited in Table 1 per EPA specifications. Trip Blanks for volatile analysis will be provided by the laboratory. All pre-preserved sample jars will be shipped to the site in accordance with federal shipping guidelines. All gasses and reagents will be supplied by approved vendors or be traceable to standard lots, and if any variation in method performance occurs, this will be compared to the change of an analytical reagent. If there is any correlation between a reagent lot and the method variations, that reagent lot may be isolated for further analysis.

Sample jars will not be accepted at any site if there is more than 10% breakage of the jars upon receipt. If the sample jars contain preservative and are broken in the receiving container, none of the sample jars in that container will be used for sampling.

All sampling equipment will be examined upon receipt from various vendors. In the case of sampling gloves, if any physical tears or discoloration exists on the gloves, they should not be used. Sampling scoops that have obvious physical damage should also not be used.

All other consumable equipment will be examined on-site and a determination as to its usability will be made based upon the product's physical appearance.

B9 Data Acquisition Requirements for Non-Direct Measurements

Existing chemical data from previous investigations at this site were used to design the scope for this investigation. Historical data were reviewed for quality assurance.

B10 Data Management

All data generated through field activities or by the laboratory shall be reduced and validated prior to reporting. No data will be disseminated by the laboratory until it has been subjected to the procedures summarized in subsections below:

B10.1 Data Collection

Most outputs are generated through computer programs that have been validated by the manufacturer prior to laboratory purchase of the instrumentation. The instruments have programs available for the analysts to manually verify integrations and quantitations as part of the manufacturer's software package. Manual verification is routinely performed annually.

B10.2 Data Reduction

Data reduction includes all processes that change either the instrument/computer-generated values, quantity of data values or numbers of data items, and frequently includes computation of summary statistics. In most cases, a programmable calculator, computer spreadsheet or computer program is used to generate statistical information. The documentation allows the reviewer to verify the validity of the data reduction process.

An extra significant figure (may be more than one) is carried through all calculations until the final, reportable result is generated. Analytical results are never corrected for blank (background) contamination.

In the data review process, the data produced are compared to information concerning the sample processing history, sample preparations, sample analysis, and associated QA data to evaluate the validity of the results. In addition, any project-specific requirements are reviewed for data compliance.

B10.2.1 Field Data Reduction Procedures

Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. The use of pH meters, thermometers, FIDs/PIDs, and specific conductance probes will generate measurements directly read from the meters following calibration per manufacturer's recommendations as outlined in Section B7.2 of this QAPP. Such data will be written into field data sheets immediately after measurements are taken. If errors are made, results will be legibly crossed

out, initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. Later, when the results forms required for this study are being filled out, the Barr QA manager and project manager, will proof the forms to determine whether any transcription errors have been made by the field crew.

B10.2.2 Laboratory Data Reduction Procedures

Laboratory data reduction procedures will be followed according to the following protocol: All data are generated by the analyst and either manually entered or electronically transferred into an electronic report from the software used to process the original data set. Copies of printouts (such as gas chromatograms) will be maintained on file.

Errors are noted, corrections are made, but the original notations are crossed out legibly. Analytical results for soil samples shall be calculated and reported on a dry-weight basis (if sufficient volume has been submitted for the percent moisture measurements). One hundred percent of the analytical data is peer reviewed.

Quality control data (e.g., laboratory duplicates, surrogates, MS/MSDs) will be compared to the method acceptance criteria. Data considered to be acceptable will be entered into the laboratory computer system. Final data packages will be sent to the Laboratory Project Manager for review. Upon approval the data packages will be sent to Barr. Unacceptable data shall be appropriately qualified in the project report. Case narratives will be prepared which will include information concerning data that fell outside acceptance limits, and any other anomalous conditions encountered during sample analysis. After reported by the laboratory, they are considered ready for third-party data validation. More information on laboratory data reduction can be found in the individual analytical SOPs located in Appendix C.

B10.3 Data Validation

Data validation procedures shall be performed for all laboratory data following the Barr SOPs included as Appendix F.

B10.3.1 Procedures Used to Evaluate Field Data

Procedures to evaluate field data for this project primarily include checking for transcription errors and review of field notebooks, on the part of field crew members. This task will be the responsibility

of the Barr Field Manager, who will otherwise not participate in making any of the field measurements, or in adding notes, data or other information to the notebook.

B10.3.2 Procedures to Review Laboratory Data

The data will be reviewed in accordance with Barr's Data Validation SOPs, located in Appendix F, which are based on the U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review, 1999/2002.

Barr data assessment will be accomplished by the joint efforts of the QA Manager and Project Manager. The data assessment by the project manager will be based on the criteria that the sample was properly collected and handled according to the associated work plan and QAPP.

The Barr QA Manager will conduct a systematic review of the data for compliance with the established QC criteria based on the spike, duplicate and blank results provided by the laboratory. Essentially, all technical holding times shall be reviewed; results of all blanks, surrogate spikes, MS/MSDs, laboratory control samples, and system performance checks shall be reviewed. One hundred percent of the data shall be reviewed.

The data reviewer will identify any out-of-control data points and data omissions and interact with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analyses may be made by the project manager based on the extent of the deficiencies and their importance in the overall context of the project.

All data generated for the projects will be computerized in a format organized to facilitate data review and evaluation. The computerized data set will include the data flags applied by the laboratory, as well as any additional data flags by the Barr QA Manager following the data validation process (Appendix F). The laboratory-provided data flags will include such items as when a concentration below required reporting limit and concentration of chemical(s) were found in laboratory blank. The data reviewer comments will indicate that the data are: (1) usable as a quantitative concentration, (2) usable with caution as an estimated concentration, or (3) unusable due to out-of-control QC results.

The overall completeness of the data package will also be evaluated by the Barr QA manager. Completeness checks will be administered on all data to determine whether deliverables specified in the QAPP are present. At a minimum, deliverables will include sample chain-of-custody forms,

analytical results, and QC summaries. The QA Manager will determine whether all required items are present and request copies of missing deliverables.

B10.4 Data Reporting

Data reporting procedures shall be carried out for field and laboratory operations as indicated below:

B10.4.1 Field Data Reporting

Field data reporting shall be conducted principally through the transmission of report sheets containing tabulated results of all measurements made in the field. Field documentation of field instrument calibrations, well logs, boring logs, sample identifications, etc. will be contained in the final field reports. Examples of field forms used for final field reports are included in Appendix G.

B10.4.2 Laboratory Data Reporting

Laboratory analyses reports will generally be submitted to Barr Engineering Co. within four weeks of the receipt of samples. The Laboratory Project Manager performs a final review of the report summaries and case narratives to determine whether the report meets project requirements. In addition to the record of chain-of-custody, the report format shall consist of the following:

- Date of issuance
- Any deviations from intended analytical strategy (in case narrative)
- Laboratory batch number
- Quality control procedures utilized and also references to the acceptance criteria
- Project name and number
- Condition of samples 'as-received'
- Discussion of if holding times were not met
- Discussion of technical problems or other observations which may have created analytical difficulties (in case narrative)
- Discussion of any laboratory quality control checks which failed to meet project criteria(in case narrative)

- Signature of the Laboratory Project Manager and Report Reviewer
- Sample collection and receipt date
- Extraction /digestion and analysis dates
- Cross referencing of laboratory sample to project sample identification numbers
- Sample preparation and analyses date for samples
- Sample data (including units and percent moisture / solid data used in dry weight corrections – if applicable)
- MS/MSD , LCS/LCSD and method blank data (percent recoveries and RPDs)
- QC data summary
- Laboratory reporting limit and method detection limits for each analyte
- Method used for analysis
- All sample results and their associated raw data for samples, quality control samples, method blanks
- Percent recovery of surrogate compounds.
- Electronic data deliverable
- Data qualifier description

Data will be received in an electronic format compatible to the Barr laboratory information management system (LIMS). Any data received in non-electronic form will be entered into the Barr LIMS database and output in spreadsheet format to be used in reports.

B10.5 Data Retention

Raw data generated for this project will be stored by the laboratory for five years. Final laboratory reports are kept in archive files by Barr Engineering Co. indefinitely.

B11 Data Acquisition Requirements

B11.1 Previous Data Collection

Data previously generated for this site will be utilized for decisions in accordance to the level of quality control performed for each event.

C Assessment and Oversight

C1 Performance and System Audits

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the work plan and QAPP. The audits of field and laboratory activities may include two separate independent parts: Internal and External audits.

C1.1 Field Audits

Internal audits of field activities (sampling and measurements) are conducted by the Barr QA Manager. The audits will include examination of field sampling records, field instrument operating records, maintenance of QA procedures, sample collection, handling and packaging in compliance with the established procedures. The audit will also include examination of QA procedures and chain-of-custody procedures to ensure they are being followed correctly. A copy of the field audit checklist is included as Appendix I. While the QA Officer may perform field audits, no field audit for this project is anticipated.

C1.2 Laboratory Audits

Many of the objectives of a routine audit are similar to those a client or independent auditor would hope to accomplish during an on-site laboratory evaluation and data audit. These goals include the following:

- Documented quality control and quality assurance procedures, including necessary corrective actions, are being applied.
- Adequate facilities and equipment area are available to perform the client's required scope of work.
- The personnel are qualified to perform the assigned tasks.
- Complete documentation is available, including sample chain-of-custody.
- Proper analytical methodology is being applied.
- Acceptable data-handling techniques are being used.

- Corrective actions identified in any previous on-site visits have been implemented.
- The laboratory management continues to demonstrate a commitment to quality.

In response to an audit, any corrective actions taken are noted with reference to the auditor's deficiency report and the laboratory's SOPs.

C1.2.1 Internal Audits

Internal audits of laboratory activities are conducted by the Laboratory QA Manager or their qualified designee (internal auditor). The audit may be either scheduled or unannounced before it is conducted. A system audit is an on-site inspection and review of one system in the QA/QC program for the laboratory. A performance audit could include the evaluation of one individual or procedure performed in the laboratory. While performance audits are a quantitative appraisal, system audits are for the most part qualitative in nature. The auditor may: (1) review the laboratories' SOPs to verify compliance with EPA procedures; (2) review hands-on procedures to ensure compliance with written SOPs; and (3) verify that proper corrective action has been taken. Personnel and facilities may also be evaluated during an audit.

If deficiencies are observed during an audit, and if deemed necessary, a findings report will be initiated. A findings report will include sufficient detail as to all remedial actions taken. The findings report indicates the proposed implementation date and the individual(s) responsible for the corrective action. A follow-up audit or other documentation may be needed to conclude the corrective action.

C1.2.2 External Audits

Laboratory performance will be evaluated by reviewing the QC procedures, SOPs, and qualifications of the laboratory. In addition to the document review, an on-site laboratory visit and evaluation is included to evaluate the audit items indicated above. Legend has participated in Barr's independent QA audit program for over 10 years, is audited on a biennial schedule and participates in Barr's blind sample program. All audit results are on file at Barr. Legend's last Barr audit occurred in February 2009 with favorable findings. No non-conformance issues were identified.

C1.2.3 Preventative Maintenance

Routine preventative maintenance is performed on laboratory(s) equipment as scheduled by laboratory personnel in accordance with the laboratories QAMs and SOPs included in Appendices B and C.

C2 Corrective Actions

Corrective actions may be required for two classes of problems: (1) a deficiency that does not adversely affect data; and (2) a deficiency that does affect data. A problem could occur from the time samples are collected up until data is reviewed, including: sampling and sample handling, sample preparation, laboratory instrumental analysis, and data review.

For any problem, a corrective action will be determined and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the Project Manager.

Any nonconformance with the established quality control procedures in the QAPP will be identified and corrected in accordance with the QAPP.

Field corrective actions will be implemented and documented in the field log book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by the Project Manager.

C2.1 Sample Collection

Technical staff and project personnel will be responsible for reporting all suspected technical or QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the Barr Field Manager. The Barr Field Manager will be responsible for assessing the suspected problems, in consultation with the Barr Project QA Manager and the Barr Project Manager, and making a decision based on the potential for the situation to impact the quality of the data. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated by the Barr Project Manager.

The Barr Project Manager will be responsible for verifying that corrective action for nonconformances are initiated by:

- Evaluating all reported nonconformances
- Controlling additional work on nonconforming items
- Determining disposition or action to be taken
- Maintaining a log of nonconformances
- Reviewing nonconformance reports and corrective actions taken

- Verifying inclusion of nonconformance in the final site documentation in project files

If appropriate, the Barr Project Manager will see that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

The Barr Project Manager or his designee is responsible for all site activities. In this role, the designee at times is required to adjust the site programs to accommodate site-specific needs. When it becomes necessary to modify a program, the responsible person notifies the Barr Project Manager of the anticipated change and implements the necessary changes after obtaining the approval of the Barr Project Manager. The Barr Project Manager must approve the change in writing or verbally prior to field implementation, if feasible. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from the established practices, and determine action to be taken.

The Barr Field Manager for the Site is responsible for the controlling, tracking, and implementation of the identified changes. Reports on all changes will be distributed to all affected parties.

C2.2 Laboratory Analyses

When nonconformances occur, analysts notify their immediate supervisor. The laboratory supervisor will evaluate the problem and decide what corrective action is required. The following guidelines are used to validate data, and determine what, if any, corrective action is necessary.

- Verify all calculations which use raw laboratory data, including sample aliquots, dilution factors, linear regression calculations, etc.
- Verify that method specific matrix interference procedures were followed. Check the analytical data which was generated for other field samples in the same analytical batch in order to determine whether the problem is unique to a single sample (a possible matrix problem).
- Review the analytical procedure with the analyst to make certain that the required procedures and sample preparation techniques were performed correctly.
- Check the initial calibration data to verify that instrumental operating requirements were met prior to starting sample analysis.
- Verify that quality control sample checks were analyzed at the proper frequency and that quality control sample performance criteria requirements were met.

- Determine if an alternative method would be more appropriate for sample analysis.
- Review log-in and chain-of-custody information to determine if sample conditions may have been affected between sampling and receipt of sample.

When a definitive explanation for the problem cannot be determined, sample reanalysis is required. All nonconformances and corrective action procedures taken to correct the problem must be documented and included in the job file.

If the nonconformance has not been corrected and the validity of the data is in question, the laboratory director, laboratory QA Officer, or Laboratory Project Manager must contact Barr. All actions will be documented in the applicable work order file.

The laboratory quality assurance department is also responsible for implementing the internal audit protocol which verify compliance with laboratory SOPs and assist in identifying and correcting any deficiencies. Follow-up audits verify that proper corrective action has been taken for the identified discrepancy.

Barr may request corrective action for any nonconformance identified by audits or data validation. Corrective action may include:

- Reanalyzing the samples, if holding time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling procedures and/or evaluating and amending analytical procedures; and/or
- Accepting data and acknowledging the level of uncertainty.

C3 Quality Assurance Reports to Management

The final report will contain QC sections that summarize data quality information collected during the project. Included in this report will be a discussion of the field activities during sample collection, a brief discussion of the QA/QC activities conducted by the laboratory, a summary of the data validation procedures performed by Barr on the laboratory data, and tabulated results of analytical data.

D Data Validation and Usability

D1 Data Review, Validation and Verification

D1.1 Data Review and Validation

For the purposes of this document, data validation is defined as the evaluation of the technical usability of the data. Data verification is defined as the determination of adherence to SOPs, the field sampling plan, the QAPP, and the laboratory(s) quality assurance plan.

Data review and validation will be performed as presented below. Verification is accomplished through laboratory audits and review of QC data.

D1.2 Laboratory Data Review and Validation

Data validation takes place on two levels. The first level of review occurs "at the bench." Analysts are charged with the responsibility of monitoring all laboratory QA/QC activities, and verifying that systems are in control. Data validation also occurs on a sample-by-sample basis. The initial review is performed by the instrument operator or analyst who is responsible for assessing the following:

- Cross-checking all sample identification numbers on work sheets, extract vials/digestate bottles, and instrument outputs.
- Calculation of surrogate recoveries and internal standard responses (when applicable), and verification that QA acceptance criteria are met.
- Verification that all calibration, tuning, linearity, and retention time drift checks are within QA acceptance criteria.
- Determination that peak chromatography and other instrument performance characteristics are acceptable.
- Confirmation that chain-of-custody is intact based on accompanying paperwork.
- Verification of all preparative and analytical procedures was conducted within method suggested holding times.

The area supervisor and/or technical supervisor perform the second level of validation and review. The analyst, technical reviewer, and/or the Laboratory Project Manager are responsible for the QC and data review of analyses and reports. The QC review of QC analyses and applicable calibrations is completed and includes the following:

- Confirmation that all quality control blanks meet QA requirements for contamination, and that associated sample data are appropriately qualified when necessary.
- Calculation of matrix spike recoveries and duplicate RPDs, and confirmation that accuracy and precision QA criteria are met or appropriately flagged when necessary.
- Comparison of all injections of a sample and comparison of matrix spikes with the original unspiked sample for acceptable replication.

After QC review the data are sent to report preparation. The final report review includes both data review and a review of report accuracy. The data review includes confirmation of all assessments previously made by the operator/analyst, and includes an evaluation of the qualitative identification of all target analytes using specific SOP interpretation criteria.

Data generated by the analyst is reviewed by a technical reviewer for data completeness and accuracy.

The final report review will assess the complete data report for completeness, accuracy of reported hits, comparison to target analyte lists, and comparison with project QC requirements. The Laboratory Project Manager generates and reviews the final report and reviews as summarized below:

- Making a comparative evaluation of data from individual fractions of a sample, and of samples from the same sit for consistency of analytical results and resolution of discrepancies.
- Checking data report or case narrative for completeness.
- Verifying QAPP specific requests have been met.

D1.3 Field Data Review and Verification

Field data is reviewed by both the QA Manager and the Field Manager. Additionally, during preparation of the final field report, technical field staff verifies their documentation for accuracy and

completeness. The QA Manager and the Barr Project Manager additionally check for completeness, representativeness and any transcription errors. If any errors are detected, the field personnel will be contacted and corrective action will be initiated.

D1.4 Barr Data Review and Validation

The data will be reviewed in accordance with Barr's Data Validation SOPs, located in Appendix F, which are based on the U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic and Inorganic Data Review, 1999/2002. Data validation procedures will use the method-specific QC acceptance limits specified in the EPA SW-846 methods and SOPs.

The specific requirements which will be checked during data validation are:

1. Holding times
2. Method blank data
3. Surrogate recovery
4. Laboratory Control Sample data
5. Matrix spike data
6. Duplicate analyses data
7. Overall data assessment

Upon completing the validation procedure for all data, a quality control review report will be compiled and submitted. The Barr SOP for data review is included as Appendix F.

D1.5 Data Verification

Data verification is defined as the determination of adherence to SOPs, the field sampling plan, the work plan, the QAPP, and the laboratory QAMs. Internal and external laboratory audits measure adherence to these elements. In addition, internal and external verification of adherence to these elements will be completed through the evaluation of field and laboratory documentation.

D2 Validation and Verification Methods

Data validation methods to be used are based on the following documents:

- The National Functional Guidelines for Inorganic Data Review (EPA 540/r-99/013)
- The National Functional Guidelines for Organic Data Review (EPA 540/R-02/012)

A brief overview of procedures for evaluating and reviewing the data are included below:

Holding Times: Compare the time and date the sample was collected (on the chain-of-custody) to the date analyzed in the laboratory data package. Verify the dates are within the SW-846 recommended holding times for the particular method.

Method Blank Data: Verify through the method blank sample data results that no significant laboratory contamination issues exist.

Surrogate Recovery: Verify the percent recovery of each surrogate falls within acceptable laboratory quality control limits included in each laboratory report, or the Barr SOP presented in Appendix F.

Laboratory Control Sample Data: Verify the percent recovery of the spiked compounds is within acceptable laboratory criteria included in each laboratory report, or the Barr SOP presented in Appendix F.

Matrix Spike Data: Verify the percent recovery of the spiked compounds is within acceptable laboratory criteria included in each laboratory report, or the Barr SOP presented in Appendix F.

Field Duplicate Analysis Data: Calculate the relative percent difference for all detections of target compounds above the laboratory reporting or minimum detection limits, and compare them to the acceptance criteria included in each laboratory report, or the Barr SOP presented in Appendix F.

Overall Data Assessment: Examine the data package as a whole and compare it to (1) the chain-of-custody to verify completeness, (2) the historical data to verify representativeness (3) the other site data to verify comparability is being achieved.

Qualification of the data may result if the evaluation criteria for data validation are not met. All data qualification will be presented on the tabulated form of the data, and in the QA review sections all site reports.

D3 Reconciliation with Data Quality Objectives

D3.1 Specific Procedures to Assess Data Precision, Accuracy and Completeness

D3.1.1 Laboratory Data

Laboratory results will be assessed for compliance with required precision, accuracy, completeness and sensitivity as follows:

D3.1.1.1 Precision

Precision of laboratory analysis will be assessed by comparing the analytical results between MS/MSD and LCS/LCSD for organic analysis, and laboratory duplicate analyses for inorganic analysis. The relative percent difference (%RPD) will be calculated for each pair of duplicate analyses using the following equation:

$$\%RPD = \left| \frac{S - D}{(S + D)/2} \, x\, 100 \right|$$

Where: S = First sample value (original or MS value)
D = Second sample value (duplicate or MSD value)

D3.1.1.2 Accuracy

Accuracy of laboratory results will be assessed for compliance with the established QC criteria that are described in the specific SOPs using the analytical results of method blanks, reagent/preparation blank, matrix spike/matrix spike duplicate samples, field blank, and bottle blanks. The percent recovery (%R) of matrix spike samples and LCS will be calculated using the following equation:

$$\%R = \frac{A - B}{C} \, x\, 100$$

Where: A = The analyte concentration determined experimentally from the spiked sample;

B = The background level determined by a separate analysis of the unspiked sample; and

C = The amount of the spike added.

D3.1.1.3 Completeness

The data completeness of laboratory analyses results will be assessed for compliance with the amount of data required for decision making. The completeness is calculated as described previously.

D3.2 Data Quality Assessment

The data will be compiled from each investigation phase and summarized in tabular and/or graphical form.

The data quality assessment process will involve multiple steps depending on the results of the data validation process. Data that has been qualified (by the laboratory or by Barr) will be assessed for the particular circumstances surrounding the sample. For example, if multiple compounds are detected in a method, field or trip blank and in the associated samples at comparable levels (as defined in Appendix F), the data result will likely be treated as a false positive; however, if the sample location is critical (i.e., compliance boundary), the data may be treated as non-false positive or rejected and resampled. This also applies to qualifications based on failure to meet matrix spike/matrix spike duplicate criteria if the sample or contaminant affected is critical to the project decision-making, in which case corrective actions may result. Corrective actions may include resampling and/or reanalysis of the sample. Detection limits may be elevated above appropriate criteria due to dilutions or matrix interferences. In this case, the necessity of the data will be evaluated as with the previous examples and potential corrective actions may include (a) reporting the data result as equal to the method detection limits and using the qualified data, or (b) resampling of critical samples.

Additional factors that may be considered when evaluating the data include:

- Data time-series or historical trends.
- Spatial distributions of results such as similar and dissimilar results from adjacent sample locations.
- Outlier analysis (when statistical sampling protocols are used).
- Statistical interpretation of large data sets (sample sizes) when statistical sampling protocols are used.

- The relationship of detected results to known site history information. For example, soil results indicating a possible chemical release beneath a bulk chemical storage and loading area or beneath a former storage tank location.
- The relationship of detected results to other transient site conditions such as dynamic contaminant migration through vadose zone soils or as a solute plume in migrating groundwater.
- The relationship of detected results to site conditions such as geologic stratigraphy, historic site development (filling, previous demolition), proximity to neighboring contamination sources.

The results will be compared to the project quality objectives that are summarized in Section A9.1.1.8 of this QAPP and summarized in Table 2.

D3.2.1 Sensitivity

Laboratory sensitivity will be assessed by comparing the analytical reporting or minimum detection limits to the applicable site standard criteria (Table 1). If the analytical detection limits presented are greater than the listed site criteria, the following procedures will be applied and a decision on the site data will be made;

- Verify the laboratory cannot achieve lower detection limits for the parameter of interest.
- Examine other matrices at the site for detections of parameter of interest.
- Establish historical likelihood that the parameter in question is a contaminant of concern.

Examine all positive detections in the samples of interest to identify if like-compounds are present.