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QUALITY ASSURANCE PROJECT PLAN
DUBLIN TCE SITE
DUBLIN, PENNSYLVANIA

May 1992

Prepared for

Sequa Corporation
3 University Plaza
Hackensack, New Jersey 07601

Prepared by

Geraghty & Miller, Inc.
201 West Passaic Street
Rochelle Park, New Jersey 07662
(201) 909-0700

1.0 TITLE PAGE

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Prepared by Geraghty & Miller, Inc. Date: May 7, 1992

Joseph Minster Date: 5/7/92
Geraghty & Miller, Inc. Project Officer
Joseph Minster

Barbara A Dolce Date: 5/7/92
Geraghty & Miller, Inc. Project Manager
Barbara A. Dolce

Lidya Gulizia Date: 5/7/92
Geraghty & Miller, Inc. Quality Assurance Officer
Lidya Gulizia

Dennis N. Flynn Date: 5-6-92
Enseco East Quality Assurance Director
Dennis Flynn

____________________ Date: ________
USEPA Region III Project Manager
Dianne J. Walker

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3.0 INTRODUCTION

Geraghty & Miller, Inc. has prepared this Quality Assurance Project Plan (QAPP) for the Sequa Corporation (Sequa) to establish sampling and analysis protocols and quality assurance/quality control (QA/QC) procedures for data collection and data analysis activities at the Dublin TCE Site in Dublin, Bucks County, Pennsylvania. These procedures are to be used in conjunction with the Remedial Investigation/Feasibility Study (RI/FS) being conducted by Geraghty & Miller at the Dublin TCE Site in response to an Administrative Order on Consent (Consent Order), between Sequa and the United States Environmental Protection Agency (USEPA) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

This QAPP has been prepared in accordance with the USEPA guidance, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" (USEPA 1980). The procedures in this QAPP will be implemented to ensure that the precision, accuracy, completeness, comparability, and representativeness of the data generated by this RI/FS can be documented. Project organization, policies, objectives, field investigation procedures, and laboratory activities are presented in this QAPP, as well as QA/QC requirements for the RI/FS activities outlined in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a). The laboratory contracted is a participant in USEPA's Contract Laboratory Program (CLP) and will adhere to procedures specified in the Statement of Work (SOW) (USEPA 1990a; 1990b) and other methods specified in this QAPP. The laboratory QAPP is included as Appendix A of this document.

3.1 SITE DESCRIPTION

The Dublin TCE Site encompasses numerous contiguous properties where ground water containing volatile organic compounds (VOCs), primarily trichloroethene (TCE) has been identified. These properties extend in a northwesterly direction from the 120 Mill Street property, which the USEPA has identified as a potential source area. The USEPA has named Sequa, along with Mr. John Thompson, the current owner of 120 Mill Street, as potentially responsible parties (PRPs) for the Dublin TCE Site.

Dublin is located within the Triassic Lowlands section of the Piedmont Physiographic Province (Greenman 1955). The borough is situated in an upland area within a region of flat to rolling hills. The nearest surface water to the 120 Mill Street property is a small, intermittent, unnamed tributary that originates near the northern corner of the borough boundary. The tributary flows to the north into Bedminster Township where it enters Deep Run. Deep Run then flows to the northeast where it enters Tohickon Creek. No other surface streams are present within Dublin (United States Geological Survey 1983a; 1983b). A more detailed description of the site and the geology is included in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a).

3.2 SITE BACKGROUND

TCE was detected in ground water in the Dublin area during a routine drinking water survey in 1986 by the Bucks County Health Department. Several parties subsequently investigated various areas in Dublin and it was inferred from limited data that the 120 Mill Street property may be a possible source of TCE. The use of TCE by various former owners has been documented (TechLaw, Inc. 1987). A detailed site background and site history are included in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a).

3.3 TARGET COMPOUNDS AND REPORTING LIMITS

For this RI/FS, the target compounds for the ground-water samples were identified by reviewing the results of previous investigations at the Dublin TCE Site (TechLaw, Inc. 1987; Geraghty & Miller, Inc. 1990; BCM, Inc. 1988a, 1991; American Resource Consultants, Inc. 1991) and by incorporating specific target parameters recommended by the USEPA Region III to confirm their presence or absence at the site. During the previous investigations noted above, the following VOCs were detected in ground-water supply and/or monitoring wells: benzene, bromodichloromethane, bromoform, chloroform, cis-1,2-dichloroethene, cis-1,3-dichloropropene, dibromochloromethane, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloropropane, methylene chloride, TCE, tetrachloroethene (PCE), toluene, trans-1,2-dichloroethene, trans-1,3-dichloropropene, 1,1,1-trichloroethane, and vinyl chloride.

Similarly, the following VOCs were detected in soil samples and were identified by reviewing the results of previous investigations (BCM, Inc. 1988b; Geraghty & Miller, Inc. 1990; Roy F. Weston, Inc. 1988; Myers 1988): chlorobenzene, chloroform, 1,3-dichlorobenzene, 1,4-dichlorobenzene, ethylbenzene, toluene, total xylenes, TCE, trans-1,2-dichloroethene, 1,1,1-trichloroethane, trichlorofluoromethane, and vinyl chloride.

Based on this information and on the additional USEPA Region III requirements, analyses for the target compound list (TCL) of VOCs, base neutral and acid (BNA) semivolatile organic compounds, pesticides, and polychlorinated biphenyls (PCBs) will be performed on designated samples to characterize the site. In addition, analyses for the target analyte list (TAL) of total metals, and in some instances dissolved metals, grain size, total organic carbon (TOC), and a defined set of treatability parameters will be conducted. The TCL and TAL constituents for the RI/FS investigation will be those set forth in the

March 1990 CLP SOW protocols for multi-media, multi-concentration organic and inorganic analyses (USEPA 1990a; 1990b).

Quantitation limits and parameter lists are provided in Tables 3-1 through 3-9. These reporting limits are as specified in the analytical protocols and/or methods referenced on the tables. VOCs will be analyzed using various analytical protocols based on the RI/FS requirements, the data quality objectives (DQOs), and the sample matrices. The protocols have been tabulated accordingly. The specified quantitation limits will be met unless sample dilutions or unknown interferences make it necessary to raise them. If quantitation limits are raised, the laboratory will make every effort to achieve sample quantitation limits that are as low as possible and will report estimated concentrations at less than the reporting limit. In accordance with CLP protocols, soil and sediment samples analyzed using the SOW routine analytical services (RAS) protocols will be reported on a dry weight basis.

3.4 DATA QUALITY OBJECTIVES

The data collected during the RI/FS will be used to provide information for the following DQOs:

- Site characterization to delineate the extent of VOCs and other potential constituents present at the Dublin TCE Site.
- Risk assessment to identify potential receptors of exposure from ground-water constituents potentially emanating from the site.
- Assessment and confirmation of the adequacy of the treatment system.

- Characterization of wastes generated at the site originating from the field investigation.

The specific data collection objective for each of the above is discussed in Task 4 of the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a). These objectives are tabulated in Table 3-10 of this QAPP. At the site, field screening or analysis using portable instruments such as organic vapor analyzers (OVAs) and combustible gas analyzers (CGAs) will be used to monitor site conditions during drilling, sampling, and other investigative activities. These analyzers generate immediate semiquantitative results that are not compound-specific, but provide information relating to evolving site and sampling conditions and adequacy of health and safety procedures. Additional field analyses using somewhat more sophisticated analytical instrumentation and calculation techniques, such as those for performing field gas chromatography (GC), determinations of hydrogen ion concentration (pH), conductivity, and water-level measurements provide greater detail and corroborative information for existing site conditions.

Various levels of data quality are achievable based largely on the instrumentation and/or technique, by incorporation of suitable calibration standards, reference and quality control (QC) checks, and degree of operator training. Results are available immediately or shortly after sample collection. Decisions to obtain confirmatory analyses on specific samples that would uphold to more stringent validation procedures are often made by implementing these investigative procedures and by reviewing the results obtained in the field.

Field samples that are sent to the contracted analytical laboratory for confirmatory analysis and/or routine monitoring will be analyzed for parameters consistent with the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a) and this QAPP. Based on the DQOs discussed previously, analyses will be performed in accordance with standard USEPA drinking water methods (USEPA 1989), air sampling protocols (USEPA 1988a), SW-846 methodologies (USEPA 1986), CLP RAS protocols (USEPA 1990a; 1990b), and/or by other recognized methods specific to the parameter (American Society for Testing and Materials [ASTM] 1985; American Society of Agronomy, Inc. and Soil Science Society of America, Inc. 1982). Satisfactory completion and compliance to the DQOs will be assured by performing analyses in accordance with the stated methods and by requesting QA/QC procedures and deliverables to be sufficiently comprehensive so that a vigorous data validation assessment may be performed. All laboratory analyses in support of the Dublin TCE Site RI/FS will be performed in accordance with the requirements set forth in the Geraghty & Miller Analytical Quality Assurance/Laboratory Control Program (AQA/LCP). This program is an internal system whereby Geraghty & Miller audits and retains laboratories that meet a required set of QA/QC guidelines. These laboratories have internal systems tailored to suit Geraghty & Miller's specific project objectives.

Additionally, the AQA/LCP specifies requirements for frequency and type of field QC samples to be collected, QA/QC requirements, and laboratory deliverables. The requirements are specified for the field work and laboratory by a system of levels.

The levels, known as Levels I through Level IV, are structured in increasing complexity, with Level I comprising the base level of QA/QC procedures and final deliverables. Each successive level requires more rigorous QA/QC procedures and greater reporting to allow for validation of final results.

Levels II and III employ various standard USEPA and other recognized methods for analysis, depending on the project requirements. The final data reported, however, vary in that Level III deliverables require more raw, supporting QA/QC data to be included in the final data package. Although Level II QA/QC and analytical procedures may be equivalent to Level III, the final data package provides less raw, supporting QA/QC data as the remainder of the supporting data deliverables are retained on file at the laboratory.

Level IV analyses are performed in a laboratory following complete CLP protocols for RAS parameters. For non-RAS analytical parameters, CLP protocols are modified appropriately for the method. Laboratory deliverables for non-RAS parameters provide as similar as possible, if not equivalent CLP documentation and compliance to rigorous QC protocols. In terms of data validation, Levels I through III are characterized by less stringent validation and deliverables documentation procedures than those of Level IV CLP analyses. Level IV is characterized by strict validation procedures that allow minimal deviation in application, if any.

All laboratory analyses in support of the Dublin TCE Site RI/FS will be performed in accordance with Levels II, III, and IV of the Geraghty & Miller AQA/LCP. Levels were assigned based on the DQOs, selected analytical protocols, and sample matrices in accordance with the proposed tasks described in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a). Refer to Table 3-10 of this QAPP for a summary of proposed RI/FS Work Plan (Geraghty & Miller, Inc. 1992a) tasks and objectives and associated AQA/LCP analytical level assignments.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Geraghty & Miller will be responsible for the implementation of the RI/FS, including the supervision of subcontractor activities, field activities, interpretation, and evaluation of data.

4.1 PROJECT ORGANIZATION

The primary personnel involved in the project, their addresses, and telephone numbers are shown on Figure 4-1 and listed below.

Geraghty & Miller, Inc.
201 West Passaic Street
Rochelle Park, New Jersey 07662
(201) 909-0700

Project Officer:	Joseph Minster
Project Manager:	Barbara A. Dolce
Quality Assurance Officer:	Lidya Gulizia
Field Activities Coordinator:	Kevin A. McGuinness
Health and Safety Officer:	Rekha Dolas

The project officer will be responsible for committing the necessary human resources of the firm to this project. The project manager will be responsible for day-to-day operations, adherence to schedules, and work quality.

The laboratory audit will be performed by a Geraghty & Miller regional quality assurance (QA) manager and/or the project QA officer. The field audit will be performed by the project QA officer and the project manager, and/or the regional QA manager. As discussed previously in Section 3.4 (Data Quality Objectives), Geraghty & Miller routinely audits laboratories as part of the AQA/LCP. Audits are performed by senior members of the AQA/LCP staff with demonstrated experience and knowledge of QA/QC procedures, and field and laboratory operations.

Analytical services will be provided by Enseco East, a laboratory division of Enseco Incorporated located in Somerset, New Jersey. Enseco East is a participant in the USEPA CLP for multi-media, multi-concentration organic analyses and is contracted through CLP OLM01.1.1. Additionally, Enseco East participates in the USEPA quarterly round-robin proficiency testing for organic and inorganic parameters. Laboratory analyses of all samples will adhere to the internal QA/QC procedures of Enseco East. These internal QA/QC procedures are detailed in the laboratory QAPP, which is included with this document as Appendix A. These procedures meet or exceed USEPA QA/QC requirements under the CLP SOW (USEPA 1990a; 1990b). A project management organization chart for Enseco East in support of the Dublin TCE Site is presented on Figure 4-2.

The review of gas chromatographic/mass spectrometric (GC/MS) tentatively identified organic compounds will be performed by the laboratory GC/MS volatile and semivolatile department analysts under the supervision of the organic laboratory director, Shu-Wen Kao. Ms. Kao has 10 years experience in the interpretation of mass spectra. A complete organizational chart for Enseco East may be found in the laboratory QAPP provided in Appendix A. Resumes for key laboratory staff are included in the appendix to the laboratory QAPP (Appendix A).

The evaluation of laboratory data by Geraghty & Miller will be performed by project chemists and data validators trained in the review of analytical data and data validation protocols. The QA officer will be responsible for reviewing the data assessments and will attest to the validity and representativeness of the data. Data collected in the field will be processed by the field activities coordinator and reviewed by the project manager and the QA officer. If quality assurance issues requiring special attention are identified, the project officer, project manager, and QA officer will ascertain the appropriate corrective action(s) and implement it (them).

Other technical advisors will be available, as needed, to provide expertise for various disciplines. An organizational chart for Geraghty & Miller personnel is provided on Figure 4-1 and qualification summaries for all key project personnel, auditors, and data validators are provided in Appendix B.

4.2 FIELD ORGANIZATION

Field investigations and activities will be according to the programs and schedules presented in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a). Selection of the sampling team members will depend on the type and extent of sampling, and will consist of a combination of one or more of the following:

- Field activities coordinator.
- Field hydrogeologist(s).
- Sampling coordinator.

- QA officer.
- Site health and safety officer.

The project manager will be responsible for coordinating on-site personnel and providing technical assistance when required.

Field hydrogeologists will be responsible for sample collection, chain-of-custody documentation, and sample shipment. A sampling coordinator will be designated by the project manager. This individual will be responsible for all sampling efforts and for assuring that the necessary shipping and packing materials and sampling equipment are available. The sampling coordinator will also be responsible for completing sampling documentation, including daily logs, water-sampling logs, calibration logs, and chain-of-custody forms. All documentation will conform to the guidelines contained within the QAPP and the Document and Data Management Protocols, which are appended to the Field Sampling Plan (FSP) (Geraghty & Miller, Inc. 1992b). The field activities coordinator will be responsible for the verification of field records and measurements in terms of accuracy of transcription, content, and precision and accuracy data. Sample bottles, preservatives (if necessary), and shipping coolers will be provided by the laboratory.

The QA officer will be responsible for the implementation of this QAPP during the field investigation. Adherence to these procedures will facilitate the collection of high quality data and increase data usability. If the guidelines described in this plan require modifications due to site conditions, changes to the work plan, or any other reasons, the QA officer will be notified, and the changes will be documented and implemented.

The site health and safety officer will be responsible for assuring that all team members adhere to the site health and safety requirements. Additional responsibilities are detailed in the Health and Safety Plan (Geraghty & Miller, Inc. 1992c).

5.0 QUALITY ASSURANCE OBJECTIVES

The overall quality assurance objective is to ensure that all data collected during field activities are of known and acceptable quality. Specific laboratory QA/QC procedures and DQOs are described in Appendix A.

The quality assurance objective parameters (precision, accuracy, completeness, representativeness, and comparability) used to ensure that data of acceptable quality are obtained, are described in detail below.

5.1 PRECISION

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of standard deviation and/or relative percent difference. Various measures of precision exist depending upon the "prescribed similar conditions." The precision of an analytical method, field measurement, or sampling technique is measured through duplicate analyses, or replicate measurements.

Measurements of the precision of laboratory-generated data are necessary to demonstrate the reproducibility of the data. Precision is evaluated by calculating the relative percent difference (RPD) between duplicate analyses. Duplicate control samples and matrix spike samples will be analyzed at the rate specified in the laboratory QAPP (Appendix A) and/or the analytical protocols to be used for the site investigation. Duplicate control samples (blank water spikes) are used to assess non-matrix-specific precision, while matrix-spike duplicates are used to assess matrix-specific precision. Using both helps determine the source(s) of inadequate precision and therefore makes the necessary corrective action easier to identify. The acceptable range of precision for each parameter will be within those specified by the CLP SOW (USEPA 1990a; 1990b) for RAS parameters. The method and/or laboratory-established limits for all other parameters will apply. In duplicate and replicate sample analyses where constituents are not detected or are present at estimated to low concentrations, professional judgment will be used in assessing precision.

The precision of field measurements will be assessed through replicate measurements, and acceptable results will vary by less than 20 percent (RPD). The precision of sampling will be assessed through a comparison of field replicate results. However, as sampling precision is difficult to quantify, it will be assessed qualitatively. An estimate of the number of field replicate samples is included in Table 5-1.

5.2 ACCURACY

Accuracy describes the degree of agreement of a measurement with an accepted reference or "true" value. Accuracy can also be described as a measure of the bias in an analytical system. Analytical accuracy will be determined from (1) the analyses of standard reference materials of known and traceable purity and quality, (2) the analyses of surrogate or system monitoring compounds, and (3) the analyses of blank and matrix samples fortified with representative analytes for the analytical fraction.

All samples for organics analyses will be spiked with surrogate or system monitoring compounds. The surrogate or system monitoring compounds used will be those specified in the CLP SOW or the designated analytical method. The results will be evaluated using the acceptance criteria specified in the CLP SOW or the analytical method. Duplicate control samples and matrix spike samples will be spiked with representative compounds and analyzed at the intervals specified in the CLP SOW and the laboratory QAPP, as appropriate (Appendix A).

Accuracy of field analytical measurements will be assured through calibration techniques and the measurement of known reference standards for pH, conductivity, and field GC analyses. Acceptable limits of accuracy will be 80 to 120 percent recovery of the known value, or as otherwise indicated by the manufacturer of the reference standard.

5.3 COMPLETENESS

Completeness is a measure of the amount of valid data obtained from any measurement system compared to the total amount of data in the data set. Valid data are defined as data generated from samples that arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a chain-of-custody record. Furthermore, samples must be analyzed within the specified analytical holding times and analyzed with the appropriate and relevant level of QC effort. The calculation for completeness will be performed after critical QC criteria have been reviewed and assessments for precision, accuracy, and achieved sensitivity have been performed. These preliminary assessments and the evaluation of the completeness objective will be done during and at the completion of each of the tasks described in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a) during data validation phases.

It is expected that Enseco East will provide data meeting QC acceptance criteria of 95 percent or more for all samples tested using the CLP RAS organic and inorganic protocols. USEPA Methods 524.2 and 8240, treatability parameters, TOC, and grain size analyses are not covered by the CLP RAS organic and inorganic protocols and, therefore, may have different QC acceptance criteria. For VOC analyses using USEPA Method 524.2 and Method 8240, completeness is also expected to be greater than 95 percent for these analyses due to the stringent QC procedures employed in the method guidelines. For the treatability parameters, TOC, and grain size, although completeness is expected to be high, it may be limited to 90 percent for some parameters due to the methods employed. As demonstrated in the CLP RAS protocols, precision and accuracy data for multi-component analyses are typically provided for a subset of the analyte list, or representative analytes for most analytical protocols and methods. A table summarizing precision, accuracy, and completeness objectives for representative analytes in the RAS protocols in water and solid matrices has been included in the laboratory QAPP (refer to Table 5-1 in Appendix A). For all other parameters, precision, accuracy and completeness objectives are provided in Tables 5-2 through 5-4.

The methods selected for this RI/FS were chosen to achieve a specified detection limit in the samples. In the assessment of the completeness objective, an evaluation of the achieved sample reporting limits or sample sensitivity will be performed. Sensitivity may be defined as the minimum concentration of an analyte that can be measured and reported. In terms of samples, sensitivity is the lowest concentration of analyte(s) that can be reliably achieved within specified limits of method precision and accuracy. The evaluation of sensitivity and the assessment of whether the necessary quantitation limit(s) has been achieved to meet the DQOs will be made by comparing the sample reporting limits to the quantitation limits listed in Tables 3-1 through 3-9.

5.4 REPRESENTATIVENESS

Representativeness expresses the degree to which data accurately and precisely represent the characteristics of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The representativeness of the data will be assessed in three areas as follows: (1) the number of locations, matrices, and samples sufficient to accurately depict site conditions; (2) the sampling procedures that must be designed so that individual samples accurately represent the chemistry of the matrix from which they were collected; and (3) the appropriateness of the analytical method used to the type of sample obtained.

5.5 COMPARABILITY

Comparability expresses the confidence with which one data set can be compared to another. The comparability of the data is assured by using standard sampling and analysis procedures, and data reporting formats. The data will be reported in a manner such that similar data sets can be compared to each other and individual comparisons can be made within each data set.

6.0 SAMPLING PROCEDURES

Procedures for collecting samples and conducting tests and other measurements are described in the FSP (Geraghty & Miller, Inc. 1992b). In certain subtasks described in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a), a preliminary field assessment will be performed to determine which specific samples and sample intervals will be sent to the laboratory for analysis. Decisions regarding laboratory analysis of soil samples will be made based on the use of an HNU photoionization detector (PID) and on visual observation of the sample. A PID will be used to screen samples for the presence of VOCs. In some cases a reading of 10 parts per million (ppm) calibration standard equivalents on the PID will be used as the action level to determine which samples from each respective area will be considered for laboratory analysis. Samples originating from borings being conducted for depth to bedrock determination that display the highest concentration of VOCs above the action level when measured by the PID will be submitted for VOC analysis. Select samples from test pits and all other soil borings that display the highest concentration of VOCs when measured by the PID will be sent to Enseco East for confirmatory analyses for VOCs, BNAs, pesticides, PCBs, and metals in accordance with the FSP (Geraghty & Miller, Inc. 1992b). Irrespective of the PID readings, any samples exhibiting unnatural discoloration or unusual odor will be retained for analysis.

Also included in the FSP is information on sampling procedures, equipment decontamination, sample documentation, sample shipment, field filtering, preservation of samples, and chain-of-custody procedures. Laboratory preservation, container types, and holding time requirements for the parameters to be analyzed are described in Table 6-1. The analytical parameters and specific methods to be used for analyzing samples from the Dublin TCE Site are included in Table 6-2.

7.0 SAMPLE CUSTODY

Sample custody is an integral part of any laboratory or field operation. Sample custody procedures are designed to provide documentation of the preparation, handling, storage, shipment, and receipt of samples. Reagents and other supplies needed for the field investigation will be procured from a local scientific supply house(s) in northern New Jersey. Whenever possible and appropriate, lot and batch numbers, dates of receipt, and dates of use on-site will be recorded in the field logs to maintain traceability of supplies and reagents.

Accountability for samples collected during this field investigation will be the responsibility of the field activities and sampling coordinators from the time samples are collected to the time when they are relinquished to the laboratory. Samples will be relinquished to the laboratory directly, or to a common carrier for transfer to the laboratory. Stringent chain-of-custody procedures will be adhered to at all times.

7.1 SAMPLE IDENTIFICATION

Each sample will be assigned a unique alphanumeric code that will be recorded on the following documents: the daily log, the sample/core log (soil and sediment), the water sampling log (water), the label affixed to the sample container, and the chain-of-custody record. The sample code will potentially consist of four elements as follows: matrix code, sample number, interval, and date. These four components will be ordered as follows:

1. First Field - Matrix code

The sample matrix codes for this project will be designated by a single letter (except for ambient air, septic tank, and septic leachate samples) and are as follows:

Ground Water	
Ground Water - Monitoring/Observation Wells	M
Ground Water - Supply Wells	R
Ground Water - Test Wells	W
Packer Test - Monitoring/Observation Wells	P
Packer Test - Supply Wells	Y
Packer Test - Test Wells	Z
Aquifer Test - Monitoring/Observation Wells	A
Aquifer Test - Supply Wells	X
Aquifer Test - Test Wells	L
Soil	
Subsurface Soil - Soil Borings	S
Subsurface Soil - Test Pits	T
Surface Soil - Background	B
Other	
Air	AR
Sediment	D
Drill Cuttings	C
Septic Tank	ST
Septic System Leachate	SL
Treatment System Effluent	E
Treatment System Influent	I

2. Second Field - Sample Number

The sample number for a well, soil boring, test pit, surface soil, or sediment sample location identification number will be designated by a two-digit numerical code. The sample number for an air, septic tank, or septic system leachate sample will be designated by a single-digit numerical code.

3. Third Field - Sample Interval or Time of Sample Collection

The third field will represent either the date of routine ground-water or air samples, the depth interval of the soil boring or test pit, the depth interval and time of collection (military time) for packer test samples, or a time (in military time) in the case of pumping tests. The third field is described below for each sample type. There is no third field assigned to drill cutting samples. The number of characters in the field is equal to four.

Ground-Water Well Sample (M, R, W) -	Month (mm) and date (dd) of collection in the format "mmdd."
Aquifer Test Samples (A, X, L) -	Actual time of sample collection with the hour and minutes in military time.
Packer Test Sample (P, Y, Z) -	The first three characters of the string identify the depth of the top of the zone being tested to the nearest foot. The last two characters represent the time interval. The time interval will be coded and the identification will be recorded on field forms.

Sediment, Subsurface, and Surface Soil Samples (D, S, T, B) - Depth of the top of the interval sampled to the nearest tenth of a foot.

Wastewater (ST, L) - Month (mm) and date (dd) of collection in the format "mmdd".

Treatment System Influent and Effluent (E, I) - Time of sample collection in military format.

Air (AR) - Month (mm) and date (dd) of collection in the format "mmdd."

Trip Blank (K) - Month (mm) and date (dd) of collection in the format "mmdd."

Replicate samples will be identified in a manner consistent with the matrix and source of the samples. The first field will contain a matrix code representative of the sample type. The second field will contain a unique sample number that will be assigned prior to sample collection. The third field will represent sample interval or time of sample collection as applicable to the matrix and source.

Field blank samples will be identified in a manner consistent with the matrix and source of the samples being collected. The first field will contain a matrix code of a single letter F. The second field will contain the sample number or sample location number applicable to the location of field blank sample collection. The third field will contain the date of sample collection.

All blank characters within a field will be assigned a leading edge zero. Examples of each potential sample identification using the described naming conventions are presented in Table 7-1.

7.2 FIELD CUSTODY

The sampling staff is responsible for the care and custody of the samples until they are delivered to the contracted laboratory or to the assigned courier. The sample containers used for shipment will be sealed on-site by the field sampling crew using strapping tape and chain-of-custody seals. Sample bottles will be kept in the shipping containers except when they are being filled. Sample shipping and handling procedures will be in compliance with the requirements of the CLP under the SOW. The CLP considers sample holding times to begin at the time the sample is received by the laboratory. Geraghty & Miller will comply with sample holding times beginning at the time of sample collection. The holding times to be calculated from sample collection have been summarized accordingly in Table 6-1 of this QAPP. The original chain-of-custody form will be dated and signed and included, along with a carbon copy, in the shipping container. A copy of the Geraghty & Miller Laboratory Task Order (LTO), discussed below in Section 7.3 (Chain-of-Custody Forms) of this QAPP, will also be included. The forms will be placed in a plastic bag and taped to the underside of the cooler lid.

7.3 CHAIN-OF-CUSTODY FORMS

The FSP (Geraghty & Miller, Inc. 1992b) describes the sampling and chain-of-custody paperwork to be completed prior to, during, and after sampling activities. The LTO form is an integral part of the Geraghty & Miller AQA/LCP and of the chain-of-custody paperwork. The LTO form(s) must be completed prior to each sampling program and is used to identify the number and type of samples to be collected, the analyses to be performed, the analytical methods to be used, the detection limits to be achieved, and the required level of laboratory QA/QC deliverables. A sample of the form is appended to the FSP (Geraghty & Miller, Inc., 1992b). Chain-of-custody forms will be completed prior to sample shipment and will identify the samples collected, the date and time of collection, the number of bottles filled, the requested analyses, and the sampling team members.

7.4 SAMPLE PACKAGING AND SHIPMENT PROCEDURES

Samples requiring refrigeration will be promptly chilled with ice to an approximate temperature of 4 degrees Celsius and packaged in an insulated cooler for shipment to the laboratory. The shipping containers will be sealed with strapping tape and chain-of-custody seals to allow the receiver to quickly ascertain whether any tampering has taken place during transport. The shipping containers will be relinquished daily to a laboratory courier for transportation to the laboratory facility.

7.5 SAMPLE RECEIPT PROCEDURES

Upon accepting custody of the shipping containers, the laboratory will document their receipt by signing the chain-of-custody record. The laboratory will record the date and time of receipt, and assess the condition of the shipping containers and sample bottles, and any other potential discrepancies. The sample custodian will bring any discrepancies to the attention of the designated laboratory program administrator for reconciliation with the Geraghty & Miller project manager, QA officer, and field activities coordinator, as appropriate. After all discrepancies are resolved, an Enseco laboratory sample acknowledgement report, a signed copy of the chain-of-custody record, and a copy of the Geraghty & Miller LTO will be returned to the project manager for the central project file. Specific sample-receiving procedures are detailed in the laboratory QAPP (Appendix A).

7.6 FINAL EVIDENCE FILE

The Geraghty & Miller project manager is designated as the record custodian and is responsible for maintaining original field records, which document sampling activities, and laboratory analysis records in a secured, central file at the Geraghty & Miller office located in Rochelle Park, New Jersey. These records should include the following: historical information (reports, data, and maps), current site maps, daily logs, instrument logs, sampling logs, signed and dated chain-of-custody documentation, field forms, laboratory correspondence files, laboratory data, field and laboratory data validation notes, and any other information specific to field and laboratory activities. A complete copy of all of the above-mentioned files will be maintained and preserved by the project manager during the pendency of the Consent Order between Sequa and the USEPA, and for a minimum of 6 years after its termination.

8.0 CALIBRATION PROCEDURES

All calibration procedures for BNAs, pesticides/PCBs, and metals conducted in accordance with the March 1990 CLP SOW will follow guidelines specified in the RAS protocols for organics and inorganics analyses (USEPA 1990a; 1990b). VOC analyses for the site investigation will be analyzed by various methodologies in order to meet the DQOs associated with the tasks specified in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a). On this basis, calibration procedures will be in accordance with the guidelines specified in either USEPA Method 524.2 Revision 3.0 (USEPA 1989), or Method 8240 (USEPA 1986). For site samples requiring analysis for treatability and waste characterization parameters, calibration will follow established method and instrument guidelines specific to the parameter as noted in *Methods of Chemical Analysis of Water and Wastes* (USEPA 1983) and *Test Methods for Evaluating Solid Waste, SW-846, Third Edition* (USEPA 1986). All other calibration procedures for laboratory equipment will be performed as detailed in the laboratory QAPP (Appendix A).

The field equipment for this project includes thermometers, a pH meter(s), a conductivity meter(s), an HNU PID vapor analyzer, water-level measurement apparatus, and a portable field GC. Field equipment will be calibrated by trained Geraghty & Miller personnel according to approved manufacturers' specifications and instructions and in accordance with protocols appended to the FSP (Geraghty & Miller, Inc. 1992b). The initial calibration of the field GC will be based on the establishment of a three-point curve for specified VOCs at the following estimated concentrations in parts per billion (ppb):

- TCE - 10, 20, and 30 ppb.
- PCE - 10, 20, and 30 ppb.
- 1,1,1-Trichloroethane - 20, 40, and 60 ppb.

- cis-1,2-Dichloroethene - 10, 20, and 30 ppb.
- trans-1,2-Dichloroethene - 15, 30, and 45 ppb.

9.0 ANALYTICAL PROCEDURES

Samples collected during the field investigation will be analyzed using the analytical methods listed in Table 6-2 of this QAPP. These methods have been chosen to meet the various DQOs for the tasks discussed in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a).

For ground water used as a drinking water supply, VOC analyses will be conducted using USEPA Method 524.2 modified for the quantitation of TCL VOCs. This VOC analytical method has been selected to provide quantitation limits in water that are below the federally mandated maximum contaminant levels. For all VOC analyses of solid matrices with the exception of the drill cutting wastes, CLP RAS protocols have been specified for analysis. Since the objective of VOC analyses for the drill cuttings is solely for the purposes of waste classification and disposal, USEPA Method 8240 will be used for analysis following a toxicity characteristic leaching procedure (TCLP) preparation of the drilling wastes. Ambient air samples will be analyzed for TCL VOC constituents using USEPA Method TO-14 from *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air* (USEPA 1988a). The methods are summarized briefly in Appendix C of this QAPP.

All BNA and pesticide/PCB analyses of ground-water, soil sediment, and test pit samples will be performed in accordance with the March 1990 organic CLP SOW for multi-media and multi-concentration samples (USEPA 1990a).

Inorganic analyses for TAL metals will be analyzed using the March 1990 CLP inorganic SOW (USEPA 1990b). All ground-water samples for TAL metals will be analyzed as total and dissolved constituents. Procedures for field filtration of metal samples are provided in the FSP (Geraghty & Miller, Inc. 1992b).

Treatability parameters will be used to assess the effectiveness of the on-site treatment system(s). The treatability parameters are as follows: alkalinity, calcium, magnesium, manganese, hardness, iron, total dissolved solids, and total suspended solids. All of these analyses will follow guidelines set forth in the respective methods described in *Methods of Chemical Analysis of Water and Wastes* (USEPA 1983).

Analytical scanning of samples in the field, using portable instruments, will be performed according to the instrument manufacturer's instructions and/or recommendations, and to the protocols appended to the FSP (Geraghty & Miller, Inc. 1992b). Samples will be tested for pH, conductivity, temperature, and in some cases, VOCs.

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

All data collected during this field investigation will be reduced, reported, and evaluated by Geraghty & Miller personnel. Flow diagrams for data management schemes originating from field and laboratory data collection to inclusion and presentation in the final RI/FS report and project file are provided on Figures 10-1 and 10-2.

10.1 DATA REDUCTION

The data reduction will consist of summarizing the raw field and laboratory data into a format that will facilitate interpretation, analysis, and evaluation. Thus, the data will be presented as tables, well logs, illustrations, maps, and graphs, as deemed appropriate by the project manager and/or project officer.

Data collected in the field will be provided in the form of daily logs; task-specific logs for field measurement of pH, temperature, PID readings, water levels, and conductivity; illustrations; maps; and chain-of-custody records. All of the documentation listed above will be completed by field personnel at the time of the collection and analysis. All field records will be reviewed for precision, accuracy, and transcription by the field activities coordinator. At the end of each week after verification has been completed, all field data will be copied. The original field data will be relinquished to the project manager for inclusion into the final evidence file. Copies of all field data will be maintained on-site in the field project file and will be the responsibility of the field activities coordinator. The exact data collection procedures to be used in support of this RI/FS are described in Appendix Q of the FSP (Geraghty & Miller, Inc. 1992b). Laboratory procedures for documentation of sample custody, data collection and validation, reporting, and record maintenance are provided in the laboratory QAPP (Appendix A).

10.2 DATA VALIDATION

Data validation is a process in which analytical data generated by the laboratory are evaluated against a specific set of requirements and specifications, and determinations of data usability and limitations are made. The data validator examines the SOW criteria from four perspectives, as follows:

- Technical requirements.
- Contractual requirements.
- Determination of compliance.
- Determination and action of how to define the usability, or how to flag the data.

The data review requirements are defined in general terms by the USEPA in their documents on functional guidelines for evaluation of organics and inorganics analyses (USEPA 1988b; 1988c). The Dublin TCE Site is under the jurisdiction of USEPA Region III, and, therefore, region-specific data validation guidelines will be adhered to (USEPA 1988d; 1990c). The guidelines referenced above are intended to be applied to data generated under CLP SOW protocols. These guidelines will be modified for non-CLP SOW methods to perform a QA/QC data assessment for parameters using Method 524.2 or SW-846 methodologies.

For treatability and waste characterization parameters, data will be evaluated for compliance to method guidelines and the following items as appropriate:

- Adherence to specified holding times.
- Field/laboratory blank detected constituents.
- Matrix spike/spike duplicate precision and accuracy.

- Field replicate precision.
- Surrogate compound recoveries.
- Laboratory duplicate precision.
- Laboratory control sample(s) precision and accuracy.
- Initial and continuing instrument calibrations and blanks.

Final validation of all project data in support of this RI/FS will be performed by Geraghty & Miller data validators. All pertinent records will be retrieved from the central project file and, in conjunction with the laboratory deliverables, will be reviewed for accuracy of transcription, accuracy, precision, completeness, and overall quality of data. Data validation packages for the USEPA Region III are comprised of a narrative and the appropriate attachments in the form of appendices (Dodd and Metzger, pers. comm. 1991). The narrative body is composed of the following:

- The overview which describes the sample set and informs the data user of the method(s) of analysis.

- The summary which provides a synopsis of the sample analysis and advises the data user of any unsuccessful analyses.

- A discussion of major QC criteria and issues that directly affect data quality in an adverse manner. The discussion may include statements regarding suspect and unusable data, or problems concerning sample integrity.

- A discussion of minor QC criteria and issues that summarizes data qualifiers that have been applied to positive values or sample quantitation limits, and informs the data user of the limitations of data use.

The attachments of a USEPA Region III data validation package include the following appendices:

- Appendix A - A glossary of data qualifiers and their definitions.
- Appendix B - USEPA regional data summary forms.
- Appendix C - Results as reported by the laboratory (CLP Form I or equivalent).
- Appendix D - Results of all tentatively identified compounds which have been corrected to exclude blank contamination (GC/MS organics only).
- Appendix E - Support documentation which substantiates qualifiers placed on data during validation (i.e., method blank forms, calibration forms, quantitation reports).

Examples of USEPA Region III organic and inorganic data validation reporting forms are included in Appendix D.

All laboratory data will be reviewed for adherence to method-specific QA/QC guidelines and to the data validation guidelines that are described above. All critical samples will be formally validated in accordance with the referenced data validation protocols. Critical samples are defined as those samples that will provide data for risk assessment, potentially responsible party (PRP) determination, engineering design, and/or site characterization. All site samples defined as analytical Level IV will be formally validated. Although some analytical Level III samples will be formally validated, other Level II and III samples will be reviewed for adherence to critical QA/QC criteria, such as holding times, calibration accuracy, and surrogate recovery. Example checklists for organic and inorganic QA/QC assessments of Level II and Level III samples are provided in Appendix E.

10.3 DATA REPORTING

Laboratory deliverables will consist of a complete hard copy data package in accordance with the March 1990 CLP RAS protocols (USEPA 1990a; 1990b) for all BNA, pesticides/PCBs, and metal analyses performed following the SOW. VOC, TOC, and grain size data deliverables will be provided in varying formats depending on the DQOs discussed in Section 3.4 (Data Quality Objectives) of this QAPP and Task 4 (Sample Analysis/Data Validation) of the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a). As such, VOC data will be provided in either an equivalent CLP format, or as a standard Enseco East laboratory deliverable supported by appropriate QC summary forms and raw data documentation. The standard laboratory data deliverable for VOC analyses and for treatability and waste characterization parameters will be supported in a manner consistent with the data reviewer's requirements for performing a QA/QC data assessment. These requirements will include, but not be limited to, the following:

- Sample data sheets.
- Blank results.
- Batch-specific laboratory QC sample results.
- Surrogate recovery summary forms.
- Calibration summaries (initial and continuing).
- Raw data.

Additionally, electronic laboratory data deliverables will be received from the laboratory on computer disk in a pre-arranged format. The data will then be imported into a data base management system. This procedure is employed to minimize data entry error and to streamline the generation of accurate data tables. The project QA officer is ultimately responsible for the data generated in the field investigation although other Geraghty & Miller personnel will be involved in the process. The project manager will be responsible for maintaining document security and storage as described in Section 7.6 (Final Evidence File).

For the RI/FS final report, the analytical data, including QC samples, will be reported in tabular form with sample identifications, matrix, parameters, reporting limits, and concentrations where applicable. These tables will include any qualifiers placed on the data as a result of validation procedures and/or by the laboratory. Electronic deliverables of the final data summary tables will be generated and provided with the final RI/FS report.

11.0 QUALITY CONTROL PROCEDURES

QC procedures will be followed in the field as well as in the laboratory. The laboratory will be responsible for performing QC samples at the frequencies specified in the CLP SOW protocols (USEPA 1990a; 1990b) and other methodologies used in support of the field investigation. The specific procedures for collecting replicate samples are detailed in the FSP (Geraghty & Miller, Inc. 1992b). The specific procedures for the preparation of laboratory QC samples are described in the laboratory QAPP (Appendix A).

11.1 LABORATORY QUALITY CONTROL PROCEDURES

Internal QC checks for laboratory activities will be carried out as specified by the USEPA CLP SOW, the specified analytical method, and/or the laboratory QAPP (Appendix A). The QC checks will include, but not be limited to, the following: method and/or reagent blanks, surrogate or system monitoring compound spikes, matrix spike/spike duplicates, laboratory control samples, laboratory duplicates, initial and continuing calibration blanks and standards, internal standards, and reference standards. The frequency of these QC checks will be as specified by the SOW (USEPA 1990a; 1990b) or the analytical method. The criteria that will be used to assess the QC checks are summarized in Tables 11-1 and 11-2. More detailed information on laboratory QC procedures can be found in the laboratory QAPP (Appendix A).

11.2 FIELD QUALITY CONTROL PROCEDURES

Field QC procedures will include the collection and use of field blanks, laboratory-prepared trip blanks, and field replicates. The frequency of each will be as follows:

Replicates	1 for every 10 field samples.
Trip blanks	1 for every cooler of VOC samples.
Field blanks	1 for every 10 field samples utilizing field sampling equipment.

Field replicates are defined as two samples collected independently at a single sampling location during a single sampling event. Field replicates will be collected for ground-water, soil, sediment, and ambient air matrices and will be analyzed for the same parameters as required of the field sample. Field replicates are useful in determining sampling variability and will be assessed qualitatively for precision.

Trip blanks are aqueous samples of demonstrated analyte-free, deionized water, which originate at the laboratory and travel unopened to and from the site with the sample containers. Trip blanks will be analyzed for VOCs and are indicative of sample-handling practices at the laboratory and the site during shipment and analysis.

Field blanks are samples of demonstrated analyte-free, deionized water, which are transferred from laboratory containers through cleaned sampling equipment, collected in a secondary bottle, and sent back to the laboratory. Field blanks are indicators of sample-handling procedures at the laboratory and the site, and of possible intrusive site conditions. They will only be prepared when field equipment (bailer, trowel, auger) is used to collect specified soil, sediment, and monitoring/observation well samples and will only be analyzed for the associated sample parameters. The frequency of field blank collection will be consistent with one in every ten field samples for each event. A summary of QC criteria for field QC samples is provided in Table 11-2.

Additionally, field QC procedures will include field measurements that will be assessed for precision by multiple determinations of the measurement parameter. Replicate measurements for pH, conductivity, and calibrated field GC constituents will vary no more than 20 percent in order to display an acceptable level of precision. Values obtained outside of this acceptance criteria will require investigation into the cause and may precipitate corrective action(s). Accuracy in the field will be maintained by adherence to specified calibration procedures and incorporation of known reference standards to verify calibrations. Refer to the FSP (Geraghty & Miller, Inc. 1992b) for additional field QC procedures that will be used during the RI/FS.

12.0 PERFORMANCE AND SYSTEM AUDITS

Geraghty & Miller will conduct laboratory and field system audits to determine the integrity of chain-of-custody procedures and to assess adherence to established data management and documentation procedures. The laboratory audit will be performed by a Geraghty & Miller regional QA manager and/or the project QA officer. The field audit will be performed by the project QA officer and the project manager, and/or the regional QA officer. These audits will be performed at the discretion of the QA officer, the project manager, and the project officer and will be conducted in accordance with USEPA guidelines for system audits of CLP laboratories (USEPA no date [a]; no date [b]). In addition, these audits will be performed prior to, or shortly after the systems are operational and on a regularly scheduled basis throughout the project during relevant RI/FS Work Plan tasks. The auditors will report the results of these audits to the project manager, who will submit the audit report to the USEPA project manager within 15 days of the completion of the audit. This report will serve to notify management of audit results, will identify areas requiring corrective action, and will identify the action taken to remedy the deficiencies noted. Audit results and corrective action(s) will also be included in the monthly progress report as required by the Consent Order between the USEPA and Sequa. An example of a field audit forms is provided in Appendix F of this QAPP.

Laboratory system audits will be performed as specified in the CLP SOW (USEPA 1990a; 1990b). At a minimum, the on-site laboratory audit will consist of a review and evaluation of the following items:

- Facility size, security, and organization.
- Instrumentation.
- Availability and utilization of standard operating procedures.

- Staff qualifications, experience, and training programs.
- Sample, reagent, and standard storage areas.
- Sample log books, bench sheets, and analytical documentation.
- Any other laboratory operation involving sample receiving, storage, identification, security, tracking, documentation, and reporting.

The laboratory retained for this project will be under contractual responsibilities outlined by the Geraghty & Miller AQA/LCP. Because Enseco East is a retained laboratory under the AQA/LCP, Geraghty & Miller has performed a comprehensive laboratory audit on the Enseco East laboratory facility; this audit covers all aspects of the laboratory operation. In accordance with the specifications of the Consent Order between the USEPA and Sequa, any laboratory contracted in support of this RI/FS must be a participant in the USEPA CLP or undergo a laboratory audit at some point during the time the laboratory is conducting analyses after the RI/FS sampling program commences. As Enseco East is a CLP participant for organic compound analyses only, a laboratory audit will be scheduled to review operations relating to inorganic parameter analyses according to the terms of the Consent Order. Internal laboratory audits are as detailed in the laboratory QAPP (Appendix A).

13.0 PREVENTATIVE MAINTENANCE PROCEDURES

The field equipment for this project includes thermometers, a pH meter(s), a conductivity meter(s), water-level measurement apparatus, an HNU trace gas analyzer equipped with a photoionization detector, and a portable field GC. Specific preventative maintenance will be performed on field equipment in accordance with manufacturers' specifications. All field equipment will be checked and calibrated by trained Geraghty & Miller personnel prior to shipment to the site. Equipment maintenance will be performed on a regularly scheduled basis as noted in Table 13-1 and as recommended by the manufacturer. All equipment maintenance will be documented in a bound notebook and will indicate date of entry, individual performing maintenance, and nature of maintenance. Equipment repair will be performed by qualified Geraghty & Miller personnel, the equipment vendor, and/or an authorized service representative. A summary of recommended spare parts, solutions, and expendable items for field equipment to be used in support of the RI/FS field investigation is provided in Table 13-1. In case of equipment failure, back-up instruments and equipment will be obtained locally from other Geraghty & Miller offices or within one day from a recognized equipment rental firm which contracts directly with Geraghty & Miller and/or the equipment vendor.

The maintenance of laboratory equipment will be performed by the laboratory according to the CLP SOW (USEPA 1990a; 1990b) or in accordance with the method and manufacturers' specifications. Laboratory equipment calibration, operation, and maintenance procedures are specified in the laboratory QAPP (Appendix A).

14.0 PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Laboratory data and field data generated during the field investigation will be assessed for their precision, accuracy, and completeness, as described previously in this QAPP. The specific formulas presented below will be used to verify adequacy of the laboratory and field procedures. The specific procedures, formulas, and calculations to be performed by the laboratory are provided in the laboratory QAPP (Appendix A). These procedures, formulas, and calculations will be reviewed and reprocessed either during formal data validation or during the QA/QC data assessment and will be based on the DQOs specified for the associated tasks of the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a). The results of these calculations will be compared to the limits established for precision, accuracy, and completeness that are provided in Tables 5-2 through 5-4 of this QAPP, and in Table 5-1 of the laboratory QAPP (Appendix A). They will be used with other indicators of data quality, such as achievement of sample reporting limits, to determine if the DQOs have been achieved.

14.1 PRECISION

All field measurements will be performed in replicate at a frequency of 10 percent. Precision will be assessed as noted in Section 5.1 (Precision) and verified by the field activities coordinator.

Precision may be measured from duplicate measurements or calculated from three or more replicates. If calculated from duplicate measurements, RPD will be determined using the following calculations:

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

where C_1 = The larger of the two observed values, and
C_2 = The smaller of the two observed values.

If calculated from three or more replicates, relative standard deviation (RSD) is used as the measure of precision and will be calculated as follows:

$$\text{RSD} = (s/X_{\text{AVE}}) \times 100\%$$

where s = The standard deviation, and
X_{AVE} = The mean of the observed values for the replicate analyses.

14.2 ACCURACY

Accuracy of field measurement and calibration will be maintained by analysis of a known reference standard obtained from a separate source other than that used for the calibration standards. Accuracy of calibration and analysis will be verified by the field activities coordinator.

The determination of the measurement of accuracy requires knowledge of the "true" or accepted value for the analyte being measured. Accuracy will be calculated in terms of percent recovery (%R) using the following equation:

$$\%R = \frac{(S - U)}{C} \times 100\%$$

where S = The measured concentration in the spiked sample,
U = The measured concentration in the unspiked sample, and
C = The actual concentration of the spike addition.

14.3 COMPLETENESS

Completeness is determined by a calculation of the percentage of measurements made that are judged to be valid measurements. It will be calculated using the following equation:

$$\%\ \text{Completeness} = 100\% \times (V/n)$$

where V = The number of measurements judged valid and usable in the data set, and

n = The total number of measurements required for the data set to achieve a specified level of confidence in decision making.

15.0 CORRECTIVE ACTION

If unacceptable conditions are identified as a result of systems audits or are observed during routine processes during the field investigations (sampling and analysis), the QA officer, project chemist, and the project manager will be responsible for documenting the condition or deficiency and initiating corrective action procedures. The specific conditions or problems will be clearly identified and isolated, cause will be determined, and appropriate corrective action plans implemented. QC criteria and acceptance limits are described in greater detail in Section 11.0 (Quality Control Procedures) and in the laboratory QAPP (Appendix A). Tables 11-1 and 11-2 provide additional information with regard to acceptance limits beyond which corrective action is required. A form for reporting and documenting the corrective action is provided in Appendix G . Corrective actions may include, but not be limited to, the following:

- Reanalyzing samples that fail to meet holding time criteria.
- Resampling and reanalyzing.
- Amending sampling procedures and analytical procedures.
- Retraining staff.

After corrective actions are implemented, their effectiveness will be determined and the condition eliminated, or the problem readdressed. If appropriate, the corrective action will be incorporated as a modification into the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a), the FSP (Geraghty & Miller, Inc. 1992b), the HASP (Geraghty & Miller, Inc. 1992c), and this QAPP.

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Upon approval of the site-specific work plan, the RI/FS will be conducted in a phased approach comprised of 11 tasks. QA/QC data assessment and validation will be performed immediately following each relevant field investigation task and subtask, and after each analytical phase. Refer to Task 4 (Sample Analysis/Data Validation) on the project schedule included in the RI/FS Work Plan (Geraghty & Miller, Inc. 1992a) for further schedule information.

During the RI/FS, the Geraghty & Miller QA officer will review all aspects of the implementation of this QAPP on a regular basis. Reviews will be conducted at the completion of each field activity and will include an assessment of data quality and the results of system audits. A written QA report will be provided to the project manager on a monthly basis and, at a minimum, will include the following:

- Results of sampling, field analyses, and analytical data completed within the previous month.
- Results of QA/QC data assessments in terms of precision, accuracy, completeness, representativeness, and comparability.
- Results of field and laboratory performance and system audits.
- Deviations from and modifications to the QAPP.
- Significant QA/QC problems, corrective action(s), and results of corrective action(s).

- Limitations of use on the measurement data.

- Recommendations for resampling and reanalysis.

This information will be used by the project manager to prepare the monthly report to the USEPA.

The laboratory will conduct internal reviews and include QA reports with the analytical data deliverable packages. A summary of the results of all audits will be reported to management as deemed appropriate by the QA officer.

At the conclusion of all field, laboratory, and data analysis and reduction tasks, a final QA report will be issued by the Geraghty & Miller project QA officer to the project manager. This report will include a statement of the overall completeness and attainment of the project DQOs. All QA reports and other relevant data files will be maintained in the final evidence file under the custody of the Geraghty & Miller project manager.

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Table 3–1. Target Compound List and Reporting Limits for Volatile Organic Compounds, to be Analyzed by USEPA Method 524.2, in Ground–Water Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits* Ground–Water (ug/L)
Chloromethane	74–87–3	0.5
Bromomethane	74–83–9	0.5
Vinyl chloride	75–01–4	0.5
Chloroethane	75–00–3	0.5
Methylene chloride	75–09–2	2
Acetone	67–64–1	5
Carbon disulfide	75–15–0	0.5
1,1–Dichloroethene	75–35–4	0.5
1,1–Dichloroethane	75–34–3	0.5
1,2–Dichloroethene (total)	540–59–0	0.5
Chloroform	67–66–3	0.5
1,2–Dichloroethane	107–06–2	0.5
2–Butanone	78–93–3	5
1,1,1–Trichloroethane	71–55–6	0.5
Carbon tetrachloride	56–23–5	0.5
Bromodichloromethane	75–27–4	0.5
1,2–Dichloropropane	78–87–5	0.5
cis–1,3–Dichloropropene	10061–01–5	0.5
Trichloroethene	79–01–6	0.5
Dibromochloromethane	124–48–1	0.5
1,1,2–Trichloroethane	79–00–5	0.5
Benzene	71–43–2	0.5
trans–1,3–Dichloropropene	10061–02–6	0.5
Bromoform	75–25–2	0.5
4–Methyl–2–pentanone	108–10–1	5
2–Hexanone	591–78–6	5
Tetrachloroethene	127–18–4	0.5
Toluene	108–88–3	0.5
1,1,2,2–Tetrachloroethane	79–34–5	0.5
Chlorobenzene	108–90–7	0.5
Ethyl benzene	100–41–4	0.5
Styrene	100–42–5	0.5
Xylenes (Total)	1330–20–7	0.5

USEPA	U.S. Environmental Protection Agency.
ug/L	Micrograms per liter.
CAS	Chemical Abstracts Service.

* Specific quantitation limits are highly matrix–dependent. The quantitation limits listed are provided for guidance and may not always be achievable.

NJ14301–T1/tab2.wk3

Table 3–2. Target Compound List and Reporting Limits for Volatile Organic Compounds, to be Analyzed by USEPA Method 8240, in Ground–Water Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits* Ground–Water (ug/L)
Chloromethane	74–87–3	10
Bromomethane	74–83–9	10
Vinyl chloride	75–01–4	10
Chloroethane	75–00–3	10
Methylene chloride	75–09–2	5
Acetone	67–64–1	100
Carbon disulfide	75–15–0	5
1,1–Dichloroethene	75–35–4	5
1,1–Dichloroethane	75–34–3	5
1,2–Dichloroethene (total)	540–59–0	5
Chloroform	67–66–3	5
1,2–Dichloroethane	107–06–2	5
2–Butanone	78–93–3	100
1,1,1–Trichloroethane	71–55–6	5
Carbon tetrachloride	56–23–5	5
Bromodichloromethane	75–27–4	5
1,2–Dichloropropane	78–87–5	5
cis–1,3–Dichloropropene	100061–01–5	5
Trichloroethene	79–01–6	5
Dibromochloromethane	124–48–1	5
1,1,2–Trichloroethane	79–00–5	5
Benzene	71–43–2	5
trans–1,3–Dichloropropene	10061–02–6	5
Bromoform	75–25–2	5
4–Methyl–2–pentanone	108–10–1	50
2–Hexanone	591–78–6	50
Tetrachloroethene	127–18–4	5
Toluene	108–88–3	5
1,1,2,2–Tetrachloroethane	79–34–5	5
Chlorobenzene	108–90–7	5
Ethyl benzene	100–41–4	5
Styrene	100–42–5	5
Xylenes (Total)	1330–20–7	5

The above reporting limits are those specified in the USEPA SW–846 Method 8240.

USEPA	U.S. Environmental Protection Agency.
ug/L	Micrograms per liter.
CAS	Chemical Abstracts Service.
*	Specific quantitation limits are highly matrix–dependent. The quantitation limits listed are provided for guidance and may not always be achievable.

NJ14301–T1/TCL2.wk3

Table 3–3. Target Compound List and Reporting Limits for Volatile Organic Compounds, to be Analyzed by USEPA CLP Protocols, in Soil Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits * Soil (Low)** (ug/kg)	Soil (Medium)** (ug/kg)
Chloromethane	74–87–3	10	1200
Bromomethane	74–83–9	10	1200
Vinyl chloride	75–01–4	10	1200
Chloroethane	75–00–3	10	1200
Methylene chloride	75–09–2	10	1200
Acetone	67–64–1	10	1200
Carbon disulfide	75–15–0	10	1200
1,1–Dichloroethene	75–35–4	10	1200
1,1–Dichloroethane	75–34–3	10	1200
1,2–Dichloroethene (total)	540–59–0	10	1200
Chloroform	67–66–3	10	1200
1,2–Dichloroethane	107–06–2	10	1200
2–Butanone	78–93–3	10	1200
1,1,1–Trichloroethane	71–55–6	10	1200
Carbon tetrachloride	56–23–5	10	1200
Bromodichloromethane	75–27–4	10	1200
1,2–Dichloropropane	78–87–4	10	1200
cis–1,3–Dichloropropene	10061–01–5	10	1200
Trichloroethene	79–01–6	10	1200
Dibromochloromethane	124–48–1	10	1200
1,1,2–Trichloroethane	79–00–5	10	1200
Benzene	71–43–2	10	1200
trans–1,3–Dichloropropene	10061–02–6	10	1200
Bromoform	75–25–2	10	1200
4–Methyl–2–pentanone	108–10–1	10	1200
2–Hexanone	591–78–6	10	1200
Tetrachloroethene	127–18–4	10	1200
Toluene	108–88–3	10	1200
1,1,2,2–Tetrachloroethane	79–34–5	10	1200
Chlorobenzene	108–90–7	10	1200
Ethyl benzene	100–41–4	10	1200
Styrene	100–42–5	10	1200
Xylenes (Total)	1330–20–7	10	1200

The above reporting limits are those specified in the USEPA March 1990 CLP SOW protocols.

USEPA	U.S. Environmental Protection Agency.
CLP	Contract Laboratory Program.
ug/kg	Micrograms per kilogram.
CAS	Chemical Abstracts Service.
*	Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the CLP contract, will be higher.
**	Soil and sediment sample quantitation limits to be used in the final analytical report will be based on the determination of the sample concentration level made from the mandatory pre–screening of the sample matrix.

NJ14301–T1/TCL3.wk3

Table 3–4. Target Compound List and Reporting Limits for Semivolatile Organic Compounds, to be Analyzed by USEPA CLP Protocols, in Ground–Water, Soil, and Sediment Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits*		
		Ground–Water (ug/L)	Soil (Low)** (ug/kg)	Soil (Medium)** (ug/kg)
Phenol	108–95–2	10	330	10000
bis(2–Chloroethyl)ether	11–44–4	10	330	10000
2–Chlorophenol	95–57–8	10	330	10000
1,3–Dichlorobenzene	541–73–1	10	330	10000
1,4–Dichlorobenzene	106–46–7	10	330	10000
1,2–Dichlorobenzene	95–50–1	10	330	10000
2–Methylphenol	95–48–7	10	330	10000
2,2–Oxybis(1–chloropropane)	108–60–1	10	330	10000
4–Methylphenol	106–44–5	10	330	10000
N–Nitroso–di–n–dipropylamine	621–64–7	10	330	10000
Hexachloroethane	67–72–1	10	330	10000
Nitrobenzene	98–95–3	10	330	10000
Isophorone	78–59–1	10	330	10000
2–Nitrophenol	88–75–5	10	330	10000
2,4–Dimethylphenol	105–67–9	10	330	10000
bis(2–Chloroethoxy)methane	111–91–1	10	330	10000
2,4–Dichlorophenol	120–83–2	10	330	10000
1,2,4–Trichlorobenzene	120–82–1	10	330	10000
Naphthalene	91–20–3	10	330	10000
4–Chloroaniline	106–47–8	10	330	10000
Hexachlorobutadiene	87–68–3	10	330	10000
4–Chloro–3–methylphenol	59–50–7	10	330	10000
2–Methylnaphthalene	91–57–6	10	330	10000
Hexachlorocyclopentadiene	77–47–4	10	330	10000
2,4,6–Trichlorophenol	88–06–2	10	330	10000
2,4,5–Trichlorophenol	95–95–4	25	800	25000
2–Chloronaphthalene	91–58–7	10	330	10000
2–Nitroaniline	88–74–4	25	800	25000
Dimethylphthalate	131–11–3	10	330	10000
Acenaphthylene	208–96–8	10	330	10000
2,6–Dinitrotoluene	606–20–2	10	330	10000
3–Nitroaniline	99–09–2	25	800	25000
Acenaphthene	83–32–9	10	330	10000
2,4–Dinitrophenol	51–28–5	25	800	25000
4–Nitrophenol	100–02–7	25	800	25000
Dibenzofuran	132–64–9	10	330	10000
2,4–Dinitrotoluene	121–14–2	10	330	10000
Diethylphthalate	84–66–2	10	330	10000

The above reporting limits are those specified in the USEPA March 1990 CLP SOW protocols.

USEPA	U.S. Environmental Protection Agency.
CLP	Contract Laboratory Program.
ug/L	Micrograms per liter.
ug/kg	Micrograms per kilogram.
CAS	Chemical Abstracts Service.
*	Specific quantitation limits are highly matrix–dependent. The quantitation limits listed are provided for guidance and may not always be achievable. Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the CLP contract, will be higher.
**	Soil and sediment sample quantitation limits to be used in the final analytical report will be based on the determination of the sample concentration level made from the mandatory pre–screening of the sample matrix.

Table 3–4. Target Compound List and Reporting Limits for Semivolatile Organic Compounds, to be Analyzed by USEPA CLP Protocols, in Ground–Water, Soil, and Sediment Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits* Ground–Water (ug/L)	Soil (Low)** (ug/kg)	Soil (Medium)** (ug/kg)
4–Chlorophenyl–phenyl ether	7005–72–3	10	330	10000
Fluorene	86–73–7	10	330	10000
4–Nitroaniline	100–01–6	25	800	25000
4,6–Dinitro–2–methylphenol	534–52–1	25	800	25000
N–Nitrosodiphenylamine	86–30–6	10	330	10000
4–Bromophenyl–phenylether	101–55–3	10	330	10000
Hexachlorobenzene	118–74–1	10	330	10000
Pentachlorophenol	87–86–5	25	800	25000
Phenanthrene	85–01–8	10	330	10000
Carbazole	86–74–8	10	330	10000
Anthracene	120–12–7	10	330	10000
Di–n–butylphthalate	84–74–2	10	330	10000
Fluoranthene	206–44–0	10	330	10000
Pyrene	129–00–0	10	330	10000
Butylbenzylphthalate	85–68–7	10	330	10000
3,3–Dichlorobenzidine	91–94–1	10	330	10000
Benzo(a)anthracene	56–55–3	10	330	10000
Chrysene	218–01–9	10	330	10000
bis(2–Ethylhexyl)phthalate	117–81–7	10	330	10000
Di–n–octylphthalate	117–84–0	10	330	10000
Benzo(b)fluoranthene	205–99–2	10	330	10000
Benzo(k)fluoranthene	207–08–9	10	330	10000
Benzo(a)pyrene	50–32–8	10	330	10000
Indeno(1,2,3–cd)pyrene	193–39–5	10	330	10000
Dibenz(a,h)anthracene	53–70–3	10	330	10000
Benzo(g,h,i)perylene	191–24–2	10	330	10000

The above reporting limits are those specified in the USEPA March 1990 CLP SOW protocols.

USEPA	U.S. Environmental Protection Agency.
CLP	Contract Laboratory Program.
ug/L	Micrograms per liter.
ug/kg	Micrograms per kilogram.
CAS	Chemical Abstracts Service.
*	Specific quantitation limits are highly matrix–dependent. The quantitation limits listed are provided for guidance and may not always be achievable. Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the CLP contract, will be higher.
**	Soil and sediment sample quantitation limits to be used in the final analytical report will be based on the determination of the sample concentration level made from the mandatory pre–screening of the sample matrix.

NJ14301–T3/Tab1–4b.wk3

Table 3-5. Target Compound List and Reporting Limits for Pesticides and Polychlorinated Biphenyls, to be Analyzed by USEPA CLP Protocols, in Ground-Water, Soil, and Sediment Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits* Ground-Water (ug/L)	Quantitation Limits* Soil (ug/kg)
alpha - BHC	319-84-6	0.05	1.7
beta - BHC	319-85-7	0.05	1.7
delta - BHC	319-86-8	0.05	1.7
gamma - BHC (Lindane)	58-89-9	0.05	1.7
Heptachlor	76-44-8	0.05	1.7
Aldrin	309-00-2	0.05	1.7
Heptachlor epoxide	1024-57-3	0.05	1.7
Endosulfan I	959-98-8	0.05	1.7
Dieldrin	60-57-1	0.10	3.3
4,4' - DDE	75-55-9	0.10	3.3
Endrin	72-20-8	0.10	3.3
Endosulfan II	33213-65-9	0.10	3.3
4,4' - DDD	72-54-8	0.10	3.3
Endosulfan sulfate	1031-07-8	0.10	3.3
4,4' - DDT	50-29-3	0.10	3.3
Methoxychlor	72-43-5	0.50	17.0
Endrin ketone	53494-70-5	0.10	3.3
Endrin aldehyde	7421-36-3	0.10	3.3
alpha - Chlordane	5103-71-9	0.05	1.7
gamma - Chlordane	5103-74-2	0.05	1.7
Toxaphene	8001-35-2	5.0	170.0
PCB - 1016	12674-11-2	1.0	33.0
PCB - 1221	11104-28-2	2.0	67.0
PCB - 1232	11141-16-5	1.0	33.0
PCB - 1242	53469-21-9	1.0	33.0
PCB - 1248	12672-29-6	1.0	33.0
PCB - 1254	11097-69-1	1.0	33.0
PCB - 1260	11096-82-5	1.0	33.0

USEPA	U.S. Environmental Protection Agency.
CLP	Contract Laboratory Program.
ug/L	Micrograms per liter.
ug/kg	Micrograms per kilogram.
CAS	Chemical Abstracts Service.
PCB	Polychlorinated biphenyl.
*	Specific quantitation limits are highly matrix-dependent. The quantitation limits are provided for guidance and may not always be achievable. Quantitation limits listed are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on a dry weight basis as required by the CLP contract, will be higher.

#NJ14301-T1/TCL5.wk3

Table 3–6. Target Analyte List and Reporting Limits for Metal Analytes, to be Analyzed by USEPA CLP Protocols, in Ground–Water, Soil, and Sediment Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Contract Required Detection Limits * Ground–Water ** (ug/L)	Contract Required Detection Limits * Soil (ug/kg)
Aluminum	7429–90–5	200	200
Antimony	7440–36–0	60	60
Arsenic	7440–38–2	10	10
Barium	7440–39–3	200	200
Beryllium	7440–41–7	5	5
Cadmium	7440–43–9	5	5
Calcium	7440–70–2	5000	5000
Chromium	7440–47–3	10	10
Cobalt	7440–48–4	50	50
Copper	7440–50–8	25	25
Iron	7440–89–6	100	100
Lead	7439–92–1	3	3
Magnesium	7439–95–4	5000	5000
Manganese	7439–96–5	15	15
Mercury	7439–97–6	0.2	0.2
Nickel	7440–02–0	40	40
Potassium	7440–09–7	5000	5000
Selenium	7782–49–2	5	5
Silver	7440–22–4	10	10
Sodium	7440–23–5	5000	5000
Thallium	7440–28–0	10	10
Vanadium	7440–62–2	50	50
Zinc	7440–66–6	20	20

USEPA	U.S. Environmental Protection Agency.
CLP	Contract Laboratory Program.
ug/L	Micrograms per liter.
ug/kg	Micrograms per kilogram.
CAS	Chemical Abstracts Service.
*	The contract required detection limits (CRDLs) are the instrument detection limits obtained in pure water that must be met using the procedure in the CLP SOW for inorganics analysis, March 1990, Exhibit E. The detection limits for samples may be considerably higher depending on the sample matrix.
**	Ground–water samples originating from aquifer tests and samples used to establish background conditions will be analyzed for total and dissolved target analyte list (TAL) constituents. The CRDLs listed above are for both total and dissolved TAL constituents.

NJ14301–QAPP/Tab2c.wk3

Table 3–7. Parameter List and Reporting Limits for Treatability Parameters, Total Organic Carbon, and Grain Size, to be Analyzed in Ground–Water or Sediment Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Method	Quantitation Limits*	
		Ground–Water (mg/L)	Sediment (mg/kg)
Alkalinity	USEPA 310.1	5	NA
Calcium	USEPA 200.7	0.2	NA
Grain size	ASTM D422, D4318 D2487–85	NA	(a)
Hardness	USEPA 200.7	0.3	NA
Iron	USEPA 200.7	0.1	NA
Magnesium	USEPA 200.7	0.2	NA
Manganese	USEPA 200.7	0.01	NA
TDS	USEPA 160.1	10	NA
TOC	Walkely–Black Method 29–3.52	NA	(b)
TSS	USEPA 160.2	5	NA

mg/L	Milligrams per liter.
mg/kg	Milligrams per kilogram.
USEPA	U.S. Environmental Protection Agency.
ASTM	American Society for Testing and Materials.
NA	Not applicable.
TDS	Total dissolved solids.
TOC	Total organic carbon.
TSS	Total suspended solids.
*	Specific quantitation limits are highly matrix–dependent. The quantitation limits listed are provided for guidance and may not always be achievable.
(a)	Particle/size analysis and classification based on weight percentage of sediment sample matrix.
(b)	Reported as percent carbon of the sediment sample matrix.

NJ14301–T2/TBL1–7.wk3

Table 3–8. Target Compound List and Reporting Limits for Volatile Organic Compounds, to be Analyzed by USEPA Method 8240, in the TCLP Leachate of Drill Cutting Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits* Leachate (mg/L)
Vinyl chloride	75–01–4	0.010
Acrylonitrile	107–13–1	0.050
Methylene chloride	75–09–2	0.0050
Carbon disulfide	75–15–0	0.0050
1,1–Dichloroethene	75–35–4	0.0050
Isobutanol	78–83–1	0.0050
Chloroform	67–66–3	0.0050
1,2–Dichloroethane	107–06–2	0.0050
2–Butanone	78–93–3	0.0050
1,1,1–Trichloroethane	71–55–6	0.0050
Carbon tetrachloride	56–23–5	0.0050
Trichloroethene	79–01–6	0.0050
1,1,2–Trichloroethane	79–00–5	0.0050
Benzene	71–43–2	0.0050
1,1,1,2–Tetrachloroethane	630–20–6	0.0050
1,1,2,2–Tetrachloroethane	79–34–5	0.0050
Tetrachloroethene	127–18–4	0.0050
Toluene	108–88–3	0.0050
Chlorobenzene	108–90–7	0.0050

USEPA	U.S. Environmental Protection Agency.
TCLP	Toxicity characteristic leaching procedure.
mg/L	Milligrams per liter.
CAS	Chemical Abstracts Service.
*	Specific quantitation limits are highly matrix–dependent. The quantitation limits listed are provided for guidance and may not always be achievable.

NJ14301–T1/PL8.wk3

Table 3–9. Target Compound List and Reporting Limits for Volatile Organic Compounds, to be Analyzed by USEPA Method TO–14, in Ambient Air Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	CAS Number	Quantitation Limits* Air [ppb (vol/vol)]
Chloromethane	74–87–3	2.5
Bromomethane	74–83–9	3.0
Vinyl chloride	75–01–4	2.5
Chloroethane	75–00–3	5.0
Methylene chloride	75–09–2	4.0
Acetone	67–64–1	10.0
Carbon disulfide	75–15–0	10.0
1,1–Dichloroethene	75–35–4	2.0
1,1–Dichloroethane	75–34–3	2.5
1,2–Dichloroethene (total)	540–59–0	2.5
Chloroform	67–66–3	2.0
1,2–Dichloroethane	107–06–2	2.0
2–Butanone	78–93–3	3.0
1,1,1–Trichloroethane	71–55–6	2.0
Carbon tetrachloride	56–23–5	2.0
Bromodichloromethane	75–27–4	2.0
1,2–Dichloropropene	78–87–5	8.0
cis–1,3–Dichloropropene	10061–01–5	3.0
Trichloroethene	79–01–6	2.5
Dibromochloromethane	124–48–1	3.0
1,1,2–Trichloroethane	79–00–5	3.0
Benzene	71–43–2	3.0
trans–1,3–Dichloropropene	10061–02–6	3.0
Bromoform	75–25–2	2.0
4–Methyl–2–pentanone	108–10–1	3.0
2–Hexanone	591–78–6	5.0
Tetrachloroethene	127–18–4	3.0
Toluene	108–88–3	3.0
1,1,2,2–Tetrachloroethane	79–34–5	4.0
Chlorobenzene	108–90–7	2.5
Ethyl benzene	100–41–4	2.5
Styrene	100–42–5	7.0
Xylenes (Total)	1330–20–7	5.0

USEPA	U.S. Environmental Protection Agency.
ppb (vol/vol)	Parts per billion measured in volume to volume.
CAS	Chemical Abstracts Service.
*	Specific quantitation limits are highly matrix–dependent. The quantitation limits listed above are for guidance and may not always be achievable.

NJ14301–T2/tab9.wk3

Table 3–10. Data Quality Objectives for Samples Collected from the Dublin TCE Site, Dublin, Pennsylvania.

Matrix	RI/FS Work Plan Subtask No.	Type of Sample	Data Use	Analytical Level	Type of Analysis
Water	3–15	Background Well	Risk assessment	IV	VOCs/BNAs/PCBs/Pesticides/Metals (Dissolved and Total)/Treatability
	3–15	Step I–Treatment system influent/effluent	Evaluation of disposal alternatives	II	VOCs
	3–15	Step I–On– or near–site well	Characterization of ground–water quality	III	VOCs/BNAs/PCBs/Pesticides/ Metals (Dissolved and Total)
	3–15	Residential/Monitoring Well	Characterization of ground–water quality	III	VOCs
	3–15	St. Luke's Church	Characterization of ground–water quality	III	VOCs
	3–15	Step II–Treatment system influent/effluent	Evaluation of disposal alternatives	II	VOCs
	3–22	Packer test samples	Characterization of ground–water quality	III	VOCs/Treatability
	3–22	Treatment system influent/effluent	Evaluation of disposal alternatives	II	VOCs

Analytical levels correspond to Geraghty & Miller analytical quality assurance/laboratory control program (AQA/LCP) deliverables.

RI/FS	Remedial Investigation/Feasibility Study.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
Treatability	Includes analyses for alkalinity, calcium, hardness, iron, magnesium, manganese, total dissolved solids, and total suspended solids.
PRP	Potentially responsible party.
UST	Underground storage tank.
TCLP	Toxicity characteristic leaching procedure.
TOC	Total organic carbon.

Table 3–10. Data Quality Objectives for Samples Collected from the Dublin TCE Site, Dublin, Pennsylvania.

Matrix	RI/FS Work Plan Subtask No.	Type of Sample	Data Use	Analytical Level	Type of Analysis
Water (Cont'd)	3–25	Treatment system influent/effluent	Evaluation of disposal alternatives	II	VOCs
	3–25	Step–drawdown pumping test sample	Evaluation of disposal alternatives Site characterization	II	VOCs/BNAs/PCBs/Pesticides/ Metals (Dissolved and Total)/Treatability
	3–25	Aquifer test samples – start and end of test	PRP determination Engineering design	IV	VOCs/BNAs/PCBs/Pesticides/Metals (Dissolved and Total)/Treatability
	3–25	Aquifer test samples – during test	PRP determination Engineering design	III	VOCs/Treatability
Soil	3–9	Test pit	Risk assessment Site characterization	IV	VOCs/BNAs/PCBs/Pesticides/Metals
	3–9	Soil boring – North of Buildings 1 and 2	Risk assessment Site characterization	IV	VOCs/BNAs/PCBs/Pesticides/Metals
	3–9	Soil boring – UST 1 (No.2 Fuel)	Site characterization	III	VOCs/BNAs
	3–9	Soil boring – UST 2 (No.4 Fuel)	Site characterization	III	VOCs/BNAs

Analytical levels correspond to Geraghty & Miller analytical quality assurance/laboratory control program (AQA/LCP) deliverables.

RI/FS	Remedial Investigation/Feasibility Study.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
Treatability	Includes analyses for alkalinity, calcium, iron, hardness, manganese, magnesium, total dissolved solids, and total suspended solids.
PRP	Potentially responsible party.
UST	Underground storage tank.
TCLP	Toxicity characteristic leaching procedure.
TOC	Total organic carbon.

Table 3–10. Data Quality Objectives for Samples Collected from the Dublin TCE Site, Dublin, Pennsylvania.

Matrix	RI/FS Work Plan Subtask No.	Type of Sample	Data Use	Analytical Level	Type of Analysis
Soil (Cont'd)	3–9	Soil boring – Fire tower	Site characterization	III	VOCs
	3–9	Background	Risk assessment	IV	VOCs/BNAs/PCBs/Pesticides/Metals
				III	TOC/Grain Size
Sediment	3–14	Background	Risk assessment	IV	VOCs/BNAs/PCBs/Pesticides/Metals
				III	TOC/Grain Size
	3–14	Drainage ditch	Risk assessment	IV	VOCs/BNAs/PCBs/Pesticides/Metals
				III	TOC/Grain Size
Solids	3–19	Drill cuttings	Evaluation of disposal alternatives	II	TCLP VOCs
	3–24	Drill cuttings	Evaluation of disposal alternatives	II	TCLP VOCs
Air	3–12	Background	Site characterization Risk assessment	IV	VOCs
	3–12	120 Mill Street property (during non–intrusive activity)	Site characterization Risk assessment	IV	VOCs

Analytical levels correspond to Geraghty & Miller analytical quality assurance/laboratory control program (AQA/LCP) deliverables.

RI/FS	Remedial Investigation/Feasibility Study.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
Treatability	Includes analyses for alkalinity, calcium, iron, hardness, manganese, magnesium, total dissolved solids, and total suspended solids.
PRP	Potentially responsible party.
UST	Underground storage tank.
TCLP	Toxicity characteristic leaching procedure.
TOC	Total organic carbon.

Table 3–10. Data Quality Objectives for Samples Collected from the Dublin TCE Site, Dublin, Pennsylvania.

Matrix	RI/FS Work Plan Subtask No.	Type of Sample	Data Use	Analytical Level	Type of Analysis
Air (Cont'd)	3–12	Downgradient (during non–intrusive activity)	Site characterization Risk assessment	IV	VOCs
	3–12	Test pits at 120 Mill Street property (during intrusive activity)	Site characterization Risk assessment	IV	VOCs
	3–12	Downgradient (during intrusive activity)	Site characterization Risk assessment	IV	VOCs

Analytical levels correspond to Geraghty & Miller analytical quality assurance/laboratory control program (AQA/LCP) deliverables.

RI/FS	Remedial Investigation/Feasibility Study.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
Treatability	Includes analyses for alkalinity, calcium, iron, hardness, manganese, magnesium, total dissolved solids, and total suspended solids.
PRP	Potentially responsible party.
UST	Underground storage tank.
TCLP	Toxicity characteristic leaching procedure.
TOC	Total organic carbon.

NJ14301–QAPP/Tbl1–10.wk3

Table 5–1. Field Quality Control Samples for the Dublin TCE Site, Dublin, Pennsylvania.

RI/FS ork Plan ubtask No.	Sample Type	Parameter	Estimated Sample Quantity	Estimated Field Blank Quantity	Estimated Trip Blank Quantity	Estimated Field Replicate Quantity
3–9	Test pit/soil boring (Background, and North of Buildings 1 and 2)	VOCs	13	3	3	2
		BNAs	13	3	NA	2
		Pesticides/PCBs	13	3	NA	2
		Metals	13	3	NA	2
3–9	Soil boring(USTs 1 and 2)	VOCs	8	1	1	1
		BNAs	8	1	NA	1
3–9	Soil boring (Fire tower and depth to bedrock)	VOCs	8	1	1	1
3–12	Air	VOCs	5	NA	NA	1
3–14	Sediment (Background and drainage ditch)	VOCs	7	1	1	2
		BNAs	7	1	NA	2
		Pesticides/PCBs	7	1	NA	2
		Metals	7	1	NA	2
		TOC	7	1	NA	2
		Grain size	7	NA	NA	1
3–15	Ground water (Background and step 1 wells)	VOCs	9	2	2	2
		BNAs	9	2	NA	2
		Pesticides/PCBs	9	2	NA	2
		Metals (total)	9	2	NA	2
		Metals (dissolved)	9	2	NA	2
		Treatability	1	1	NA	1
3–15	Ground water (Step 2 wells)	VOCs	23	2	2	3
3–20	Drill cuttings	VOCs	10	NA	NA	NA
3–22	Packer test samples	VOCs	66	NA	16	4
3–25	Aquifer test samples	VOCs	8	NA	2	1
		BNAs	3	NA	NA	1
		Pesticides/PCBs	3	NA	NA	1
		Metals (total)	3	NA	NA	1
		Metals (dissolved)	2	NA	NA	1
		Treatability	8	NA	NA	1

RI/FS	Remedial Investigation/Feasibility Study.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid semivolatile organic compounds.
PCBs	Polychlorinated biphenyls.
T	Underground storage tank.
atability	Includes analyses for alkalinity, calcium, iron, hardness, manganese, total dissolved solids, and total suspended solids.
TOC	Total organic carbon.
NA	Not applicable.

Table 5–2. Summary of Precision, Accuracy, and Completeness for Volatile Organic Compounds, to be Analyzed by USEPA Method 524.2, in Ground–Water Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Precision (RPD)	Accuracy (% R)	Completeness (%)
Chloromethane	20	80–120	> 95
Bromomethane	20	80–120	> 95
Vinyl chloride	20	80–120	> 95
Methylene chloride	50	50–150	> 95
Acetone	50	50–150	> 95
Carbon disulfide	50	50–150	> 95
1,1–Dichloroethene	20	80–120	> 95
1,1–Dichloroethane	20	80–120	> 95
1,2–Dichloroethene (total)	20	80–120	> 95
Chloroform	20	80–120	> 95
1,2–Dichloroethane	20	80–120	> 95
2–Butanone	50	50–150	> 95
1,1,1–Trichloroethane	20	80–120	> 95
Carbon tetrachloride	20	80–120	> 95
Bromodichloromethane	20	80–120	> 95
1,2–Dichloropropene	20	80–120	> 95
cis–1,3–Dichloropropene	20	80–120	> 95
Trichloroethene	20	80–120	> 95
Dibromochloromethane	20	80–120	> 95
1,1,2–Trichloroethane	20	80–120	> 95
Benzene	20	80–120	> 95
trans–1,3–Dichloropropene	20	80–120	> 95
Bromoform	20	80–120	> 95
4–Methyl–2–pentanone	50	50–150	> 95
2–Hexanone	50	50–150	> 95
Tetrachloroethene	20	80–120	> 95
Toluene	20	80–120	> 95
1,1,2,2–Tetrachloroethane	20	80–120	> 95
Chlorobenzene	20	80–120	> 95
Ethyl benzene	20	80–120	> 95
Styrene	20	80–120	> 95
Xylenes (Total)	20	80–120	> 95

USEPA	U.S. Environmental Protection Agency.
RPD	Relative percent difference.
% R	Percent recovery.
%	Percent.
>	Greater than.

NJ14301–QAPP\tbl3–2.wk3

Table 5–3. Summary of Precision, Accuracy, and Completeness for Representative Volatile Organic Compounds, to be Analyzed by USEPA Method TO–14, in Ambient Air Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Precision (RPD)	Accuracy (% R)	Completeness (%)
1,1–Dichloroethene	20	80–115	>95
Methylene chloride	20	80–115	>95
1,1,2,2–Tetrachloroethane	20	80–115	>95
Toluene	20	80–115	>95
Trichloroethene	20	80–115	>95

USEPA	U. S. Environmental Protection Agency.
RPD	Relative percent difference.
% R	Percent recovery.
%	Percent.

NJ14301–QAPPAtbl3.wk3

Table 5–4. Summary of Precision, Accuracy, and Completeness for Treatability Parameters, Total Organic Carbon, and Grain Size to be Analyzed in Ground–Water or Sediment Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Matrix	Parameter	Precision (RPD)	Accuracy (% R)	Completeness (%)
Water	Alkalinity	7	88–112	>90
	Calcium	20	80–120	>95
	Hardness	20	80–120	>95
	Iron	20	80–120	>95
	Magnesium	20	80–120	>95
	Manganese	20	80–120	>95
	TDS	9	87–109	>90
	TOC	5	93–107	>90
	TSS	14	78–118	>90
Sediment	TOC	25	75–125	>90
	Grain size	NA	NA	NA

USEPA	U.S. Environmental Protection Agency.
RPD	Relative percent difference.
% R	Percent recovery.
%	Percent.
TDS	Total dissolved solids.
TOC	Total organic carbon.
TSS	Total suspended solids.
>	Greater than.
NA	Not applicable.

NJ14301–QAPP/tbl3–4.wk3

Table 6–1. Parameters, Sample Volumes, Container Types, Preservatives, and Holding Times for Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Matrix	Sample Quantity (1)	Container Type (2)	Preservative	Holding Time (3)
Organic Compounds					
VOCs	Water	3 x 40 mL	G Teflon–lined septum	HCl to pH<2 Cool 4 degrees Celsius	7 days unpreserved (aromatics only) 14 days preserved
VOCs	Soil	2 x 120 mL	G (wide mouth) Teflon–lined cap	None Cool 4 degrees Celsius	14 days
VOCs	Air	4 L	Summa canister	None Cool 4 degrees Celsius	14 days
BNAs	Water	2 x 1 L	G (amber) Teflon–lined cap	None Cool 4 degrees Celsius	7 days to extraction 40 days to analysis
BNAs	Soil	1 x 240 mL	G (wide mouth) Teflon–lined cap	None Cool 4 degrees Celsius	14 days to extraction 40 days to analysis
Pesticides/PCBs	Water	2 x 1 L	G (amber) Teflon–lined cap	None Cool 4 degrees Celsius	7 days to extraction 40 days to analysis
Pesticides/PCBs	Soil	1 x 240 mL	G (wide mouth) Teflon–lined cap	None Cool 4 degrees Celsius	14 days to extraction 40 days to analysis

<	Less than.
mL	Milliliters.
L	Liters.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
TDS	Total dissolved solids.
TSS	Total suspended solids.
TOC	Total organic carbon.

1 Recommended sample volume and/or quantity for sample analysis; treble volumes are required for matrix spike, matrix spike duplicate, and matrix duplicate water samples for organic and inorganic parameters.

2 Glass (G) or polyethylene (P). All containers will be I–Chem 200 series (provided by the laboratory).

3 Holding time measured from date of sample collection (not date of laboratory sample receipt).

NJ14301–T2/table4–1.wk3

Table 6-1. Parameters, Sample Volumes, Container Types, Preservatives, and Holding Times for Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Matrix	Sample Quantity (1)	Container Type (2)	Preservative	Holding Time (3)
Total Metals					
All, except mercury	Water	2 x 500 mL	P	HNO3 to pH<2 Cool 4 degrees Celsius	180 days
All, except mercury	Soil	1 x 240 mL	P or G	None Cool 4 degrees Celsius	180 days
Mercury	Water	2 x 500 mL	P	HNO3 to pH<2 Cool 4 degrees Celsius	28 days
Mercury	Soil	1 x 240 mL	P or G	None Cool 4 degrees Celsius	28 days
Dissolved Metals					
All, except mercury	Water	2 x 500 mL	P	Field filter on-site HNO3 to pH<2 Cool 4 degrees Celsius	180 days
Mercury	Water	2 x 500 mL	P	Field filter on-site HNO3 to pH<2 Cool 4 degrees Celsius	28 days

<	Less than.
mL	Milliliters.
L	Liters.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
TDS	Total dissolved solids.
TSS	Total suspended solids.
TOC	Total organic carbon.

1 Recommended sample volume and/or quantity for sample analysis; treble volumes are required for matrix spike, matrix spike duplicate, and matrix duplicate water samples for organic and inorganic parameters.

2 Glass (G) or polyethylene (P). All containers will be I-Chem 200 series (provided by the laboratory).

3 Holding time measured from date of sample collection (not date of laboratory sample receipt).

Table 6–1. Parameters, Sample Volumes, Container Types, Preservatives, and Holding Times for Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Matrix	Sample Quantity (1)	Container Type (2)	Preservative	Holding Time (3)
Treatability					
Alkalinity	Water	1 x 500 mL	P	None Cool 4 degrees Celsius	14 days
Calcium	Water	1 x 500 mL	P	HNO3 to pH<2 Cool 4 degrees Celsius	180 days
Hardness	Water	1 x 500 mL	P	HNO3 to pH<2 Cool 4 degrees Celsius	180 days
Iron	Water	1 x 500 mL	P	HNO3 to pH<2 Cool 4 degrees Celsius	180 days
Magnesium	Water	1 x 500 mL	P	HNO3 to pH<2 Cool 4 degrees Celsius	180 days
Manganese	Water	1 x 500 mL	P	HNO3 to pH<2 Cool 4 degrees Celsius	180 days

<	Less than.
mL	Milliliters.
L	Liters.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
TDS	Total dissolved solids.
TSS	Total suspended solids.
TOC	Total organic carbon.

1 Recommended sample volume and/or quantity for sample analysis; treble volumes are required for matrix spike, matrix spike duplicate, and matrix duplicate water samples for organic and inorganic parameters.

2 Glass (G) or polyethylene (P). All containers will be I–Chem 200 series (provided by the laboratory).

3 Holding time measured from date of sample collection (not date of laboratory sample receipt).

NJ14301–T2/table4–1.wk3

Table 6–1. Parameters, Sample Volumes, Container Types, Preservatives, and Holding Times for Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Matrix	Sample Quantity (1)	Container Type (2)	Preservative	Holding Time (3)
TDS	Water	1 x 500 mL	P	None Cool 4 degrees Celsius	7 days
TSS	Water	1 x 500 mL	P	None Cool 4 degrees Celsius	7 days
Wet Chemistry/Physical Properties					
TOC	Water	1 x 250 mL	G Teflon–lined cap	HNO3 to pH<2 Cool 4 degrees Celsius	28 days
TOC	Soil	1 x 250 mL	G (wide mouth) Teflon–lined cap	None Cool 4 degrees Celsius	7 days
Grain size	Soil	2 x 500 mL	G (wide mouth)	None	7 days

<	Less than.
mL	Milliliters.
L	Liters.
VOCs	Volatile organic compounds.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
TDS	Total dissolved solids.
TSS	Total suspended solids.
TOC	Total organic carbon.

1 Recommended sample volume and/or quantity for sample analysis; treble volumes are required for matrix spike, matrix spike duplicate, and matrix duplicate water samples for organic and inorganic parameters.

2 Glass (G) or polyethylene (P). All containers will be I–Chem 200 series (provided by the laboratory).

3 Holding time measured from date of sample collection (not date of laboratory sample receipt).

NJ14301–T2/table4–1.wk3

Table 6–2. Parameters and Methods of Analysis for Ground–Water, Solids, Soil, Sediment, and Air Samples from the Dublin TCE Site, Dublin, Pennsylvania.

Parameter	Method
Ground–Water	
VOCs	USEPA 524.2
BNAs	CLP RAS
Pesticides/PCBs	CLP RAS
Metals (total and dissolved)	CLP RAS
Treatability	
Alkalinity	USEPA 310.1
Calcium	USEPA 200.7
Hardness	USEPA 200.7
Iron	USEPA 200.7
Magnesium	USEPA 200.7
Managanese	USEPA 200.7
TDS	USEPA 160.1
TSS	USEPA 160.2
Soil/Sediment	
VOCs	CLP RAS
BNAs	CLP RAS
Pesticides/PCBs	CLP RAS
Metals	CLP RAS
Grain size	ASTM D422, D4318, and D2487–85
TOC	Walkely–Black Method 29–3.52
Solids (drill cuttings)	
VOCs	USEPA 1311, USEPA 8240
Air	
VOCs	USEPA TO–14

VOCs	Volatile organic compounds.
USEPA	U.S. Environmental Protection Agency.
BNAs	Base neutral and acid extractable organic compounds.
PCBs	Polychlorinated biphenyls.
ASTM	American Society for Testing and Materials.
CLP RAS	Contract laboratory program routine analytical services (in accordance with USEPA March 1990 protocols).
TDS	Total dissolved solids.
TSS	Total suspended solids.
TOC	Total organic carbon.

NJ14301–T2/Parametr.wk3

Table 7–1. Description of Sample Identification String for Samples Collected from the Dublin TCE Site, Dublin, Pennsylvania.

Matrix	Type of Sample	First Field	Second Field	Third Field	Example	Description
Water	Ground Water–Monitoring/ Observation Well	M	Well I.D. No.	Month and date of sample collection in mmdd format.	M010503	Monitoring/Observation Well No. 1 collected on May 3.
	Ground Water–Supply Well	R	Well I.D. No.	Month and date of sample collection in mmdd format.	R030607	Supply Well No. 3 collected on June 7.
	Ground Water–Test Well	W	Well I.D. No.	Month and date of sample collection in mmdd format.	W010922	Test Well No. 1 collected on September 22.
	Packer Test–Monitoring/ Observation Well	P	Well I.D. No.	Depth of top of zone tested to nearest foot and time of sample collection in coded format.	P0560A	Packer Test for Monitoring/Observation Well No. 5 at 60–foot depth collected at Time A.
	Packer Test–Supply Well	Y	Well I.D. No.	Depth of top of zone tested to nearest foot and time of sample collection in coded format.	Y06100D	Packer Test for Supply Well No. 6 at 100–foot depth collected at Time D.
	Packer Test–Test Wells	Z	Well I.D. No.	Depth of top of zone tested to nearest foot and time of sample collection in coded format.	Z01220B	Packer Test for Test Well No. 1 at 22–foot depth collected at Time B.
	Aquifer Test–Monitoring/ Observation Well.	A	Well I.D. No.	Month and date of sample collection in mmdd format.	A061012	Aquifer Test for Monitoring/Observation Well No. 6 collected on October 12.
	Aquifer Test–Supply Wells	X	Well I.D. No.	Month and date of sample collection in mmdd format.	X031120	Aquifer Test for Supply Well No. 3 collected on November 20.
	Aquifer Test–Test Wells	L	Well I.D. No.	Month and date of sample collection in mmdd format.	L021218	Aquifer Test for Test Well No. 2 collected on December 18.
	Treatment System Influent	I	Sample I.D. No.	Time of sample collection in military format.	I081840	Treatment System Influent No. 8 collected at 18:30.
	Treatment System Effluent	E	Sample I.D. No.	Time of sample collection in military format.	E051130	Treatment System Effluent No. 5 collected at 11:30.

QA/QC uality assurance/quality control.
I.D. No. entification number.
mmdd Month and date.

Table 7–1. Description of Sample Identification String for Samples Collected from the Dublin TCE Site, Dublin, Pennsylvania.

Matrix	Type of Sample	First Field	Second Field	Third Field	Example	Description
Soil/Sediment Solids	Subsurface Soils–Soil Borings	S	Boring I.D. No.	Depth of the top of the interval sampled in tenths of a foot.	S0210.5	Soil Boring No. 2 collected at 10.5–foot depth.
	Subsurface Soils–Test Pits	T	Test Pit I.D. No.	Depth of the top of the interval sampled in tenths of a foot.	T0101.0	Test Pit No. 1 collected at 1.0–foot depth.
	Surface Soil–Background	B	Sample I.D. No.	Depth of the top of the interval sampled in tenths of a foot.	B0100.0	Background Soil Sample not collected at the surface.
	Sediment	D	Boring I.D. No.	Depth of the top of the interval sampled in tenths of a foot.	D0202.5	
	Drill Cuttings	C	Sample I.D. No.	Not assigned.	C10	Drill Cutting No. 10.
Wastewater	Septic Tank	ST	Sample I.D. No.	Month and date of sample collection in mmdd format.	ST10504	Setpci tank sample No. 1 collected on May 4.
	Septic System Leachate	SL	Sample I.D. No.	Month and date of sample collection in mmdd format.	SL10504	Septic system leachate sample No. 1 collected on May 4.
Air	Air Sample	AIR	(No second field)	Month and date of sample collection in mmdd format.	AIR0121	Air sample collected on January 21.
QA/QC Samples	Field Blank	F	Well or Sample I.D. No.	Date of sample collection.	F050128	Field blank collected at Well No. 5 on January 28.
	Trip Blank	K	Trip Blank I.D. No.	Date of sample collection.	K010317	Trip blank No. 1 for samples collected on March 17.

Quality assurance/quality control.
Identification number.
Month and date.

2/descid.wk3

GERAGHTY & MILLER, INC.

Table 11-1. Summary of Laboratory Acceptance Criteria for the Analytical Data from the Dublin TCE Site, Dublin, Pennsylvania.

		Quality Control Acceptance Criteria							
Matrix	Parameter/Method	Method/ Reagent Blank (1)	Surrogates/System Monitoring Compounds and Limits	Laboratory Control Sample(s)	MS/MSD	Laboratory Duplicate	Calibration Criteria (Blank, Curve, RF, and/or RSD)	Internal Standards	Other Criteria
Water	VOCs/USEPA 524.2	<QL	4-Bromofluorobenzene 1,2-Dichloroethane-d4 Toluene-d8 (<30% response decrease from CCV, or <50% response decrease from ICV)	LFB/sequence (2) (80-120%R; RPD<20%)	NA	NA	5-point initial calibration; <30% response decrease from CCV, or <50% response decrease from ICV.	Fluorobenzene	12 hr BFB tune; MDL Study
	VOCs/USEPA 8240	<QL	4-Bromofluorbenzene (86-115%) 1,2-Dichloroethane-d4 (76-114%) Toluene-d8 (88-110%)	Duplicate control samples	Per batch of 20 as per SW-846	Per batch of 20 as per SW-846	5-point initial calibration (RF > 0.3; RSD < 30%) 1 point continuing calibration (RF > 0.3; RSD < 25%)	Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5	12 hr BFB tune
	BNAs/CLP RAS	<QL	App. A Table 5-1	NA	App. A Table 5-1	NA	3/90 SOW	3/90 SOW	12 hr DFTPP tune
	Pesticides and PCBs/ CLP RAS	<QL	App. A Table 5-1	NA	App. A Table 5-1	NA	3/90 SOW	NA	Performance evaluation standard; % Breakdown DDT and Endrin
	Metals/CLP RAS	<CRDL	NA	90-110%R 80-120%R for Hg	App. A Table 5-1	RPD<20%	3/90 SOW	NA	NA
	<u>Treatability</u>								
	Alkalinity	<QL	NA	88-112%R	NA	RPD<7%	NA	NA	Reference Std.
	Calcium	<QL	NA	80-120%R	80-120%R	RPD<20%	90-110%CCV	NA	NA
	Hardness	<QL	NA	NA	NA	NA	NA	NA	Reference Std.
	Magnesium	<QL	NA	80-120%R	80-120%R	RPD<20%	90-110%CCV	NA	NA
	Manganese	<QL	NA	80-120%R	80-120%R	RPD<20%	90-110%CCV	NA	NA
	Iron	<QL	NA	80-120%R	80-120%R	RPD<20%	90-110%CCV	NA	NA
	TDS	<QL	NA	87-109%R	NA	RPD<9%	NA	NA	Reference Std.
	TSS	<QL	NA	78-118%R	NA	RPD<14%	NA	NA	Reference Std.

See footnotes on page 2.

Table 11-1. Summary of Laboratory Acceptance Criteria for the Analytical Data from the Dublin TCE Site, Dublin, Pennsylvania.

		Quality Control Acceptance Criteria							
Matrix	Parameter/Method	Method/ Reagent Blank (1)	Surrogates/System Monitoring Compounds and Limits	Laboratory Control Sample(s)	MS/MSD	Laboratory Duplicate	Calibration Criteria (Blank, Curve, RF, and/or RSD)	Internal Standards	Other Criteria
Soil/Sediment/ Solids	VOCs/CLP RAS	<QL	App. A Table 5-1	NA	App. A Table 5-1	NA	3/90 SOW	3/90 SOW	12 hr BFB tune
	BNAs/CLP RAS	<QL	App. A Table 5-1	NA	App. A Table 5-1	NA	3/90 SOW	3/90 SOW	12 hr DFTPP tune
	Pesticides and PCBs/ CLP RAS	<QL	App. A Table 5-1	NA	App. A Table 5-1	NA	3/90 SOW	NA	72 hr sequence; % Breakdown DDT and Endrin
	Metals/CLP RAS	<CRQL	NA	90-110%R 80-120%R for Hg	App. A Table 5-1	RPD<20%	3/90 SOW	NA	NA
	TOC	<QL	NA	75-125%R	NA	RPD<20%	NA	NA	NA
	Grain size	NA	NA	NA	NA	Equivalent classification	NA	NA	NA
Air	VOCs/USEPA TO-14	<QL	Table 3-3	Table 3-3	NA	RPD<20%	3-point calibration	NA	Check standard; tuning criteria as per TO-14

MS/MSD	Matrix spike/matrix spike duplicate.	NA	Not applicable.	Hg	Mercury.
RF	Response factor.	CCV	Continuing calibration verification.	CRDL	Contract required detection limit.
RSD	Relative standard deviation.	ICV	Initial calibration verfication.	Std.	Standard.
VOCs	Volatile organic compounds.	MDL	Method detection limit.	TDS	Total dissolved solids.
USEPA	U.S. Environmental Protection Agency	hr	Hour.	TSS	Total suspended solids.
QL	Quantitation limit.	BFB	Bromofluorobenzene.	TOC	Total organic carbon.
LFB	Laboratory fortified blank.	BNAs	Base neutral and acid semivolatile organic compounds.	(1)	Allowable levels for common laboratory contaminants as per the validation guidelines and the 3/90 SOW.
%R	Percent recovery.	CLP RAS	Contract laboratory program routine analytical services.		
RPD	Relative percent difference.	App.	Appendix.		
<	Less than.	3/90 SOW	USEPA March 1990 Statement of Work.	(2)	For target compound list ketones, 50-150% R acceptance limits will be used.
≥	Greater than.	DFTPP	Decafluorotriphenylphosphine.		
		PCBs	Polychlorinated biphenyls.		

-t3/AcceptCri.wk3

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Table 11–2. Summary of Field Quality Control Acceptance Criteria for the Dublin TCE Site, Dublin, Pennsylvania.

Field QC	QC Criteria	Quality Control Review/Corrective Action
Laboratory Analyses		
Trip blanks	– Absence of target VOC constituents in blank. – Permissible levels of common laboratory VOC contaminants (<10 x QL). – Collected at required frequency.	– Review laboratory sample–handling practices and documentation. – Review field sample–handling practices and documentation.
Field blanks	– Absence of target constituents in blank. – Permissible levels of common laboratory organic contaminants (<10 x QL). – Collected at required frequency.	– Review laboratory sample–handling practices and documentation. – Review field sample–handling practices and documentation.
Field replicates	– RPD less than 20%. – Collected at required frequency.	– Review of field sample–handling practices and documentation. – Review of laboratory analytical practices and documentation. – Visual inspection of sample material to qualitatively determine degree of sample heterogeneity.
Field Analyses		
Replicate measurements (pH, conductivity, and field GC)	– RPD less than 20%. – Replicate at 10% frequency.	– Review field analysis procedure. – Verify equipment usage and condition. – Reanalyze sample.
Reference standards (pH, conductivity, and field GC)	– 80–120% R, or as per reference source. – Measured at 10% frequency.	– Review field analysis procedure. – Verify equipment usage and condition. – Reanalyze sample.

QC	Quality control.
VOC	Volatile organic compound.
QL	Quantitation limit.
RPD	Relative percent difference.
<10 x	Less than ten times.
%	Percent.
GC	Gas chromatograph.
%R	Percent recovery.

Table 13–1. Summary of Recommended Spare Parts and Preventative Maintenance Schedule for Field Equipment Usage at the Dublin TCE Site, Dublin, Pennsylvania.

Equipment/Instrument	Spare Part(s)	Maintenance Schedule
Thermometer	Back–up thermometer	Daily inspection
pH Meter	Standard buffer solution, electrode, batteries, electrolyte solution, cleaning compound	Daily inspection
Conductivity meter	Standard solution, electrode, batteries, electrolyte solution, cleaning compound	Daily inspection
HNU trace gas analyzer	Replacement lamp, ion chamber assembly, calibration gas cylinder, regulator, cleaning compound, battery charger	Annual servicing Monthly cleaning Daily inspection
Portable field GC	Syringes, septa, columns, gases, ferrules, standard solution, recorder paper	Annual servicing Daily inspection

GC	Gas chromatograph.

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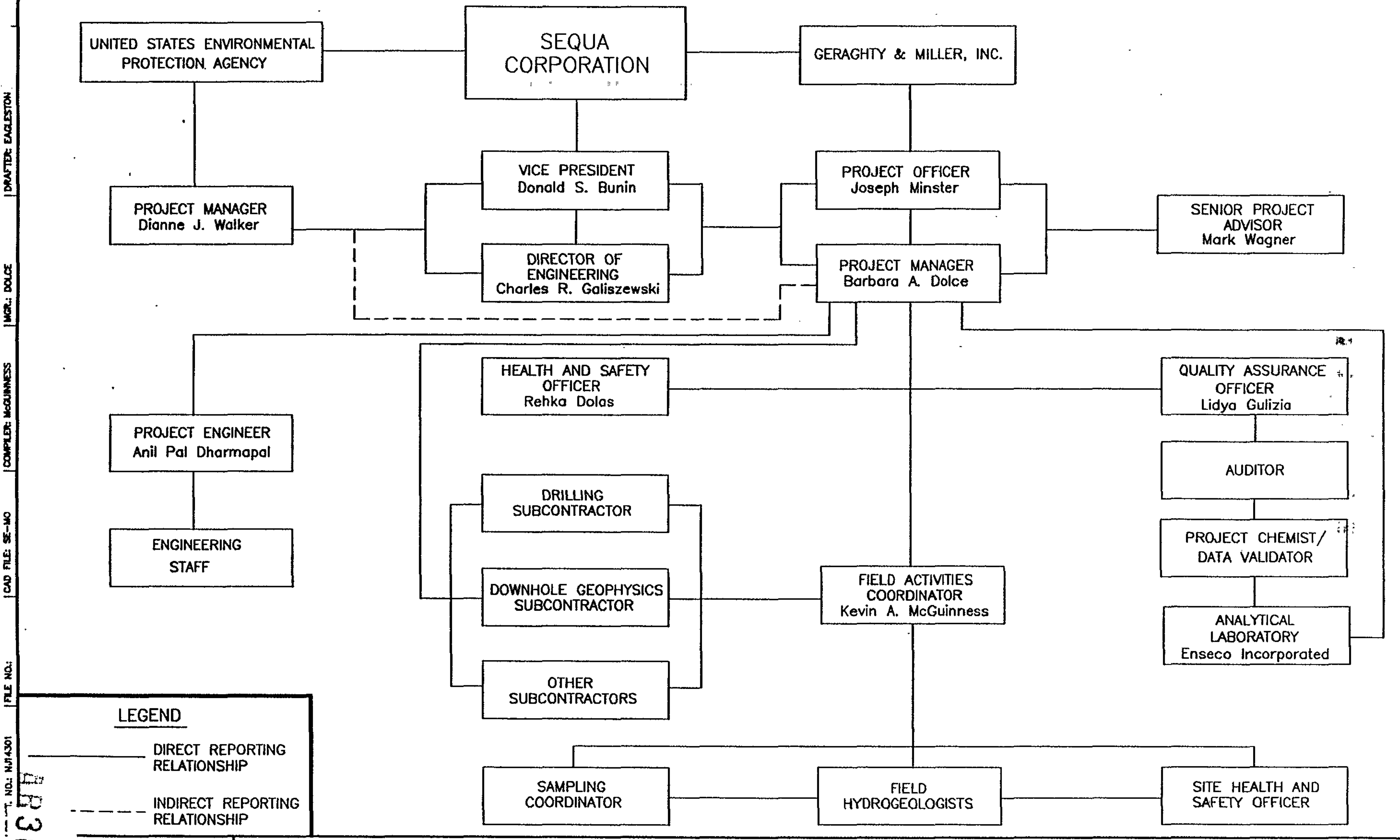

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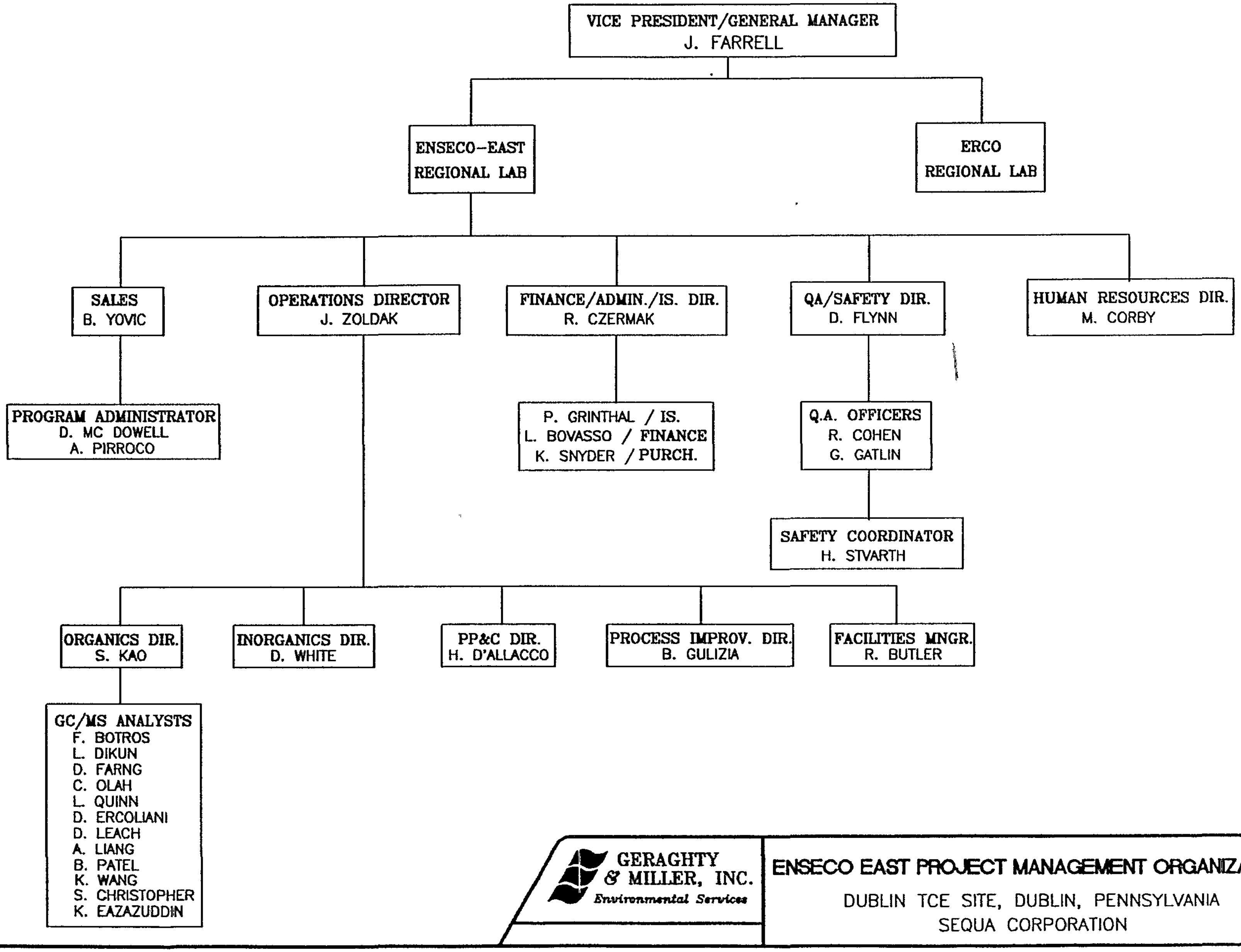
SCALE
NONE

GERAGHTY
& MILLER, INC.
nvironmental Services

GERAGHTY & MILLER, INC. PROJECT MANAGEMENT ORGANIZATION

DUBLIN TCE SITE, DUBLIN, PENNSYLVANIA
SEQUA CORPORATION

FIGURE
4-1



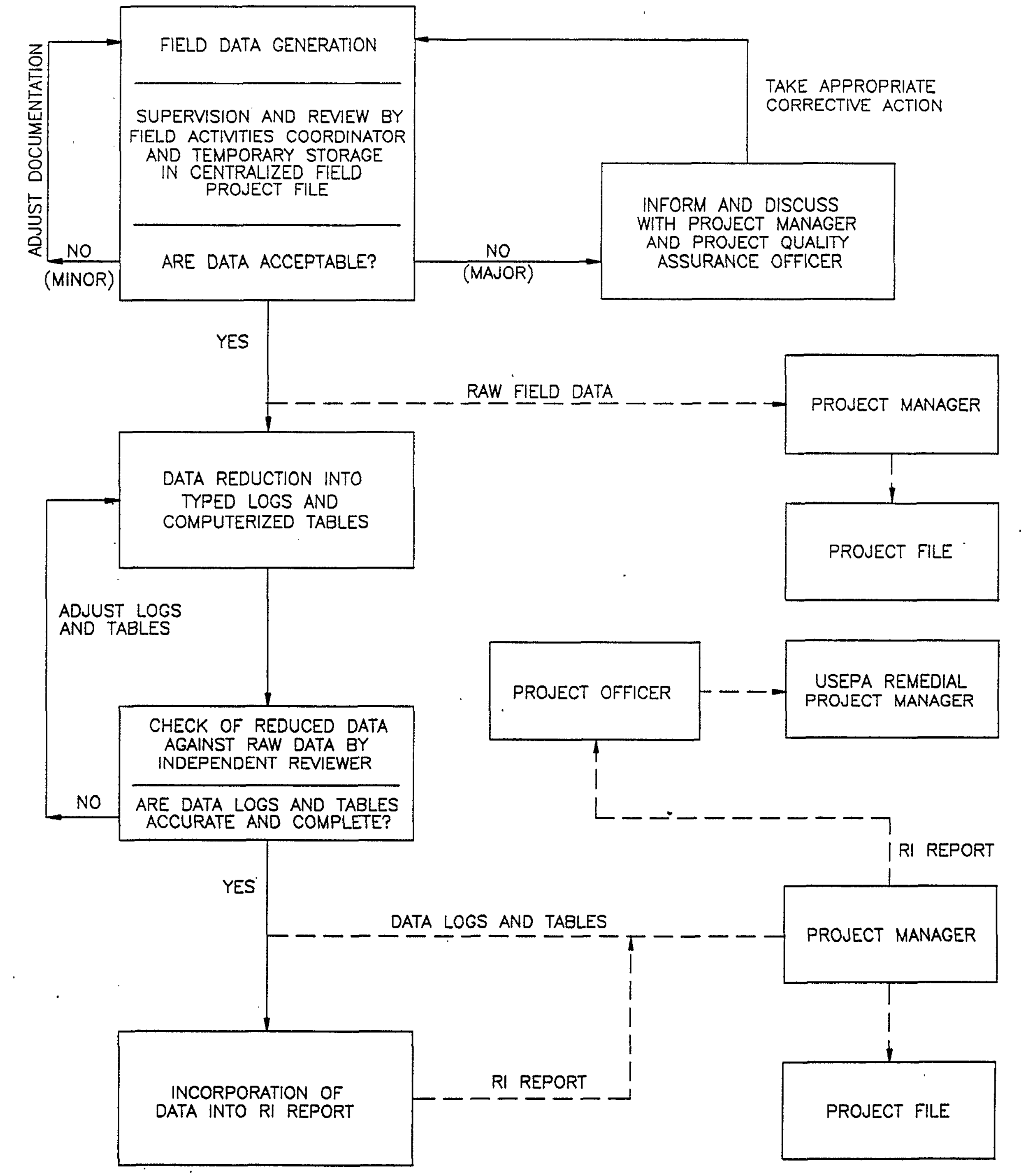
GERAGHTY & MILLER, INC.
Environmental Services

ENSECO EAST PROJECT MANAGEMENT ORGANIZATION

DUBLIN TCE SITE, DUBLIN, PENNSYLVANIA
SEQUA CORPORATION

FIGURE
4-2

DWG DATE: MAR92 | PRJCT NO: | FILE NO.: SEQ-POC | DRAWING: SEQ-PEC | CHECKED: L. GULIZIA | APPROVED: L. GULIZIA | DRAFTER: E. EAGLESTON



DRAFTER: E.EAGLESTON
APPROVED: B.DOLCE
CHECKED: R.EVELEIGH
DRAWING: SQ-21
FILE NO.: -
PRJCT NO.: NJ14301
DWG DATE: 27FEB92

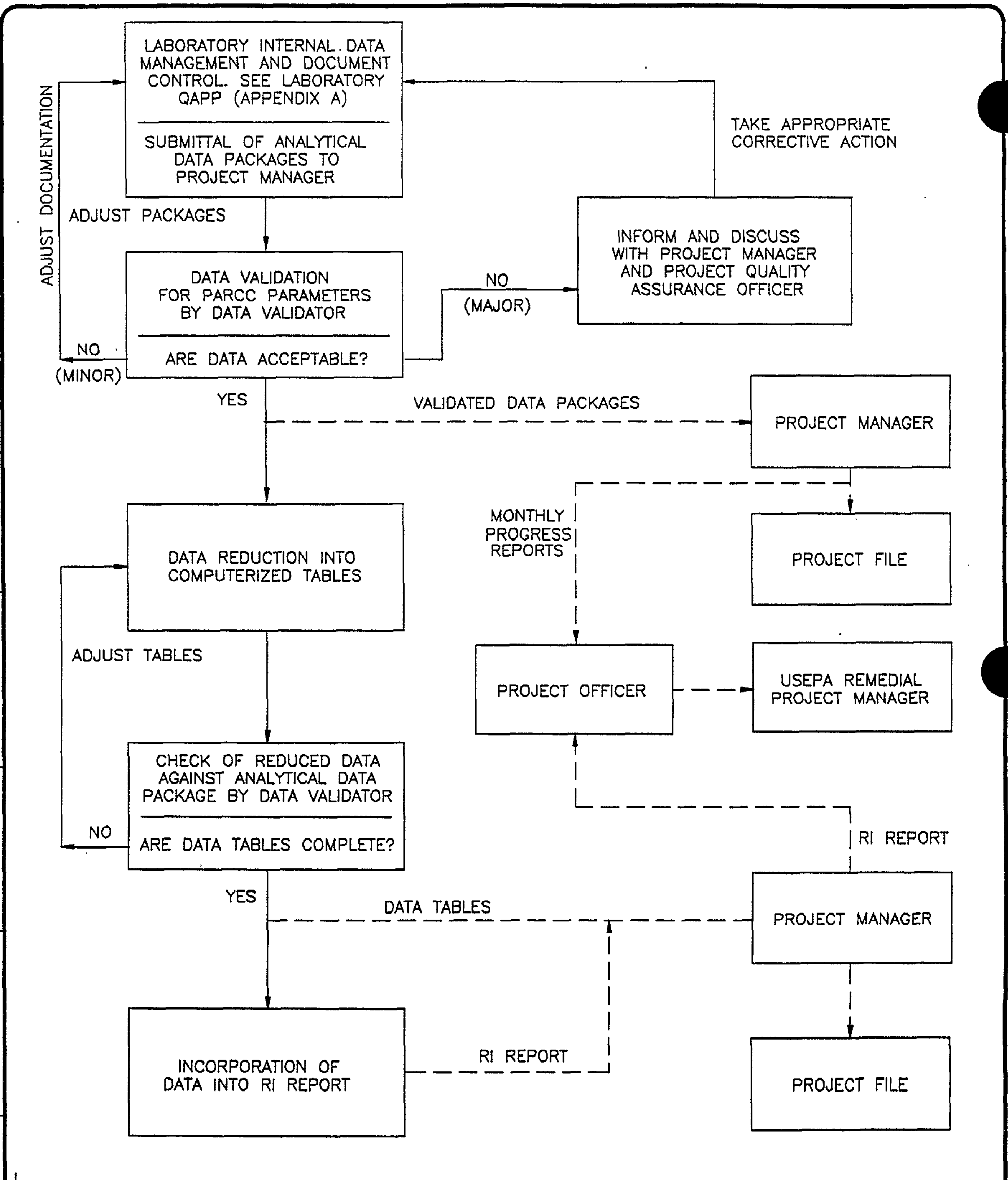
GERAGHTY & MILLER, INC.
Environmental Services

FIELD DATA MANAGEMENT SCHEME

DUBLIN TCE SITE, DUBLIN, PENNSYLVANIA
SEQUA CORPORATION

FIGURE
10-1

DRAFTER: E.EAGLESTON | APPROVED: B.DOLCE | CHECKED: R.EVELEIGH | DRAWING: SQ-22 | FILE NO.: - | PRJCT NO.: NJ14301 | DWG DATE: 27FEB92



GERAGHTY & MILLER, INC.
Environmental Services

LABORATORY DATA MANAGEMENT SCHEME

DUBLIN TCE SITE, DUBLIN, PENNSYLVANIA
SEQUA CORPORATION

FIGURE
10-2

APPENDIX A

ENSECO EAST LABORATORY QUALITY ASSURANCE PROJECT PLAN

Section No.: 1
Revision No.: 1.0
Date: 3/92
Page: 1 of 1

Enseco
A CORNING Company

ENSECO EAST
LABORATORY QUALITY ASSURANCE PROJECT PLAN
for

GERAGHTY AND MILLER, INC.
IN SUPPORT OF
SEQUA CORPORATION
DUBLIN TCE SITE
DUBLIN BOROUGH
BUCKS COUNTY, PA

March 3, 1992

Barbara Dolce
Barbara Dolce, Project Manager
Geraghty and Miller, Inc.

Lidya Gulizia
Lidya Gulizia, Project QA Officer
Geraghty and Miller, Inc.

Donald J McDowell
Don McDowell, Program Administrator
Enseco East

Dennis N. Flynn
Dennis Flynn, Regional Director of Quality Assurance
Enseco East

Dianne J. Walker, Project Manager
EPA Region III

Enseco Incorporated
2200 Cottontail Lane
Somerset, New Jersey 08875
201/469-5800 Fax: 201/469-7516

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3. PROJECT DESCRIPTION

This quality assurance project plan (QAPjP) outlines specific quality assurance (QA) and quality control (QC) procedures to be followed by Enseco in generating chemical analyses related to the Geraghty and Miller, Inc. Dublin TCE Site, Dublin, Pennsylvania. The plan calls for the analysis of water, soil, sediment, solid and air samples.

3.1 Purpose

The purpose of this QAPjP is to provide a detailed description of all elements involved in the generation of data of acceptable quality and completeness for the monitoring of volatiles and semivolatile organic compounds, Metals, Pesticide, Polychlorinated Biphenyls (PCB'S) and miscellaneous wet chemistry tests. Guidelines for this plan have been obtained from "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," Office of Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. Environmental Protection Agency (U.S. EPA), EPA-600/4-83-004, February 1983 and "Preparing Perfect Project Plans," Office of Research and Development, Risk Reduction Engineering Laboratory, U.S. EPA, EPA-600/9-89-087, October 1989. This plan has been prepared as a Category II plan as described in the latter document.

3.2 Scope

The scope of this QAPjP is to outline QC requirements for all data generated during the project based on quality judgements using the following three types of information.

- Overall qualifications data which includes internal and external performance and systems audits to ensure that there are adequate facilities and equipment, qualified personnel, documented laboratory procedures, accurate data reduction, proper validation, and complete reporting.
- Data that measure the daily performance of the laboratory according to the specific method employed. This includes data on calibration procedures and instrument performance.
- Data that evaluate the overall quality of the package that is used to determine precision, accuracy, representativeness, completeness, and comparability which is in compliance with the data quality objectives listed in Section 5. Such data includes laboratory method blanks, and duplicate control samples.

3.3 Analyses

The groundwater samples will be analyzed for one or more of the following parameters:

Volatile Organics
Semivolatile Organics
Pesticides/PCB's
Metals
Alkalinity
Hardness
TDS
TSS

The soil and sediment samples will be analyzed for one or more of the following parameters:

Volatile Organic
Semivolatile Organics
Metals
Pesticides/PCB's
Total Organic Carbon
Grainsize Analyses

The solid (drill cuttings) and air samples will be analyzed for the following parameter:

Volatile Organics

4. PROJECT ORGANIZATION AND RESPONSIBILITIES

In order to ensure that all QA/QC procedures are strictly adhered to, specific responsibilities must be assigned to each individual involved in the project.

Don McDowell is the designated Enseco program administrator (PA). The responsibility for day to day management of the project rests with the PA. These responsibilities include, but are not limited to, scheduling bottle shipments to the field, scheduling the project within the laboratory, ensuring proper login of the samples, communicating progress and/or anomalies encountered in the laboratory to the client, and approving the final report issued to the client.

The QA director, Dennis Flynn, will oversee and be responsible for all QA/QC activities including audits, preparation of QA specifications, and corrective action. Dennis Flynn reports directly to John Farrell, the Enseco regional manager, and indirectly to Peggy Sleevi, the Enseco Corporate QA director.

Laboratory managers are responsible for producing fully documented data of acceptable quality from their respective laboratories. Figure 4-1 illustrates the Enseco organizational structure.

Figure 4-1. Enseco Organizational Chart.

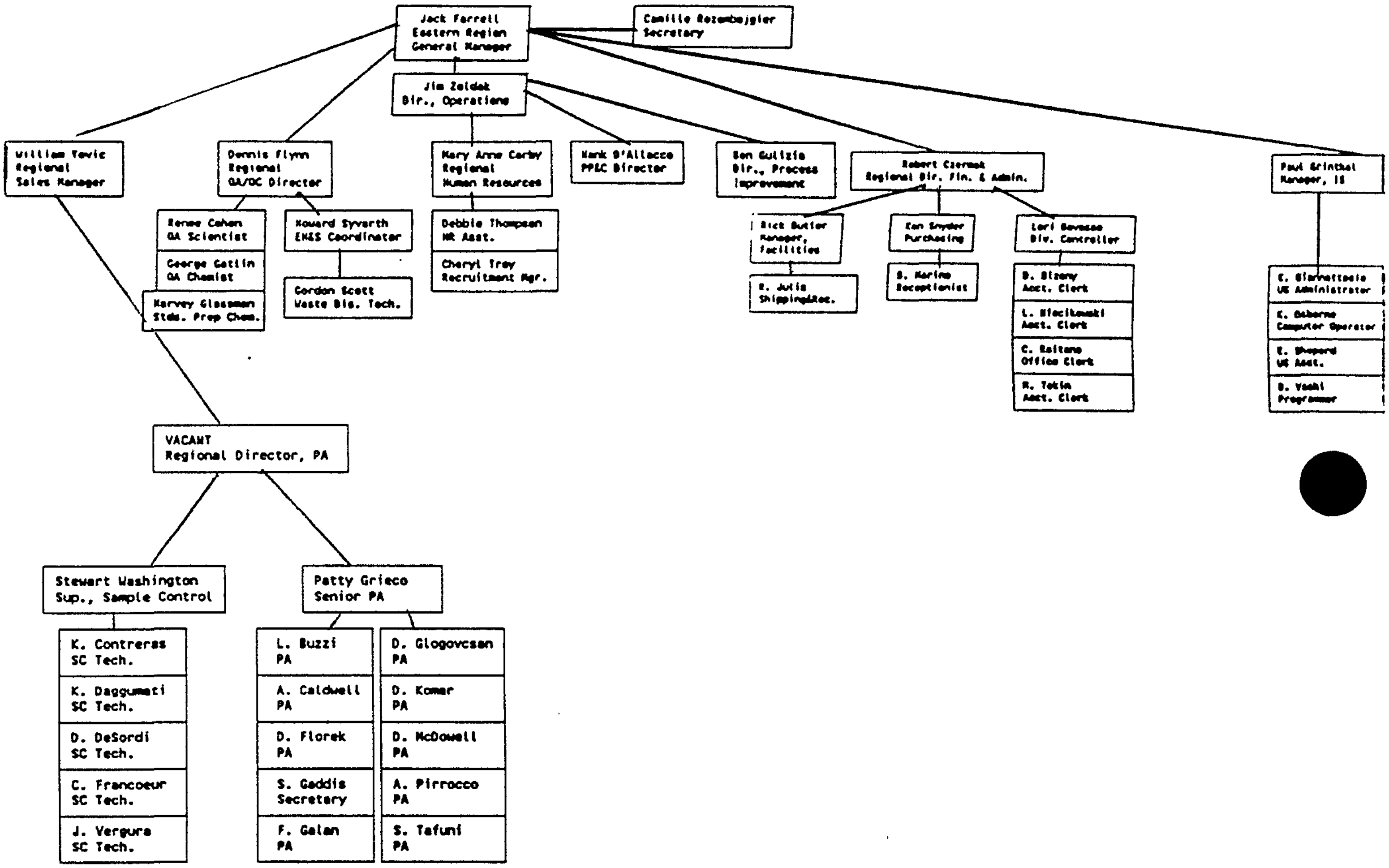


Figure 4-1. Enseco Organizational Chart.

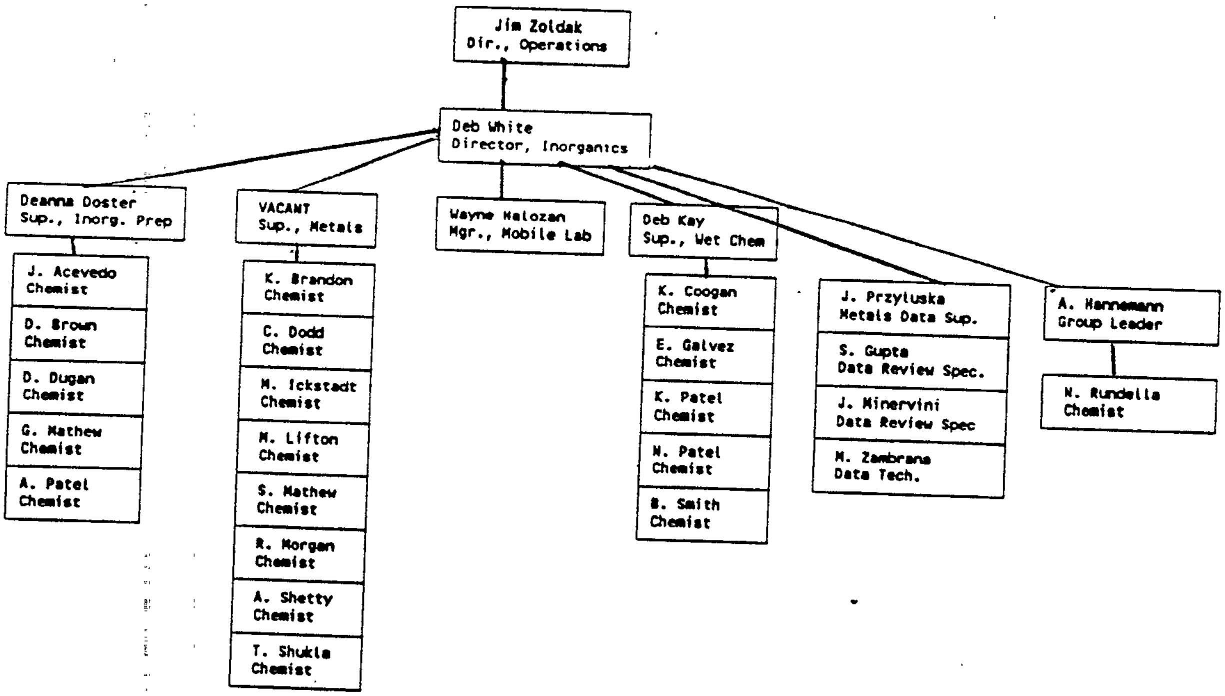
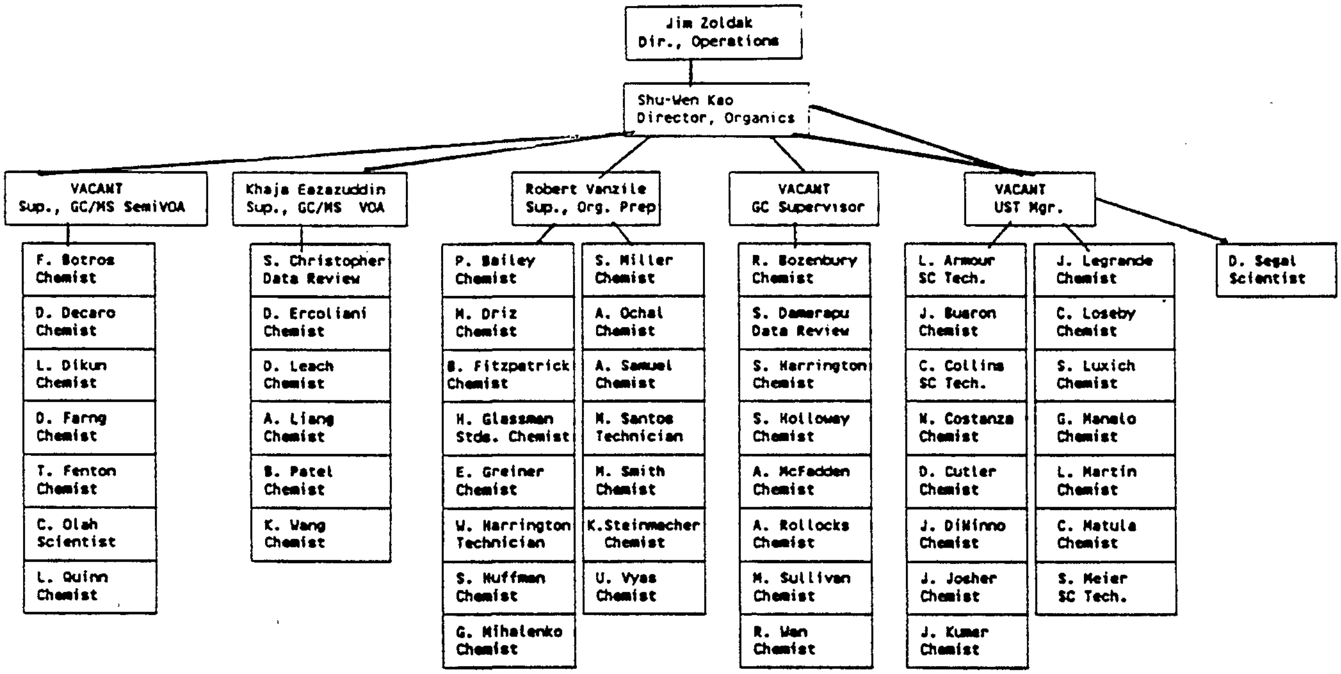


Figure 4-1. Enseco Organizational Chart.



5. QUALITY ASSURANCE OBJECTIVES

5.1 Quality Assurance Objectives

Quality assurance objectives can be expressed in terms of precision, accuracy, representativeness, comparability, and completeness. Table 5-1 lists quantitative data quality objectives (precision, accuracy, and completeness) for the project-specific parameters.

Adherence to the data quality objectives will be quantitatively measured by comparing the results of the Duplicate Control Samples (DCS) to control limits. DCS consist of a standard control matrix which are spiked with a group of target compounds representative of the method analytes. A DCS pair is analyzed for every 20 samples processed by a method.

The DCS pair is used to monitor both the precision and accuracy of the analytical method on an ongoing basis, independent of matrix effects. DCS are monitored for accuracy (average percent recovery) of each analyte in the DCS pair and precision (relative percent difference - RPD) between each analyte in the DCS pair. Section 11 defines Calculation of Data Quality Indicators. Section 9, Internal Quality Control Checks, lists specific laboratory QC samples to be analyzed with this project and their frequency.

Percent completeness is defined as the number of valid data points obtained divided by the number of data points attempted. To be considered complete, the data set must contain all QC check analyses verifying precision and accuracy for all of the analytical protocols. Less obvious is whether that data are sufficient to achieve the goals of the project. All data are reviewed in terms of goals in order to determine if the data base is sufficient. Percent completeness objectives are listed in Table 5-1.

Representativeness can be defined as the degree to which the data accurately represents the media from which it is collected. Representativeness can be measured by comparison of field duplicate results. Comparability expresses the confidence with which two data sets can be compared. Comparability can be measured by the adherence to QC practices and criteria contained in this plan.

5.2 Control Limits

Control limits of the duplicate control sample (DCS) are taken from EPA CLP or reference methodology where available. Control limits for accuracy and precision are subject to periodic updating. The control limits used will be those in effect at the time and may be different from those listed in this document due to the periodic updating of these limits. Control limits listed in Table 5-1 represent the present control limits of the DCS for Enseco East. Each Enseco division calculates its own historical control limits.

5.3 Duplicate Control Samples and Quality Assurance Objectives

Precision and accuracy are assessed by the laboratory by comparing the results of DCS to the control limits. Accuracy is expressed as the average percent recovery of the DCS pair and precision is expressed as the relative percent difference.

For all inorganics tests, if DCS are out of control limits, all samples which are associated with the unacceptable DCS must be reprepped and/or reanalyzed. For multianalyte organic tests, if greater than 20% of the accuracy or precision results are out of control the data is considered suspect and the samples associated with the unacceptable DCS are reprepped and/or reanalyzed. If less than 20% of the accuracy or precision results are out of control, the data is investigated and reported if the data meets the QC requirements of the method.

Occasionally it is apparent that although a DCS is out of control, the samples associated with this DCS are unaffected and within all other QC criteria and the data is acceptable for its intended use. In these cases, the laboratory may report the data with a narrative. All decisions such as this would be fully documented and technically supported in the narrative.

5.4 Matrix Specific QC

For organics analysis, the percent recovery and relative percent difference (RPD) of the matrix spike (MS) pair will be calculated. For inorganic analyses, the MS percent recovery and matrix duplicate RPD will be calculated. This allows for demonstration of the effect of the matrix on the method performed. Reextraction and reanalysis decisions are made based on the DCS, Method Blanks, and QC requirements of the methods.

5.5 Surrogates

Surrogates are organic compounds which are similar to the analytes of interest in chemical behavior, but which are not normally found in environmental samples. Surrogates are added to samples to monitor the effect of the matrix on the accuracy of analysis. Results are reported in terms of percent recovery. Limits to which recoveries are compared are presented in Table 5-2. Surrogate recoveries are not evaluated for reextraction and/or reanalysis decisions when performing non-CLP analyses. When CLP analyses and protocols are followed the contractual requirements of the method are followed.

Table 5-1. Quality Assurance Objectives for Measurement Data

Constituent Matrix: Water	Method	Precision (RPD)	Accuracy (% Recovery)	Completeness (%)
VOLATILE ORGANICS				
BENZENE	8240/CLP	<11	76-127	>95
CHLOROBENZENE	8240/CLP	<13	75-130	>95
1,1-DICHLOROETHENE	8240/CLP	<14	61-145	>95
TRICHLOROETHENE	8240/CLP	<14	71-120	>95
TOLUENE	8240/CLP	<13	76-125	>95
SEMIVOLATILE ORGANICS				
1,2,4-TRICHLOROBENZENE	8270/CLP	<28	39-98	>95
ACENAPHTHENE	8270/CLP	<31	46-118	>95
2,4-DINITROTOLUENE	8270/CLP	<38	24-96	>95
PYRENE	8270/CLP	<31	26-127	>95
N-NITROSO-DI-N-PROPYLAMINE	8270/CLP	<38	41-116	>95
1,4-DICHLOROBENZENE	8270/CLP	<28	36-97	>95
PENTACHLOROPHENOL	8270/CLP	<50	9-103	>95
PHENOL	8270/CLP	<42	12-110	>95
2-CHLOROPHENOL	8270/CLP	<40	27-123	>95
4-CHLORO-3-METHYLPHENOL	8270/CLP	<42	23-97	>95
4-NITROPHENOL	8270/CLP	<50	10-80	>95

Representative analytes are assessed for Precision, Accuracy and Completeness.

Table 5-1. Quality Assurance Objectives for Measurement Data

Constituents Matrix: Water/Soil	Method	Precision (RPD)	Accuracy (% Recovery)	Completeness (%)
INORGANICS - METALS				
ALUMINUM	6010/CLP	<20	80-120	>95
ANTIMONY	6010/CLP	<20	80-120	>95
ARSENIC	7060/CLP	<20	80-120	>95
BARIUM	6010/CLP	<20	80-120	>95
BERYLLIUM	6010/CLP	<20	80-120	>95
CADMIUM	6010/CLP	<20	80-120	>95
CALCIUM	6010/CLP	<20	80-120	>95
CHROMIUM	6010/CLP	<20	80-120	>95
COBALT	6010/CLP	<20	80-120	>95
COPPER	6010/CLP	<20	80-120	>95
IRON	6010/CLP	<20	80-120	>95
LEAD	7421/6010 CLP	<20	80-120	>95
MAGNESIUM	6010/CLP	<20	80-120	>95
MANGANESE	6010/CLP	<20	80-120	>95
MERCURY	7470/7471 CLP	<20	80-120	>95

Representative analytes are assessed for Precision, Accuracy and Completeness.

Table 5-1. Quality Assurance Objectives for Measurement Data

Constituents Matrix: Water/Soil	Method	Precision (RPD)	Accuracy (%Recovery)	Completeness (%)
NICKEL	6010/CLP	<20	80-120	>95
POTASSIUM	6010/CLP	<20	80-120	>95
SELENIUM	7740/CLP	<20	80-120	>95
SODIUM	6010/CLP	<20	80-120	>95
SILVER	6010/CLP	<20	80-120	>95
THALLIUM	7841/CLP	<20	80-120	>95
TIN	6010/CLP	<20	80-120	>95
VANADIUM	6010/CLP	<20	80-120	>95
ZINC	6010/CLP	<20	80-120	>95

Table 5-1. Quality Assurance Objectives for Measurement Data

Constituents Matrix: Water	Method	Precision (RPD)	Accuracy (% Recovery)	Completeness (%)
CHLORINATED PESTICIDES AND POLYCHLORINATED BIPHENYLS (PCB'S)				
LINDANE	8080/CLP	<15	56-123	>95
HEPTACHLOR	8080/CLP	<20	40-131	>95
ALDRIN	8080/CLP	<22	40-120	>95
DIELDRIN	8080/CLP	<18	52-126	>95
ENDRIN	8080/CLP	<21	56-121	>95
4,4' DDT	8080/CLP	<27	38-127	>95

Representative analytes are assessed for Precision, Accuracy and Completeness.

Table 5-1. Quality Assurance Objective for Measurement Data

Constituents Matrix: Water/Soil	Method	Precision (RPD)	Accuracy (%Recovery)	Completeness (%)
ALKALINITY	310.1	7.0	88-112	>95
HARDNESS	200.7/314A	20	80-120	>95
TDS	160.1	8.5	87-109	>95
TSS	160.2	14	78-118	>95
TOC	WALKELY-BLACK	*	*	*
TOC	415.2	29	93-107	>95

Representative analytes are assessed for Precision, Accuracy and Completeness.

* Criteria to be established.

Table 5-1. Quality Assurance Objective for Measurement Data

Constituents Matrix: Solid	Method	Precision (RPD)	Accuracy (% Recovery)	Completeness (%)
VOLATILE ORGANICS				
BENZENE	8240/CLP	<21	66-142	>95
CHLOROBENZENE	8240/CLP	<21	60-133	>95
1,1-DICHLOROETHENE	8240/CLP	<22	59-172	>95
TRICHLOROETHENE	8240/CLP	<24	62-137	>95
TOLUENE	8240/CLP	<21	59-139	>95
SEMIVOLATILE ORGANICS				
1,2,4-TRICHLOROBENZENE	8270/CLP	<23	38-107	>95
ACENAPHTHENE	8270/CLP	<19	31-137	>95
2,4-DINITROTOLUENE	8270/CLP	<47	28-89	>95
PYRENE	8270/CLP	<36	34-142	>95
N-NITROSO-DI-N-PROPYLAMINE	8270/CLP	<38	41-126	>95
1,4-DICHLOROBENZENE	8270/CLP	<27	28-104	>95
PENTACHLOROPHENOL	8270/CLP	<47	17-109	>95
PHENOL	8270/CLP	<35	26-90	>95
2-CHLOROPHENOL	8270/CLP	<50	25-102	>95
4-CHLORO-3-METHYLPHENOL	8270/CLP	<33	26-103	>95
4-NITROPHENOL	8270/CLP	<50	11-114	>95

Representative analytes are assessed for Precision, Accuracy and Completeness.

Table 5-1. Quality Assurance Objectives for Measurement Data

Constituents Matrix: Solid	Method	Precision (RPD)	Accuracy (% Recovery)	Completeness (%)
POLYCHLORINATED BIPHENYLS (PCB'S)				
AR1254	8080	20	20-160	>95

Representative analytes are assessed for Precision, Accuracy and Completeness.

Table 5-1. Quality Assurance Objectives for Measurement Data

Constituents Matrix: Soil/Sediment	Method	Precision (RPD)	Accuracy (% Recovery)	Completeness (%)
CHLORINATED PESTICIDES AND POLYCHLORINATED BIPHENYLS (PCB'S)				
LINDANE	8080/CLP	<50	46-127	>95
HEPTACHLOR	8080/CLP	<31	35-130	>95
ALDRIN	8080/CLP	<43	34-132	>95
DIELDRIN	8080/CLP	<38	31-134	>95
ENDRIN	8080/CLP	<45	42-139	>95
4,4' DDT	8080/CLP	<50	23-134	>95

Representative analytes are assessed for Precision, Accuracy and Completeness.

Table 5-2. Surrogate Recoveries for Organics Analysis

Constituents	Method	Accuracy	Accuracy
Matrix:		Water	Soil
1,2-DICHLOROETHANE-d4	8240	76-114	70-121
TOLUENE-d8	8240	88-110	84-138
BROMOFLUOROBENZENE	8240	86-115	59-113
NITROBENZENE-d5	8270	35-114	23-120
2-FLUOROBIPHENYL	8270	43-116	30-115
TERPHENYL-d14	8270	33-141	18-137
PHENOL-d6	8270	10-110	24-113
2-FLUOROPHENOL	8270	21-100	25-121
2,4,6-TRIBROMOPHENOL	8270	10-123	19-122
2-CHLOROPHENOL-d4 *	8270	33-110	20-130
1,2-DICHLOROBENZENE *	8270	16-110	20-130
TETRACHLORO-M-XYLENE*	8080	60-150	60-150
DECACHLOROBIPHENYL*	8080	60-150	60-150

* Denotes advisory limits, used only in CLP 3/90 analyses.

6. SAMPLE CUSTODY

The laboratory chain of custody (COC) begins when containers are sent from the laboratory. Sample containers are sent in sealed coolers along with COC forms (figure 6-1) and bottle inventory forms (figure 6-2). Upon completion of sampling, samples are appropriately labeled. While on site, sample containers are always under the personal custody of a member of the sampling team or are secured in sealed coolers. The samples are then packed in the cooler and sealed. They are then transported to the laboratory daily via an Enseco courier or a common carrier with a completed COC record.

Samples are received by the Enseco sample custodian or his/her designate, who records and files all shipping documentation. Coolers are inspected for proper seals and labels and the contents are removed and coordinated with packing lists, COC records and the Geraghty and Miller Laboratory Task Order (LTO). An Enseco East Cooler Temp Log is completed for each cooler in the shipment. The LTO, COC and Temp Log information will be faxed to Geraghty and Miller (figure 6-3) within four hours of the time that the cooler(s) is received at Enseco. For coolers received at Enseco East after 5:00 PM, this information will be faxed the following morning.

The samples are then logged into the computerized sampling tracking system. Enseco sample identification numbers are assigned to each sample and their condition is documented on the sample receiving form. Any discrepancies involving sample integrity, sample breakage, cooler temperature, holding times expiring in transit, appropriate container use, preservatives, and missing or incorrect documentation are immediately noted. The PA for the project is notified and the samples are not sent to the specific laboratory for analysis until the PA resolves the problem with the client.

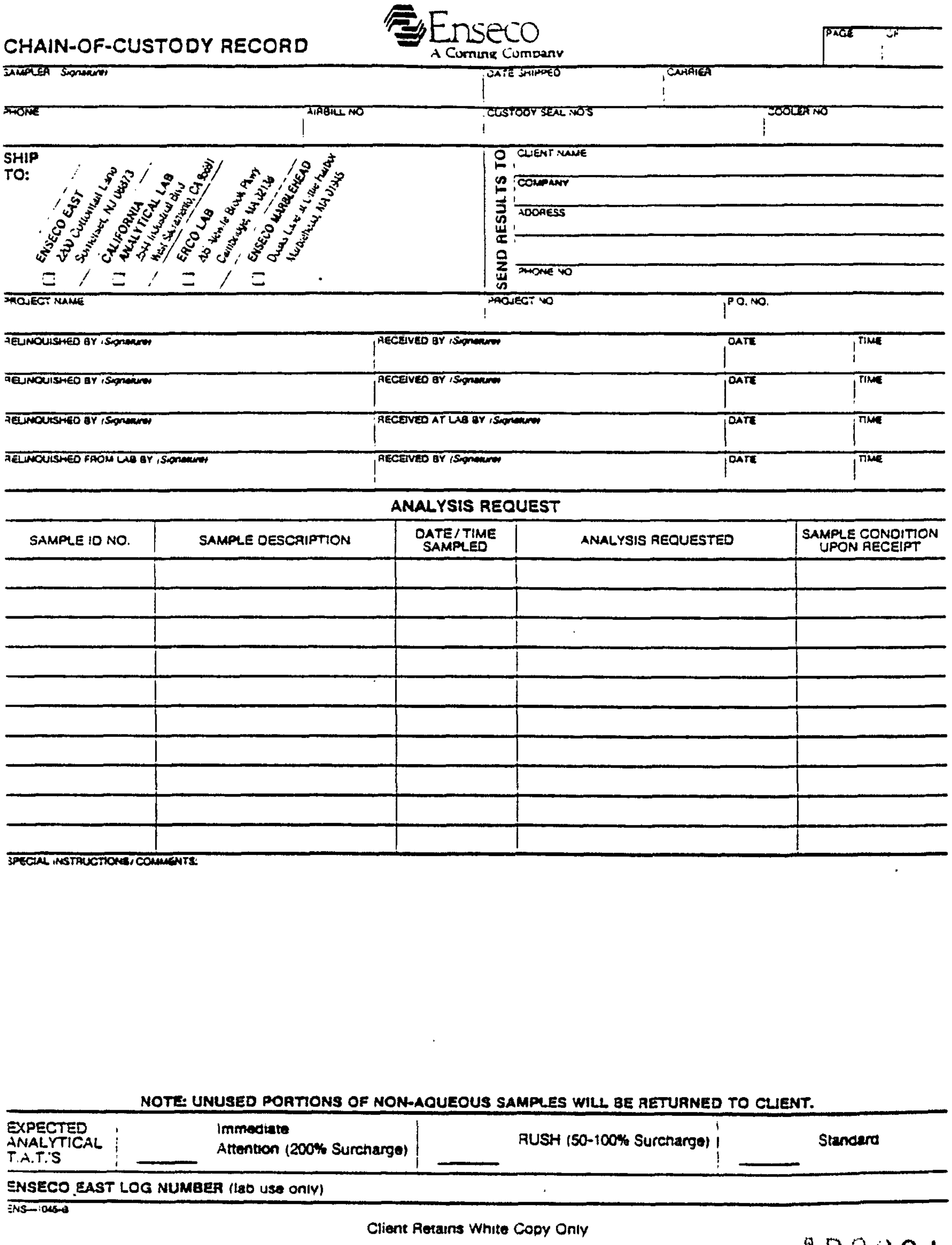
When all of the log-in procedures have been completed, the sample custodian stores the samples in the walk-in refrigerator. An internal chain of custody form is then implemented. The volatiles samples are segregated in refrigerators in the volatiles laboratory under a separate internal chain of custody.

The internal chain of custody forms for both the walk in refrigerator and the separate volatiles refrigerators are shown in figures 6-4 and 6-5. For all samples other than volatiles, analysts log the samples out of sample control and initial and date the logbook. Samples are relinquished by a member of the sample control staff. They are returned and the date and time of sample receipt is noted in the logbook and initialed by a member of the sample control department. In the volatiles laboratory, the samples are delivered to the volatiles department subsequent to login. They are relinquished by a member of the sample control department and received by a member of the volatiles department. Initials of both persons, and the date and time are noted in the logbook. Whenever a sample is taken out and returned to the refrigerator for analysis, the date and time of access and return is noted in the logbook.

A confirmation of samples received, a copy of the chain of custody documentation and the G&M LTO is sent to the client within two working days of cooler receipt date. For all samples, the date of sample disposal is recorded. All internal chain of custody forms are maintained as part of the QC records.

Finally, all samples and extracts will be retained after analysis is complete. Unused portions of samples and extracts will be disposed of 30 days subsequent to report delivery, unless notified otherwise prior to the 30-day disposal period.

Figure 6-1. Chain-of-Custody Form.



CHAIN-OF-CUSTODY RECORD

Enseco
A Corning Company

PAGE OF

SAMPLER (Signature)	DATE SHIPPED	CARRIER

PHONE	AIRBILL NO	CUSTODY SEAL NO'S	COOLER NO

SHIP TO:

☐ ENSECO EAST
2200 Cottontail Lane
Somerset, NJ 08873

☐ CALIFORNIA ANALYTICAL LAB
2544 Industrial Blvd
West Sacramento, CA 95691

☐ ERCO LAB
205 Alewife Brook Pkwy
Cambridge, MA 02138

☐ ENSECO MARBLEHEAD
Doaks Lane at Little Harbor
Marblehead, MA 01945

SEND RESULTS TO

CLIENT NAME
COMPANY
ADDRESS
PHONE NO

PROJECT NAME	PROJECT NO	P.O. NO.

RELINQUISHED BY (Signature)	RECEIVED BY (Signature)	DATE	TIME
RELINQUISHED BY (Signature)	RECEIVED BY (Signature)	DATE	TIME
RELINQUISHED BY (Signature)	RECEIVED AT LAB BY (Signature)	DATE	TIME
RELINQUISHED FROM LAB BY (Signature)	RECEIVED BY (Signature)	DATE	TIME

ANALYSIS REQUEST

SAMPLE ID NO.	SAMPLE DESCRIPTION	DATE/TIME SAMPLED	ANALYSIS REQUESTED	SAMPLE CONDITION UPON RECEIPT

SPECIAL INSTRUCTIONS/COMMENTS:

NOTE: UNUSED PORTIONS OF NON-AQUEOUS SAMPLES WILL BE RETURNED TO CLIENT.

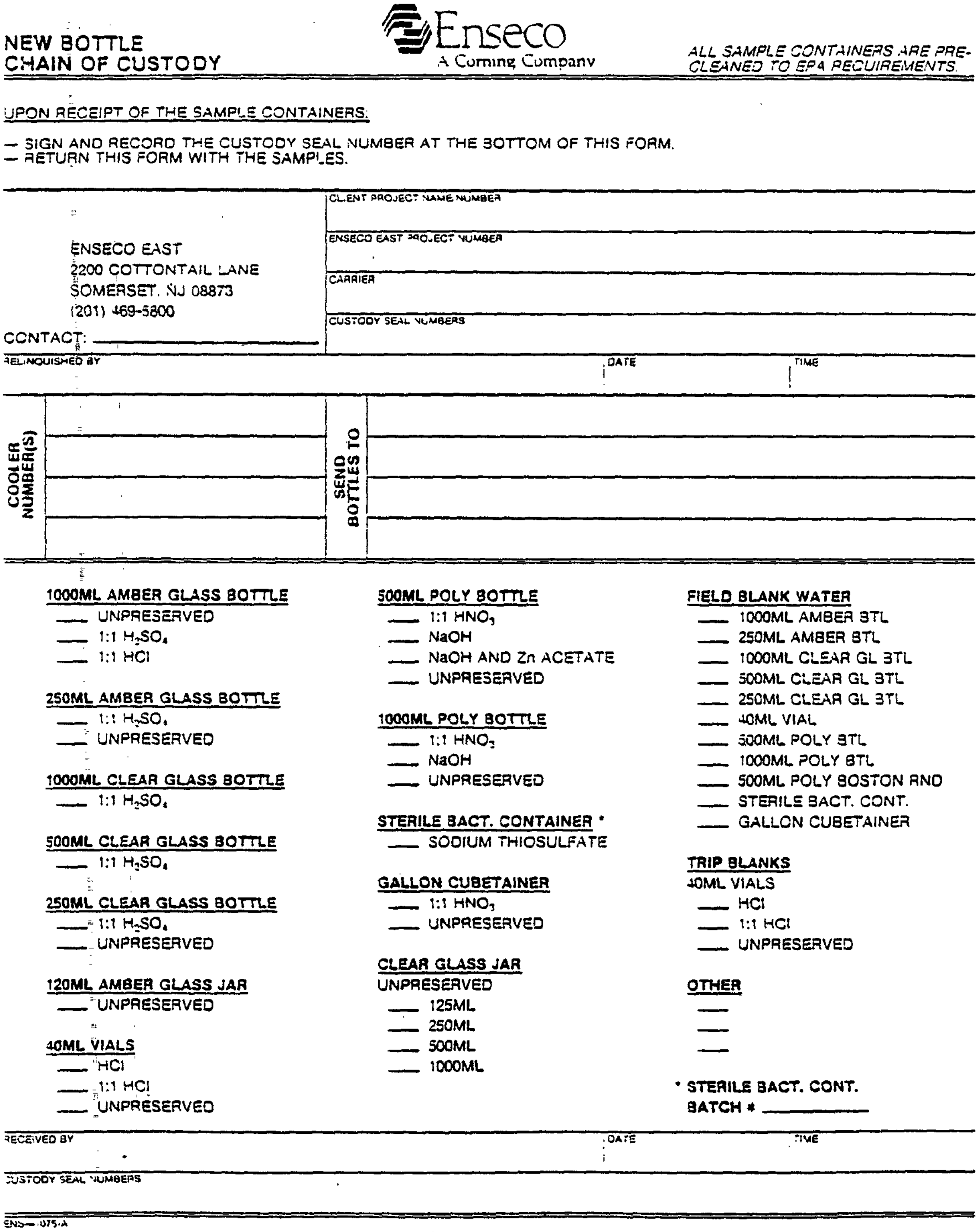
EXPECTED ANALYTICAL T.A.T.'S	____ Immediate Attention (200% Surcharge)	____ RUSH (50-100% Surcharge)	____ Standard

ENSECO EAST LOG NUMBER (lab use only)

ENS—1045-8

Client Retains White Copy Only

Figure 6-2. Bottle Inventory Form.



NEW BOTTLE
CHAIN OF CUSTODY

Enseco
A Corning Company

ALL SAMPLE CONTAINERS ARE PRE-CLEANED TO EPA REQUIREMENTS.

UPON RECEIPT OF THE SAMPLE CONTAINERS:

— SIGN AND RECORD THE CUSTODY SEAL NUMBER AT THE BOTTOM OF THIS FORM.
— RETURN THIS FORM WITH THE SAMPLES.

ENSECO EAST
2200 COTTONTAIL LANE
SOMERSET, NJ 08873
(201) 469-5800

CONTACT: ____________

CLIENT PROJECT NAME/NUMBER
ENSECO EAST PROJECT NUMBER
CARRIER
CUSTODY SEAL NUMBERS

RELINQUISHED BY | DATE | TIME

COOLER NUMBER(S)

SEND BOTTLES TO

1000ML AMBER GLASS BOTTLE
___ UNPRESERVED
___ 1:1 H_2SO_4
___ 1:1 HCl

250ML AMBER GLASS BOTTLE
___ 1:1 H_2SO_4
___ UNPRESERVED

1000ML CLEAR GLASS BOTTLE
___ 1:1 H_2SO_4

500ML CLEAR GLASS BOTTLE
___ 1:1 H_2SO_4

250ML CLEAR GLASS BOTTLE
___ 1:1 H_2SO_4
___ UNPRESERVED

120ML AMBER GLASS JAR
___ UNPRESERVED

40ML VIALS
___ HCl
___ 1:1 HCl
___ UNPRESERVED

500ML POLY BOTTLE
___ 1:1 HNO_3
___ NaOH
___ NaOH AND Zn ACETATE
___ UNPRESERVED

1000ML POLY BOTTLE
___ 1:1 HNO_3
___ NaOH
___ UNPRESERVED

STERILE BACT. CONTAINER *
___ SODIUM THIOSULFATE

GALLON CUBETAINER
___ 1:1 HNO_3
___ UNPRESERVED

CLEAR GLASS JAR
UNPRESERVED
___ 125ML
___ 250ML
___ 500ML
___ 1000ML

FIELD BLANK WATER
___ 1000ML AMBER BTL
___ 250ML AMBER BTL
___ 1000ML CLEAR GL BTL
___ 500ML CLEAR GL BTL
___ 250ML CLEAR GL BTL
___ 40ML VIAL
___ 500ML POLY BTL
___ 1000ML POLY BTL
___ 500ML POLY BOSTON RND
___ STERILE BACT. CONT.
___ GALLON CUBETAINER

TRIP BLANKS
40ML VIALS
___ HCl
___ 1:1 HCl
___ UNPRESERVED

OTHER
___
___
___

*** STERILE BACT. CONT.**
BATCH # ____________

RECEIVED BY | DATE | TIME

CUSTODY SEAL NUMBERS

ENS—075-A

Clients retains white copy only.

Figure 6-3. Cooler Temp Log Form.

Enseco-East
Cooler Temp Log

Date/Time Project Received: ______________ ______________

Delivered by: ___ Fed-X ___ Express ___ AYS ___ UPS ___ On-Time
___ Airborne ___ DHL ___ Metro ___ Client

		Custody Seals	# Blue Ice Blocks	Time Cooler opened	Time Cooler Temped
Cooler # ______	Temp ______	______	______	______	______
Cooler # ______	Temp ______	______	______	______	______
Cooler # ______	Temp ______	______	______	______	______
Cooler # ______	Temp ______	______	______	______	______
Cooler # ______	Temp ______	______	______	______	______
Cooler # ______	Temp ______	______	______	______	______
Cooler # ______	Temp ______	______	______	______	______
Cooler # ______	Temp ______	______	______	______	______

Condition of Blue Ice: ______________________________

Comments: ______________________________

Figure 6-4. Internal Chain of Custody Form, Logbook

Enseco East

INTERNAL CHAIN OF CUSTODY

PROJECT # ____________ SAMPLE # ____________

STORAGE LOCATION ____________

Gas Soil Solid Solid-Waste Aqueous Aqueous-waste Sludge Oil

TESTS REQUESTED: (Bottle numbers assigned:)

ORGANICS
ORGANICS PREP

VO*** ______
OAI ______
ABN ______
HERBICIDES ______
PEST/PCB ______
TPHC-IR ______
FINGERPR. ______
OIL/GREASE ______

COMPOSITING ______
RADIOLOGICAL ______
% WATER ______
OTHER ______

INORGANICS
METALS PREP

METALS ______
CORROS ______
IGNIT/FLASH ______
REACT CN/S ______
EPTOX METS ______
EPTOX ORG ______
TCLPV ______
TCLPC ______
TCLPM ______
~~TCLPO ______~~

INORGANICS
WET CHEM

ALKALINITY ______
ACIDITY ______
*BOD ______
CHLORIDE ______
*RES.CHLORINE ______
COD ______
*COLOR/ODOR ______
CONDUCTIVITY ______
*Cr^{+6} ______
TOT.CYANIDE ______
*DISS.O_2 ______
*FECAL COLIFORM ______
FLUORIDE ______
*MBAS ______
*ORTHO PHOS ______
TOTAL PHOS ______

INORGANICS
WET CHEM

AMMONIA(NH_3) ______
*NITRATE(NO_3) ______
*NITRITE(NO_2) ______
NO_3-NO_2 ______
TON** ______
TKN ______
*pH ______
PHENOL ______
SULFATE(SO_4) ______
*SULFITE(SO_3) ______
SULFIDE(SO_2) ______
*SET.SOLIDS ______
TS ______
TSS ______
TDS ______
TOC ______
TOX ______
*TOTAL COLIFORM ______
*TURBIDITY ______

~~ARE LAB CHRONICLES NEEDED?~~ ______

*** Sample aliquots for volatile organic analysis are stored in the GC/MS refrigera
**TON (Total organic nitrogen): Ammonia and Total Kjheldhal Nitrogen (TKN) is analyzed. The difference of the 2 parameters is TON.
* Indicates 'Short Holding Time' parameter

RELINQUISHED BY:	RECEIVED BY:	DATE	TIME	REASON FOR TRANSFER	BOTTLE CODE

Figure 6-5. Internal Chain of Custody Form, Volatiles

ENSECO EAST
GC & GCMS VOLATILES
SAMPLE CUSTODY LOG

ANALYSES REPORTED

GCMS VOA
GC VOA
GC DAI

Storage Location	Project No.	Sample Nos.	Matrix	Preserved	Unpreserved	Unknown

Initially Relinquished By: ____________ *Date:* ________ *Received By:* ____________ *Date:* ______
Leachates Initially Relinquished By: __________ *Date:* ______ *Received By:* ____________ *Date:* ______

Sample Nos. Out	Date/Time Initials	Sample Nos. In	Date/Time Initials

Disposal Date/Initials: ______________ **PROJECT NO.:** ______________

7. ANALYTICAL PROCEDURES AND CALIBRATION

7.1 Analytical Procedures

In accordance with the objectives of this QAPjP, aqueous samples will be analyzed for one or more of the following parameters: volatile and semivolatile organic compounds, pesticide/PCB's, metals, hardness, alkalinity, TDS and TSS. The soil and sediment samples will be analyzed for one or more of the following parameters: volatile and semivolatile organic compounds, metals, total organic carbon, grainsize and pesticides/PCB's. Methodology and holding times are quoted in Table 7-1 and 7-2. Quality control samples to be analyzed with each type of analysis are outlined in Section 9.

The following tables list the compounds by methodology with associated reporting limits. Reporting limits presented are minimum reporting limits; factors such as high level target compounds and matrix interferences will generally raise reporting limits.

All analytical laboratory work with the exception of the grainsize analysis will be performed at an Enseco laboratory. The total organic carbon (TOC) analysis is to be performed at Enseco-California Analytical Laboratory located in West Sacramento, California. The grainsize analysis will be performed by Mellick Tully of South Bound Brook, New Jersey. If it becomes necessary to have another laboratory provide additional assistance, the project manager at Geraghty and Miller, Inc. will be contacted prior to subcontracting for their approval and authorization.

7.2 Calibration Procedures and Frequency

Enseco will employ the analytical methods found in "Test Methods for Evaluating Solid Waste (SW-846), 3rd edition (1986), Update I (1989), Office of Solid Waste and Emergency Response, US EPA, the current Contract Laboratory Program Statements of Work (SOW 3/90 organics and inorganics) and other methods referenced in Section 14 of this QAPjP. Methods contained in SW-846 and the current SOW's cite specific initial calibration and continuing calibration check procedures that are required to conduct the analyses. Examples of these specific procedures follow in this section.

7.2.1 Gas Chromatography/Mass Spectrometry -- Volatiles

The instrument is hardware-tuned using 50 ng of 4-bromofluorobenzene (BFB). Ion abundance criteria must meet those listed in SW-846. Initial calibration is required at 20 ug/L, 50 ug/L, 100 ug/L, 150 ug/L, and 200 ug/L. Average response factors (RF) and relative standard deviations (RSD) are calculated for each compound. Calibration check compounds (CCC) and system performance check compounds (SPCC) are used to monitor initial and continuing calibration performance. For the initial calibration to be considered valid, the RSD must be less than or equal to 30.0% for CCCs. The RF for SPCCs must be 0.300 or greater (0.250 or greater for bromoform). Analysis of samples can proceed for 12 hours following the time of the BFB injection once these criteria are met, based on time of injection.

Continuing calibration is achieved by meeting instrument calibration criteria for 50 ng BFB, and injection of a calibration standard containing all of the compounds. For a continuing calibration to be valid, SPCCs must meet the same criteria as that for the curve. The RFs for the CCCs must be less than or equal to 25.0% difference from the average RF of the curve. sample analysis can proceed for 12 hours from the time of the BFB injection once these criteria are met, based on time of injection.

7.2.2 Gas Chromatography/Mass Spectrometry -- Semivolatiles

Semivolatile calibration procedures follow the same analytical calibration scheme as that of volatiles with the following differences. Decafluorotriphenylphosphine (DFTPP) is used to meet ion abundance criteria. The initial calibration is required at 20 ng/ul, 50 ng/ul, 80 ng/ul, 120 ng/ul, and 160 ng/ul. Nine compounds are not required in the 20 ng/ul standard, as specified in the method. There are 13 CCCs and 4 SPCCs listed in the method.

The minimum acceptable RF for SPCCs is 0.050. The maximum percent RSD for the CCCs in the initial calibration is 30.0%. The percent difference required for continuing calibrations is 30.0%, compared to the average RF of the initial calibration.

For all GC/MS analyses, if the continuing calibration standard criteria cannot be met, the system must be recalibrated using a five point curve.

7.2.3 GC Analyses

GC analyses calibration criteria vary widely depending upon the method quoted. This generally consists of the following. A five point calibration curve is analyzed and calibration factors are calculated by either the internal or external standard approach. Percent RSD must then be calculated. Most methods require a percent RSD less than 20%. The calibration is checked on an ongoing basis (generally every 10 samples). If the percent difference exceeds that which is required in the method, (most methods require 15%) the system is recalibrated and all samples analyzed since the last acceptable calibration check are reanalyzed.

7.2.4 Metals

For Metals analyses, two types of analytical methodology are employed; inductively coupled argon plasma emission spectroscopy (ICP), and atomic absorption spectroscopy (AA).

Each ICP is calibrated prior to use using criteria described in the SW-846 protocol. The calibration is verified using standards from an independent source. Interelement correction factors are determined every six months. The linear range of the instrument is established once every quarter using a linear range verification check standard. No values are reported above this upper concentration value without dilution.

A calibration curve is established daily by analyzing a minimum of two standards, including an initial calibration blank (ICB) and an initial calibration verification (ICV). The ICV must agree within +/-10% of its true value for the analysis to proceed. The calibration is monitored throughout the run by analyzing a continuing calibration blank (CCB) and a continuing calibration verification standard (CCV) every ten samples. The CCV must agree within +/-10% of its true value for the data to be deemed acceptable.

If this criterion is not met, all samples which are not bracketed by acceptable CCV's must be reanalyzed.

An interelement check standard is analyzed at the beginning and end of each analytical run, to verify that interelement and background correction factors have remained constant. Results outside of established criteria trigger reanalysis of samples.

Each AA unit is calibrated prior to any analyses being conducted. A calibration curve is prepared with a minimum of a calibration blank and three standards and then verified with a standard that has been prepared from an independent source at a concentration near the middle of the calibration range (Initial Calibration Verification - ICV). The ICV must agree within +/- 10% of the true value. The calibration is then verified every ten sample by the use of a CCV which must agree within +/-10% of the true value. Results outside of this trigger reanalysis of all samples analyzed since the last acceptable calibration check. All samples for graphite furnace atomic absorption methods are spiked after digestion (analytical spike) to verify the absence of matrix effects or interferences. The method of standard additions is used to quantitate the sample when interferences are indicated by the analytical spike results.

7.2.5 Conventional Analyses

While calibration and standardization procedures vary in wet chemistry methods dependent upon the type of system and analytical methodology required for a specific analysis, the principles of calibration apply universally. For most of the analyses each system is calibrated prior to analyses being conducted. A description of one of the more common calibration approaches is as follows. A five point curve is generated. A correlation coefficient is determined and must be greater than 0.995. The calibration is checked every ten samples and must agree within +/- 10%, or the ten samples analyzed prior to the unacceptable calibration check are reanalyzed.

Table 7-1. **Recommended Containers, Preservatives and Holding Times - Aqueous Samples**

Sample Container	Preservation	Parameters/Methods	Recommended Maximum Holding Times[a,b]
3 x 40 ml glass (VOA)	4degC, HCl to pH < 2	Volatile Organics/ Method 8240	14 days
3 x 40 ml glass (VOA)	4degC, HCl to pH < 2	Volatile Organics/ CLP 3/90	14 days
3 x 40 ml glass (VOA)	4degC, HCl to pH < 2	Volatile Organics/ 524.2 modified	14 days
2 x 1 liter amber glass	4degC	Semivolatile Organics/ Method 8270	7 days until extraction; 40 days after extraction
2 x 1 liter amber glass	4degC	Semivolatile Organics/ CLP 3/90	7 days until extraction; 40 days after extraction
2 x 1 liter amber glass	4degC	Pesticide/PCB CLP 3/90	7 days until extraction; 40 days after extraction
1 x 1000 ml polyethylene	HNO3 to pH < 2	Metals/ICP + GFAA Methods 6010,7060 7421,7740,7841	6 months
		Mercury/Method 7470	28 days

---

[a] Holding time is calculated from the date of sample collection.
[b] Additional volume must be collected for MS/MSD/MD

Table 7-1. **Recommended Containers, Preservatives and Holding Times - Aqueous Samples (cont'd)**

Sample Container	Preservation	Parameters/Methods Times[ab]	Recommended Maximum Holding
1 x 250 ml polyethylene	HNO3 to pH < 2	TOC	28 Days
1 x 500 ml polyethylene	4degC	TDS/TSS	7 Days
1 x 500 ml polyethylene	4degC	Alkalinity	14 Days

---

[a] Holding time is calculated from the date of sample collection.
[b] Additional volume must be collected for MS/MSD/MD

Table 7-2. **Recommended Containers, Preservatives, and Holding Times - Soil, Sediment, Solid Samples**

Sample Container	Preservation	Parameters/Methods	Recommended Maximum Holding Times[a]
		Solid Samples	
2 x 125 ml glass (VOA)	4degC	Volatile Organics/ Method 8240	14 days
2 x 125 ml glass (VOA)	4degC	Volatile Organics/ 3/90 CLP	14 days
1 x 16 oz jar, glass	4degC	Semivolatile Organics/ Method 8270	14 days until extraction; 40 days after extraction
1 x 16 oz jar, glass	4degC	Semivolatile Organics/ CLP 3/90	14 days until extraction; 40 days after extraction
		Pesticide/PCB CLP 3/90	14 days until extraction; 40 days after extraction
1 x 250 ml jar, glass		Metals/ ICP + GFAA Methods 6010,7060 7740,7841	6 months
		Mercury/Method 7471	28 days
1 x 250 ml jar, glass	4degC	TOC	7 days
2 x 500 ml jar, glass	4degC	Grainsize	7 days

---

[a] Holding time is calculated from the date of sample collection.

Analytical Method: 3/90 CLP Organic SOW - Volatile Organic Analysis

		Quantitation Limits*			
Volatiles	CAS Number	Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
1. Chloromethane	74-87-3	10	10	1200	(50)
2. Bromomethane	74-83-9	10	10	1200	(50)
3. Vinyl Chloride	75-01-4	10	10	1200	(50)
4. Chloroethane	75-00-3	10	10	1200	(50)
5. Methylene Chloride	75-09-2	10	10	1200	(50)
6. Acetone	67-64-1	10	10	1200	(50)
7. Carbon Disulfide	75-15-0	10	10	1200	(50)
8. 1,1-Dichloroethene	75-35-4	10	10	1200	(50)
9. 1,1-Dichloroethane	75-34-3	10	10	1200	(50)
10. 1,2-Dichloroethene (total)	540-59-0	10	10	1200	(50)
11. Chloroform	67-66-3	10	10	1200	(50)
12. 1,2-Dichloroethane	107-06-2	10	10	1200	(50)
13. 2-Butanone	78-93-3	10	10	1200	(50)
14. 1,1,1-Trichloroethane	71-55-6	10	10	1200	(50)
15. Carbon Tetrachloride	56-23-5	10	10	1200	(50)
16. Bromodichloromethane	75-27-4	10	10	1200	(50)
17. 1,2-Dichloropropane	78-87-5	10	10	1200	(50)
18. cis-1,3-Dichloropropene	10061-01-5	10	10	1200	(50)
19. Trichloroethene	79-01-6	10	10	1200	(50)
20. Dibromochloromethane	124-48-1	10	10	1200	(50)
21. 1,1,2-Trichloroethane	79-00-5	10	10	1200	(50)
22. Benzene	71-43-2	10	10	1200	(50)
23. trans-1,3-Dichloropropene	10061-02-6	10	10	1200	(50)
24. Bromoform	75-25-2	10	10	1200	(50)
25. 4-Methyl-2-pentanone	108-10-1	10	10	1200	(50)
26. 2-Hexanone	591-78-6	10	10	1200	(50)
27. Tetrachloroethene	127-18-4	10	10	1200	(50)
28. Toluene	108-88-3	10	10	1200	(50)
29. 1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200	(50)
30. Chlorobenzene	108-90-7	10	10	1200	(50)
31. Ethyl Benzene	100-41-4	10	10	1200	(50)
32. Styrene	100-42-5	10	10	1200	(50)
33. Xylenes (Total)	1330-20-7	10	10	1200	(50)

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher

Analytical Method: 3/90 CLP Organic SOW - Semivolatile Organic Analysis

Semivolatiles	CAS Number	Quantitation Limits* Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
34. Phenol	108-95-2	10	330	10000	(20)
35. bis(2-Chloroethyl) ether	111-44-4	10	330	10000	(20)
36. 2-Chlorophenol	95-57-8	10	330	10000	(20)
37. 1,3-Dichlorobenzene	541-73-1	10	330	10000	(20)
38. 1,4-Dichlorobenzene	106-46-7	10	330	10000	(20)
39. 1,2-Dichlorobenzene	95-50-1	10	330	10000	(20)
40. 2-Methylphenol	95-48-7	10	330	10000	(20)
41. 2,2'-oxybis (1-Chloropropane)*	108-60-1	10	330	10000	(20)
42. 4-Methylphenol	106-44-5	10	330	10000	(20)
43. N-Nitroso-di-n-propylamine	621-64-7	10	330	10000	(20)
44. Hexachloroethane	67-72-1	10	330	10000	(20)
45. Nitrobenzene	98-95-3	10	330	10000	(20)
46. Isophorone	78-59-1	10	330	10000	(20)
47. 2-Nitrophenol	88-75-5	10	330	10000	(20)
48. 2,4-Dimethylphenol	105-67-9	10	330	10000	(20)
49. bis(2-Chloroethoxy) methane	111-91-1	10	330	10000	(20)
50 2,4-Dichlorophenol	120-83-2	10	330	10000	(20)
51. 1,2,4-Trichlorobenzene	120-82-1	10	330	10000	(20)
52. Naphthalene	91-20-3	10	330	10000	(20)
53. 4-Chloroaniline	106-47-8	10	330	10000	(20)
54. Hexachlorobutadiene	87-68-3	10	330	10000	(20)
55. 4-Chloro-3-methylphenol	59-50-7	10	330	10000	(20)
56. 2-Methylnaphthalene	91-57-6	10	330	10000	(20)
57. Hexachlorocyclopentadiene	77-47-4	10	330	10000	(20)
58. 2,4,6-Trichlorophenol	88-06-2	10	330	10000	(20)
59. 2,4,5-Trichlorophenol	95-95-4	25	800	25000	(50)
60. 2-Chloronaphthalene	91-58-7	10	330	10000	(20)
61. 2-Nitroaniline	88-74-4	25	800	25000	(50)
62. Dimethylphthalate	131-11-3	10	330	10000	(20)
63. Acenaphthylene	208-96-8	10	330	10000	(20)
64. 2,6-Dinitrotoluene	606-20-2	10	330	10000	(20)
65. 3-Nitroaniline	99-09-2	25	800	25000	(50)
66. Acenaphthene	83-32-9	10	330	10000	(20)
67. 2,4-Dinitrophenol	51-28-5	25	800	25000	(50)
68. 4-Nitrophenol	100-02-7	25	800	25000	(50)

* Previously known by the name bis(2-Chloroisopropyl)

Analytical Method: 3/90 CLP Organic SOW -
Semivolatile Organic Analysis (con't)

		Quantitation Limits*			
Semivolatiles	CAS Number	Water ug/L	Low Soil ug/Kg	Med. Soil ug/Kg	On Column (ng)
69. Dibenzofuran	132-64-9	10	330	10000	(20)
70. 2,4-Dinitrotoluene	121-14-2	10	330	10000	(20)
71. Diethylphthalate	84-66-2	10	330	10000	(20)
72. 4-Chlorophenyl-phenyl ether	7005-72-3	10	330	10000	(20)
73. Fluorene	86-73-7	10	330	10000	(20)
74. 4-Nitroaniline	100-01-6	25	800	25000	(50)
75. 4,6-Dinitro-2-methylphenol	534-52-1	25	800	25000	(50)
76. N-nitrosodiphenylamine	86-30-6	10	330	10000	(20)
77. 4-Bromophenyl-phenylether	101-55-3	10	330	10000	(20)
78. Hexachlorobenzene	118-74-1	10	330	10000	(20)
79. Pentachlorophenol	87-86-5	25	800	25000	(50)
80. Phenanthrene	85-01-8	10	330	10000	(20)
81. Anthracene	120-12-7	10	330	10000	(20)
82. Carbazole	86-74-8	10	330	10000	(20)
83. Di-n-butylphthalate	84-74-2	10	330	10000	(20)
84. Fluoranthene	206-44-0	10	330	10000	(20)
85. Pyrene	129-00-0	10	330	10000	(20)
86. Butylbenzylphthalate	85-68-7	10	330	10000	(20)
87. 3,3'-Dichlorobenzidine	91-94-1	10	330	10000	(20)
88. Benzo(a)anthracene	56-55-3	10	330	10000	(20)
89. Chrysene	218-01-9	10	330	10000	(20)
90. bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000	(20)
91. Di-n-octylphthalate	117-84-0	10	330	10000	(20)
92. Benzo(b)fluoranthene	205-99-2	10	330	10000	(20)
93. Benzo(k)fluoranthene	207-08-9	10	330	10000	(20)
94. Benzo(a)pyrene	50-32-8	10	330	10000	(20)
95. Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000	(20)
96. Dibenz(a,h)anthracene	53-70-3	10	330	10000	(20)
97. Benzo(g,h,i)perylene	191-24-2	10	330	10000	(20)

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

Analytical Method: 3/90 CLP Organic SOW - Pesticide/PCB Analysis

Pesticides/Aroclors	CAS Number	Quantitation Limits* Water ug/L	Soil ug/Kg	On Column (pg)
98. alpha-BHC -	319-84-6	0.05	1.7	5
99. beta-BHC	319-85-7	0.05	1.7	5
100. delta-BHC	319-86-8	0.05	1.7	5
101. gamma-BHC (Lindane)	58-89-9	0.05	1.7	5
102. Heptachlor	76-44-8	0.05	1.7	5
103. Aldrin	309-00-2	0.05	1.7	5
104. Heptachlor epoxide	1024-57-3	0.05	1.7	5
105. Endosulfan I	959-98-8	0.05	1.7	5
106. Dieldrin	60-57-1	0.10	3.3	10
107. 4,4'-DDE	72-55-9	0.10	3.3	10
108. Endrin	72-20-8	0.10	3.3	10
109. Endosulfan II	33213-65-9	0.10	3.3	10
110. 4,4'-DDD	72-54-8	0.10	3.3	10
111. Endosulfan sulfate	1031-07-8	0.10	3.3	10
112. 4,4'-DDT	50-29-3	0.10	3.3	10
113. Methoxychlor	72-43-5	0.50	17.0	50
114. Endrin ketone	53494-70-5	0.10	3.3	10
115. Endrin aldehyde	7421-36-3	0.10	3.3	10
116. alpha-Chlordane	5103-71-9	0.05	1.7	5
117. gamma-Chlordane	5103-74-2	0.05	1.7	5
118. Toxaphene	8001-35-2	5.0	170.0	500
119. Aroclor-1016	12674-11-2	1.0	33.0	100
120. Aroclor-1221	11104-28-2	2.0	67.0	200
121. Aroclor-1232	11141-16-5	1.0	33.0	100
122. Aroclor-1242	53469-21-9	1.0	33.0	100
123. Aroclor-1248	12672-29-6	1.0	33.0	100
124. Aroclor-1254	11097-69-1	1.0	33.0	100
125. Aroclor-1260	11096-82-5	1.0	33.0	100

* Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

There is no differentiation between the preparation of low and medium soil samples in this method for the analysis of Pesticides/Aroclors.

Analytical Method: 3/90 CLP Inorganic SOW - Metal Analysis

INORGANIC TARGET ANALYTE LIST (TAL)

Analyte	Contract Required Detection Limit (1,2) (ug/L)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

Analytical Method: Method 524.2 Revision 3.0 - Modified (524-TCL-GM-A)

Component	Reporting Limit
Chloromethane	0.5
Bromomethane	0.5
Vinyl chloride	0.5
Chloroethane	0.5
Methylene chloride	0.5
Acetone	2.0
Carbon disulfide	2.0
1,1-Dichloroethene	0.5
1,1-Dichloroethane	0.5
1,2-Dichloroethene^(cis/trans	0.5
Chloroform	0.5
1,2-Dichloroethane	0.5
2-Butanone	2.0
1,1,1-Trichloroethane	0.5
Carbon tetrachloride	0.5
Bromodichloromethane	0.5
1,2-Dichloropropane	0.5
trans-1,3-Dichloropropene	0.5
Trichloroethene	0.5
Dibromochloromethane	0.5
1,1,2-Trichloroethane	0.5
Benzene	0.5
cis-1,3-Dichloropropene	0.5
Bromoform	0.5
4-Methyl-2-pentanone	2.0
2-Hexanone	2.0
1,1,2,2-Tetrachloroethane	0.5
Tetrachloroethene	0.5
Toluene	0.5
Chlorobenzene	0.5
Ethylbenzene	0.5
Styrene	0.5
Xylenes (total)	0.5

Analytical Method: Volatile Organic Analysis (8240CP-TCL-AP)

Component	Reporting Limit
Chloromethane	10
Bromomethane	10
Vinyl chloride	10
Chloroethane	10
Methylene chloride	5.0
Acetone	10
Carbon disulfide	5.0
1,1-Dichloroethene	5.0
1,1-Dichloroethane	5.0
1,2-Dichloroethene^(cis/trans	5.0
Chloroform	5.0
1,2-Dichloroethane	5.0
2-Butanone	10
1,1,1-Trichloroethane	5.0
Carbon tetrachloride	5.0
Vinyl acetate	10
Bromodichloromethane	5.0
1,2-Dichloropropane	5.0
cis-1,3-Dichloropropene	5.0
Trichloroethene	5.0
Dibromochloromethane	5.0
1,1,2-Trichloroethane	5.0
Benzene	5.0
trans-1,3-Dichloropropene	5.0
Bromoform	5.0
4-Methyl-2-pentanone	10
2-Hexanone	10
1,1,2,2-Tetrachloroethane	5.0
Tetrachloroethene	5.0
Toluene	5.0
Chlorobenzene	5.0
Ethylbenzene	5.0
Styrene	5.0
Xylenes (total)	5.0

Analytical Method: Volatile Organic Analysis (8240CPL-TCL-S)

Component	Reporting Limit
Chloromethane	10
Bromomethane	10
Vinyl chloride	10
Chloroethane	10
Methylene chloride	5.0
Acetone	10
Carbon disulfide	5.0
1,1-Dichloroethene	5.0
1,1-Dichloroethane	5.0
1,2-Dichloroethene^(cis/trans	5.0
Chloroform	5.0
1,2-Dichloroethane	5.0
2-Butanone	10
1,1,1-Trichloroethane	5.0
Carbon tetrachloride	5.0
Vinyl acetate	10
Bromodichloromethane	5.0
1,2-Dichloropropane	5.0
cis-1,3-Dichloropropene	5.0
Trichloroethene	5.0
Dibromochloromethane	5.0
1,1,2-Trichloroethane	5.0
Benzene	5.0
trans-1,3-Dichloropropene	5.0
Bromoform	5.0
4-Methyl-2-pentanone	10
2-Hexanone	10
1,1,2,2-Tetrachloroethane	5.0
Tetrachloroethene	5.0
Toluene	5.0
Chlorobenzene	5.0
Ethylbenzene	5.0
Styrene	5.0
Xylenes (total)	5.0

Analytical Method: Alkalinity (ALK-TOT-AT)

Component	Reporting Limit
Alkalinity	5.0 mg/L

Analytical Method: Hardness (HARDNESS-AT)

Component	Reporting Limit
Hardness	0.3 mg/L

Analytical Method: Total Dissolved Solids (TDS-BAL-A)

Component	Reporting Limit
Total Dissolved Solids	10 mg/L

Analytical Method: Total Suspended Solids (TSS-BAL-A)

Component	Reporting Limit
Total Suspended Solids	1.0 mg/L

The Level 2 review is performed by a data review specialist, supervisor, or peer whose function is to provide an independent review of the data package. This review is also conducted according to an established set of guidelines and is structured to ensure that:

* calibration data are scientifically sound, appropriate to the method, and completely documented;
* QC samples are within established guidelines;
* qualitative identification of sample components is correct;
* quantitative results are correct;
* documentation is complete and correct (e.g., anomalies in the preparation and analysis have been documented; out-of-control forms are complete, if required; holding times are documented, etc.);
* the data are ready for incorporation into the final report; and
* the data package is complete and ready for data archiving.

The Level 2 review is structured so that all calibration data and QC sample results are reviewed and all of the analytical results from 10% of the samples are checked back to the benchsheet. If no problems are found with the data package, the review is complete. If any problems are found with the data package, an additional 10% of the samples are checked to the benchsheet. The process continues until no errors are found or until the data package has been reviewed in its entirety.

An important element of the Level 2 review is the documentation of any errors that have been identified and corrected during the review process. Enseco believes that the data package submitted by the analyst for Level 2 review should be free of errors. Any errors that are found are documented and transmitted to the appropriate supervisor. The cause of each error is then addressed with additional training or clarification of procedures to ensure that quality data will be generated at the bench.

The Level 2 data review is also documented with the signature of the reviewer and the date. The project is then approved and a final report is prepared.

Before the report is released to the client, the program administrator reviews the report to ensure that the data meet the overall objectives of the client, as understood by the program administrator. This is the Level 3 review.

In addition, the divisional QA department randomly audits 5% of all projects reported. The QA audit includes verifying that holding times have been met; calibration checks are adequate; qualitative and quantitative results are correct; documentation is complete; and QC results are complete and accurate. During the review, the QA department checks the data from 20% of the samples back to the benchsheet. If no problems are found with the data package, the review is complete. If any problems are found with the data package, an additional 10% of the samples are checked back to the benchsheet. The process continues until no errors are found or until the data package has been reviewed in its entirety.

8.2 Data Reporting

In general, Enseco reports contain the following items.

* General Discussion - Descriptions of samples types, tests performed, problems encountered, and general comments are given.

* Analytical Data - Data are reported by sample by test and are not blank-corrected. Pertinent information including dates sampled, received, prepared, and extracted are included on each results page. The Enseco reporting limit for each analyte is also given.

- * QC Information - Analytical results for laboratory blanks are reported where applicable. In addition, the results (average percent recovery and relative percent difference) of the DCS analyzed with the project are listed. Control limits are reported.
- * Methodology - References for analytical methodologies used are cited.

Standard CLP deliverables will be reported for the specific CLP analyses. Other non CLP analyses will be reported as per the guidelines of the Geraghty and Miller AQA/LCP. Inorganic CLP deliverables will be those of the most recent Statement of Work (3/90) with the exception of the Form XIII and Form XIV. The data presented on these forms will be provided in the raw data package.

8.3 Project Files

Project files are created for each project handled within the laboratory. These files contain all documents associated with the project. This includes correspondence from the client, chain-of-custody records, raw data, copies of laboratory notebook entries pertaining to the project, and a copy of the final report. When a project is complete, all records are passed to the document custodian who puts the files into the document archive. All files are secured in limited access areas and are signed in and out of the area under chain of custody. Raw data and all pertinent records will be retained for a minimum of ten years in accordance with the RI/FS requirements.

9. INTERNAL QUALITY CONTROL CHECKS

9.1 Laboratory QC Checks

Enseco's general QC protocols for analytical analyses include the following items.

- A minimum of one method blank is analyzed per sample batch to detect contamination during preparation and/or analysis.
- Duplicate control samples (DCS) consisting of target analytes spiked into a blank matrix and analyzed for every 20 samples to determine accuracy and precision.
- Matrix Spikes and matrix spike duplicates for organics analyses and matrix spikes and matrix duplicate for inorganic analyses will be analyzed for every 20 samples to determine the affect of the matrix on the method performed.
- Internal and Surrogate standards will be added where appropriate to quantitate results, determine recoveries, and to account for sample-to-sample variation.
- Calibration of instrumentation will be determined according to the appropriate EPA methods.

9.2 Specific QC Assignments by Sample Group

Specific laboratory QC samples which will be analyzed per sample Group are as follows:

DCS = Duplicate Control Samples
MS = Matrix Spike
SD = Matrix Spike Duplicate
DU = Matrix Duplicate
MB = Method Blank

Organics:	DCS:	Per twenty samples
	MS/SD:	Per twenty samples per matrix
	MB:	Per sample batch per matrix
Inorganics:	DCS:	Per twenty samples
	MS/DU:	Per twenty samples per matrix
	MB:	Per sample batch per matrix

Note:

1. It is the responsibility of Geraghty and Miller to collect sufficient sample and designate MS/SD/MD analyses on the chain of custody and LTO.
2. For non-CLP parameters accuracy and precision are determined through the results of the DCS. For CLP parameters the contract required QA/QC will be performed.

10. PERFORMANCE AND SYSTEM AUDITS

10.1 External Audit of Enseco by U.S. EPA

Enseco participates in a wide variety of certifications, programs, and contracts and is subjected to rigorous external audits by many government agencies and private clients.

Enseco presently holds an EPA CLP contract for organics, and is audited on a regular basis by the U.S. EPA under this contract. Quarterly performance evaluations are also performed under this contracts in addition to participating in U.S. EPA WS/WP series performance evaluation samples.

Enseco is available for an audit in reference to this project specifically by Geraghty and Miller or by US EPA Region III.

10.2 Enseco Internal Audits

Enseco is subjected to quarterly systems audits by the QA department. These audits are intended to serve two purposes:

1) to ensure that laboratories are complying with the procedures defined in laboratory SOPs, QAPjPs, and contracts.

2) to determine any sample flow or analytical problems. The frequency of the audits will be increased if any problems are suspected.

The Enseco QA department also performs data audits on five percent of projects prior to their release to the clients. These audits cover not only the validity of the results, but determine whether the data quality objectives required by the client have been met. Any errors associated with the project are corrected prior to the project's release, and are reported to the divisional personnel and to corporate QA and Operations on a monthly basis.

A corporate QA audit is performed on an annual basis by the corporate director of quality assurance. This audit is intended to check compliance with Enseco's overall QA program.

All audits by divisional and corporate QA staff are performed more frequently, or specifically directed audits are performed if any problems are suspected in the laboratory.

11. CALCULATION OF DATA QUALITY INDICATORS

By following all of the procedures outlined in this QAPjP and by thoroughly documenting all work that is performed, Enseco will closely monitor data precision, accuracy, and completeness. Validity of reporting limits is also assured.

11.1 Data Quality

For this project, the methods to determine precision and accuracy, and their acceptability are well defined in the data quality objectives section and in the analytical methods.

11.2 Precision

Precision is determined by the comparison of duplicate control samples. The RPD of duplicate control samples will be used to estimate the precision. The following equation will be used to determine this.

$$RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100$$

where:

RPD = relative percent difference;
D_1 = first sample value; and
D_2 = second sample value (duplicate).

11.3 Accuracy

The determination of accuracy of a measurement requires a knowledge of the true or accepted value for the analyte being measured. The average percent recovery of duplicate control samples will be used to estimate accuracy. Accuracy will be calculated in terms of average percent recovery in the following equation.

$$\text{Average percent recovery} = 100 \text{ X } \frac{\bar{X}}{T}$$

where:

$\bar{X}$ = average of observed value(s) for measurement(s); and
T = "true" value.

11.4 Analytical Completeness

Determining whether a data base is complete or incomplete is a subjective evaluation. To be considered complete, the data set must contain all QC check analyses verifying precision and accuracy for all of the analytical protocols. Less obvious is whether that data are sufficient to achieve the goals of the project. All data are reviewed in terms of goals in order to determine if the data base is sufficient.

Percent completeness is calculated as follows:

$$\text{Completeness} = \frac{\text{valid data obtained}}{\text{total data needed}} \times 100$$

11.5 Detection Limits

The sensitivity of an analytical method is related to the detection limit (i.e., the lowest concentration of an analyte that can be detected at a specific confidence level). Definitions of instrument detection limit (IDL), method detection limit (MDL), and practical quantitation limit (PQL) follow in this section.

IDL - This is the smallest signal above background noise that an instrument can detect at a 99% confidence level. An IDL is measured by analyzing three replicate standards. It is calculated as three times the standard deviation of the replicate analyses. IDLs are determined for metals analyses.

MDL - This is the minimum signal level required to qualitatively identify a specific analyte by a specific procedure at a greater than 99% confidence interval. An MDL is measured by analyzing a minimum of three replicates spiked at 1-5 times the expected method detection limit. It is calculated by the SD times the student T-value at the desired confidence level. Enseco uses a 99% confidence interval and seven spiked replicates of a control matrix in determination of method detection limits.

PQL - This is the minimum level that can be reliably achieved by a method within specified limits of precision and accuracy. Enseco's PQL is derived from the evaluation of interlaboratory method detection limit studies. This is the Enseco Reporting Limit.

Enseco determines the MDL for routine methods using a blank matrix. MDLs are repeated annually (IDLs for metals are determined quarterly), and are kept on file in the QA Office. Enseco has on file method detection limits and/or IDLs for Metals for all analyses performed for this project.

12. CORRECTIVE ACTION

Corrective actions for laboratory problems are specified in Enseco SOPs. Specific QC procedures are designed to help analysts determine the need for corrective action. Often, personal experience is most valuable in alerting the analyst to suspicious data or malfunctioning equipment. Corrective action taken at this point helps to avoid collection of poor quality data.

Problems not immediately detected during the course of analysis may require more formalized, long-term corrective action. The essential steps in the corrective action systems are as follow.

1. Identify and define the problem.
2. Assign responsibility for investigating the problem.
3. Investigate and determine the cause of the problem.
4. Determine a corrective action to eliminate the problem.
5. Assign and accept responsibility for implementing the corrective action.
6. Establish effectiveness of the corrective action and implement it.
7. Verify that the corrective action has eliminated the problem.

This scheme is generally accomplished through request to the QA department. Any laboratory analyst or project member may notify the QA director of a problem. The QA director initiates the corrective action scheme by relating the problem to the appropriate laboratory managers and/or program administrators who investigate or assign responsibility for investigating the problem and its cause. Once determined, an appropriate corrective action is approved by the QA director. Its implementation is later verified through an audit.

Close scrutiny is paid to the quality and validity of the analytical data for any given analysis. Data acceptability is judged utilizing precision and accuracy information in the DCS. Corrective action at the bench level is generally triggered by out of control DCS. The nature of each corrective action is be determined by the method employed. In instances, a reanalysis, reextraction, or recalibration may be necessary to correct the problem.

13. QUALITY ASSURANCE REPORTS TO MANAGEMENT

This reporting system is a valuable tool for measuring the overall effectiveness of the QA program. It serves as an instrument for evaluating the program design, identifying problems and trends, and planning for future needs. Divisional QA directors submit extensive monthly reports to the vice president of QA and the divisional director. These reports include the following items.

- The results of the monthly systems audits including any corrective actions taken.
- Performance evaluation scores and commentaries.
- Results of site visits and audits by regulatory agencies and clients.
- Problems encountered and corrective actions taken.
- Holding time violations.
- Comments and recommendations.

In addition, on a monthly basis, a summary of the 5% QA audit of reported data is sent to the corporate QA office.

14. REFERENCES

"Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans", Office of Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. EPA, EPA-600/4-83-004, February, 1983.

"Preparing Perfect Project Plans", Risk Reduction Engineering Laboratory, Office of Research and Development, EPA-600/9-89-087, October 1989.

"Test Methods for Evaluating Solid Waste: (SW-846), 3rd edition (1986), Update I (1989), Office of Solid Waste and Emergency Response, U.S. EPA.

"Methods for Chemical Analysis of Water and Waste", Environmental Monitoring and Support Laboratory, USEPA, March 1983.

"Contract Laboratory Program 3/90 Organic Statement of Work" Document Number OLM01.1.1, Contracts Management Division, U.S. EPA.

"Contract Laboratory Program 3/90 Inorganic Statement of Work" Document Number ILM01.0, Contracts Management Division, U.S. EPA.

APPENDIX A

JAMES J. ZOLDAK

DIRECTOR OF OPERATIONS

PROFESSIONAL QUALIFICATIONS

Mr. Zoldak has 16 years of diversified experience in the field of analytical chemistry. He has held numerous senior management level positions and has demonstrated his ability to manage complex and technically challenging resources.

EXPERIENCE

1991 - Present

DIRECTOR OF OPERATIONS (Eastern Region)
Enseco, Incorporated, Somerset, NJ

Directs operations for the New Jersey laboratory including analytical and support departments.

Directs technical performance and quality compliance activities for the lab.

Has responsibility for bottomline profits for the now >$12 million operation.

Oversees the development and implementation of productivity improvement programs for the lab.

Oversees the operation of the Cambridge satellite laboratory.

1989 - 1991

CORPORATE DIRECTOR OF OPERATIONS
Enseco, Incorporated, Somerset, NJ

Established the monthly operational strategy for the company.

Coordinated interdivisional and inter-regional transfer of projects to meet client needs and internal capacity limits.

Monitored productivity and capacity programs throughout the network.

Oversaw the design development and project management of facility buildout and remodeling.

Provided operational and technical input into the development and review of large capital expenditure requests.

Provided operational and technical input into the review of quarterly and annual sales forecasts and operational budgets.

Directed an inter-regional effort for development of a formal, self-paced training program for the company.

Oversaw the Total Quality program at Enseco.

1987 - 1989 **DIVISION DIRECTOR**
Enseco, Incorporated, Somerset, NJ

Originated Enseco East from conceptual design through start-up of a functioning full-service laboratory.

Developed design and managed the buildout program of the New Jersey facility.

Defined and staffed functional departments within the lab.

Directed the program of certifying the laboratory for participation in both state and federal programs.

Responsible for taking the lab to over $3,000,000 in revenue in the first 9 months of operation.

1983 - 1987 **PROGRAM MANAGER**
Advanced Analytics, Incorporated

Directed a commercial program for the provision of environmental air monitoring and other analytical services in the field utilizing state-of-the-art technology.

Developed analytical methods in support of the commercial program.

Developed proposals to provide services to commercial and governmental clients.

Worked with federal and state agencies for the adoption of new protocols utilizing novel technical instrumentation.

1979 - 1983 **DIRECTOR OF LAB OPERATIONS**
CompuChem Laboratories, Chicago, IL

Designed the lab facility and directed the startup of CompuChem's first regional laboratory.

Grew the business from a virgin territory to $1,000,000 by the second year of operation.

Acted as technical support to the local and national sales effort.

1979 - 1981 **MANAGER OF GC/MS LABORATORY**
RTP, North Carolina

Developed a one instrument GC/MS lab into an unprecedented lab with over 18 instruments by the end of the second year.

Grew the menu of services and revenues from less than $1,000,000 in two protocols to $2,500,000 in a broad base of services.

Grew the department from a staff of two to more than 25, operating 24 hours a day, six days a week.

Qualified the laboratory to participate in Federal contracts valued at over $3,000,000.

1978 - 1979 **APPLICATIONS CHEMIST/INSTRUCTOR**
Finnigan Institute, Finnigan Corporation

Developed and validated methods for use in contracted research utilizing Finnigan GC/MS systems.

Designed and presented technical operator's training courses for Finnigan customers.

1976 - 1978 **RESEARCH CHEMIST** (Water Resource Center)
U. S. Environmental Protection Agency

Developed methods utilizing various instrumentation for the analysis of target organic compounds in drinking water.

Performed analyses as part of method validation studies. Conducted analyses of standard materials sent to certified labs as measures of accuracy and precision.

EDUCATION

M.S. Environmental Science - Miami University, 1978

B.S. Chemistry - Miami University, 1974

DENNIS FLYNN

REGIONAL QA/QC DIRECTOR

PROFESSIONAL QUALIFICATIONS

Mr. Flynn is an Environmental Scientist with experience in many types of analyses in environmental and industrial hygiene laboratories. He has five years experience in analytical chemistry; including GC, GC/MS, AA, IR, and classical wet chemistry techniques. He is also experienced in field and laboratory methods for industrial hygiene, and has managed an environmental laboratory in the Boston area.

EXPERIENCE

1991 to Present — **DIRECTOR, QUALITY ASSURANCE** (Eastern Region)
Enseco East, Somerset, New Jersey

Oversight of Quality Assurance program for Enseco Eastern Regional laboratories and direction of QA and EH&S programs at Enseco-East.

1990 - 1991 — **DIRECTOR, QUALITY ASSURANCE**
Enseco-Erco, Cambridge, MA

Direction of Quality Assurance and Environmental Health and Safety programs at Enseco-Erco Laboratory. Implementation of Enseco Quality Assurance program, Total Quality Management initiatives, and client-specific quality assurance programs.

1988 - 1990 — **QUALITY ASSURANCE SPECIALIST**
Enseco-Erco, Cambridge, MA

Responsibilities for laboratory and data audits; audits by private clients, State and Federal agencies; technical assistance to clients regarding QC issues; performance evaluation programs, preparation of site-specific Quality Assurance Project Plans (QAPPs). Also responsible for the implementation of the Enseco QAPP and submitting recommendations for corrective action to management. Maintained files for SOPs, and performed reviews and approvals of SOPs as needed.

1988 - 1990 — **ENVIRONMENTAL HEALTH & SAFETY COORDINATOR**
Enseco-Erco, Cambridge, MA

Managed Enseco Environmental Health and Safety program at the Erco Division including Employee Right-to-Know, Respiratory Protection Program, Emergency Contingency Operations, Hazardous Waste Disposal, Chair of the Erco Safety Committee.

1987 - 1988 **LABORATORY DIRECTOR**
Certified Engineering & Testing Co., Weymouth, MA.

Responsible for overall operation of laboratory including submission of written reports to clients, quarterly profit and loss statements, delegation of responsibilities among and hiring of personnel, purchasing equipment, laboratory certifications, primary client contact, and bid proposals.

1986 - 1987 **CHEMIST/MASS SPECTROSCOPY**
Certified Engineering & Testing Co., Weymouth, MA.

Responsible for startup and operation of GC/MS instrumentation for analysis of volatile organic compounds according to EPA methods.

1986 **CHEMIST/METALS AND GAS CHROMATOGRAPHY**
Certified Engineering & Testing Co., Weymouth, MA.

Responsible for sample preparation and analysis of samples for metals by atomic absorption, analysis for pesticides and volatile organic compounds by gas chromatography, and NIOSH methods analyses.

1985 - 1986 **ENVIRONMENTAL SCIENTIST**
Hunter Environmental Sciences, Inc., Lincoln, MA.

Variety of responsibilities including Section 21E site assessments, asbestos audits, startup of Massachusetts DEQE certification on laboratory division, metals chemist.

1983 - 1985 **GRADUATE TEACHING ASSISTANT**
ENVSCI 503 - "Methods of Pollution Measurement", University of Massachusetts, Amherst, MA.

Responsible for lectures, examinations, grading, and preparation of laboratory experiments following "Standard Methods for the Analysis of Water and Wastes".

EDUCATION

B.S. Chemical Engineering, 1975. Georgia Institute of Technology.
B.S. Environmental Science, 1973. University of Massachusetts, Amherst, MA.

PUBLICATIONS AND PRESENTATIONS

Flynn, Dennis W., "Continuous Lactate Fermentation of Cheese Whey Using Mixed Cultures of S. thermophilus and L. bulgaricus", Senior Honors Thesis, University of Massachusetts, Amherst, MA, 1986.

Flynn, Dennis W., "Metals in Amherst Drinking Water - An Analysis of the Effects of Flushing", University of Massachusetts, Amherst, MA, 1982.

Flynn, Dennis W., "A Kinetic Study Metals, Trihalomethanes, and Free Chlorine in Amherst Drinking Water", Presented to the Connecticut Valley Undergraduate Chapter of the American Chemical Society, University of Massachusetts, Amherst, May 1982.

PROFESSIONAL MEMBERSHIPS AND ACTIVITIES

American Chemical Society

DON McDOWELL

PROGRAM ADMINISTRATOR

PROFESSIONAL QUALIFICATIONS

Mr. McDowell has had 6 years experience in the environmental industry with extensive background in the analysis of environmental samples, and 3 years client service experience.

EXPERIENCE

1989 to Present **PROGRAM ADMINISTRATOR**
Enseco East, Somerset, New Jersey

Responsible for daily project management of major accounts which includes log-in/log release, coordination with lab coordination with clients, and report and invoice generation and review. Interacts with clients to provide technical support in the areas of data challenges, regulatory needs, general lab practices, data quality objectives, and QAPP review. Also, interacts with the Sales force to insure overall clients satisfaction and account development. Provides sales support to clients by negotiating prices, writing proposals, and visiting clients.

Provides marketing and sales support to Enseco by forecasting future work, negotiating contracts, attending conferences and exhibitions.

Develops and assists in training less experienced staff in all PA functions.

1986 - 1989 **VARIOUS TECHNICAL AND SUPERVISORY POSITIONS**
Intl. Technology Corporation, Edison, NJ.

Responsibilities included supervisor for ten technicians and wet chemistry lab, assistant supervisor of the Metals Department, directed and supervised all state certifications for the lab, reviewed all data prior to presentation to client, write laboratory standard procedures, development and utilization of computer software for maintaining of records, training and development of personnel, and operation of all laboratory equipment and instrumentation.

EDUCATION

B.S. Environmental Studies, 1980. University of New Haven, West Haven, CT.

SHU-WEN KAO

DIRECTOR OF ORGANIC LABORATORY

PROFESSIONAL QUALIFICATIONS

Ms. Kao has eleven years of diversified experience in the environmental analytical chemistry. She has held numerous top level management positions and has direct bench experience in the analysis of environmental samples for organic, inorganic, and trace metal parameters. Ms. Kao has served as Organic Director for both Engineering and Industrial accounts and sonsults with client and staff on technical issues, especially in the area of organic analysis.

EXPERIENCE

1990 to Present	**Organic Laboratory Director, Enseco East** Ms. Kao is responsible for overseeing the operations of the entire Organic Laboratory operations including Chromatography, GC/MS, and the Organic Extractions Groups.She provided technical guidance to staff and clients.
1988 to 1990	**GC/MS Laboratory Manager, Enseco East** Ms. Kao is primarily responsible for supervising the volatile and semi-volatile analytical sections. Her responsibilities include scheduling sample workload and report turnaround, training new staff, implementing Enseco's QA/QC program for the GC/MS department, and setting instruments up to perform EPA Methods 624 and 625, New Jersey ECRA and CLP work. Ms. Kao is also the System Manager for the Finnigan Incos 50 using Formaster to generate CLP reports and system manager of the HP-1000 RTE A series computer for GC/MS application.
1987 - 1988	**Organic Section Manager, BCM Inc.** Ms. Kao was responsible for the supervision of the GC, GC/MS and organic extraction departments performing environmental analysis of priority pollutants-PCB, pesticides and herbicides using EPA methodology and analysis of air samples by NIOSH procedures. She was the System Manager of the HP-RTE E series data system for GC/MS, and System Manager of the HP-1000 RTEA series lab automation system. Ms. Kao's experience also includes the operation of HP-5995 and 5985 GC/MS to analyze water, soil and air samples based on EPA CLP criteria, and the preparation of Tier I/II data packages.

1986 - 1987	**Project Engineer, IT Corporation** Ms. Kao was responsible for biokinetic studies of activated sludge systems to treat hazardous wastewater, preparation of ECRA documents and development of preliminary sampling and analysis plans. She also operated the HP-5995 GC/MS to analyze priority pollutants in water and soil, and interpreted data.
1985	**Environmental Chemist, Princeton Aqua Science** Ms. Kao was responsible for the operation of a GC/MS, analysis of priority pollutants in water and soil, quality control, and data interpretation.
1981 - 1985	**Research Assistant, University of Illinois** Ms. Kao was responsible for developing the anaerobic filter technology of coal gasification wastewater treatment.
1978 - 1980	**Teaching and Research Assistant, Louisiana State University Medical Center** Ms. Kao was responsible for teaching a biochemistry laboratory course and the separation and GC analysis of Bile Acids of Reptiles.

EDUCATION

M.S. Civil Engineering, University of Illinois (1985)
B.S. Chemical Engineering, University of Illinois (1985)
M.S. Biochemistry, Louisiana State University Medical Center (1980)
B.S. Chemisty, Tunghai University, Taichung, Taiwan (1978)

PROFESSIONAL AFFILIATIONS

American Water Works Association
Water Pollution Federation

DEBRA K. WHITE

INORGANICS LABORATORY DIRECTOR

PROFESSIONAL QUALIFICATIONS

Ms. White has over nine years of experience in the analysis of environmental samples and related QA/QC practices. She has direct bench experience as well as managerial experience in both sample preparation and inorganic analysis.

EXPERIENCE

1989 - Present
INORGANICS LABORATORY DIRECTOR
Enseco East, Somerset, New Jersey

Ms. White currently oversees the operations of the Inorganics Department which includes the Metals, Inorganic Prep and Wet Chemistry Groups. In this capacity she serves as a Client Manager to provide technical consultation and project specific assistance.

1986-1989
INORGANIC SECTION MANAGER
Roy F. Weston, Inc.

Responsibilities included the technical oversight and operational management of the metals, general chemistry, sample preparation and physical testing units which comprised the inorganics section. She supervised a staff of twenty-six technicians and chemists. Ms. White also managed the design and construction of a 40,000 sq. ft. laboratory.

1985-1986
INORGANIC PROJECT OFFICER
U.S. Environmental Protection Agency
Hazardous Response Support, Analytical Support Branch

Ms. White was responsible for the technical and contractual oversight of sixteen inorganic CLP laboratories. She also was involved in the technical oversight of the preaward activities, PE studies,development of CLP analytical protocols and the coordination of technical review caucuses.

1984-1985
INORGANIC CHEMIST
U.S. Environmental Protection Agency
Central Regional Laboratory

Ms. White performed the technical review of inorganic CLP data to assess the usability for regional programs.

1983-1984 LABORATORY DIRECTOR
JTC Environmental Consultants

Ms. White was responsible for analytical scheduling, supervision of staff and review of chemical laboratory results.

1982-1983 ASSISTANT LABORATORY DIRECTOR
JTC Environmental Consultants

Responsibilities included the preliminary review of analytical results, training staff, documentation of laboratory operating procedures, and the implementation of quality control practices.

1980-1982 ANALYTICAL CHEMIST
JTC Environmental Consultants

Applied GC,AA, and HPLC techniques in the analysis of environmental samples. Performed instrument maintenance, training and supervised sample preparation technicians.

EDUCATION

B.A. Chemistry, 1978. Cedar Crest College
Graduate Study, Analytical Chemistry-Environmental Applications
University of Maryland.

WAYNE K. HALOZAN

METALS LAB MANAGER

PROFESSIONAL QUALIFICATIONS

Mr. Halozan has over 7 years experience in the environmental field. He has direct bench experience in the analysis of metals and microbiology on environmental samples as well as some wet chemistry. He also has supervisory experience in metals analysis as well as in the client services department.

EXPERIENCE

1990 to Present
METALS LAB MANAGER
Enseco East, Somerset, New Jersey

Mr. Halozan is Manager of the Mobile Lab and 30 employees in the Metals Department.

1985 - 1990
CHEMIST
Recon Systems, Inc., Three Bridges, New Jersey

Mr. Halozan managed and operated the atomic absorption laboratory for an environmental consulting firm. Experienced with Atomic Absorption (Flame Absorption and Emission), Hydride Generation, Graphite Furnace (Flameless Absorption), Spec 20, Infrared Spectrometer, and Gas Chromatography.

EDUCATION

B.A. Chemistry, 1982, Stockton State College.

DEBORAH KAY

WET CHEMISTRY SUPERVISOR

PROFESSIONAL QUALIFICATIONS

Ms. Kay has had an extensive background in inorganic analysis of environmental samples. She has direct bench experience as well as supervisory experience in area of inorganic analysis.

EXPERIENCE

1989 to Present	WET CHEMISTRY SUPERVISOR Enseco East, Somerset, New Jersey Ms. Kay currently is responsible for the daily operations of the wet chemistry laboratory. Ms. Kay is responsible for the training of new staff in the inorganic methods. Responsibilities also include scheduling work to meet method holding times, hiring staff, reviewing data and fully implementing the Enseco QA plan in her department.
1987-1989	INORGANICS LABORATORY SUPERVISOR Killiam Associates Ms. Kay managed a staff of chemists and laboratory technicians within the inorganics department. Her responsibilities included the tracking of samples and the scheduling of analytical work for that department.
1986-1987	QUALITY CONTROL TECHNICIAN Olin Hunt Chemical Corp. Ms. Kay was responsible for the analytical testing of raw materials, in process materials as well as finished goods. Worked closely with production managers to see that specific batches met required specifications.
1984-1986	SHIFT SUPERVISOR-INORGANIC LABORATORY TECHNICIAN ETTC Ms. Kay was responsible for the scheduling of work for her department as well as reviewing analytical data. Performed extraction and analysis of environmental samples according to NJDEP protocols.

EDUCATION

B.S. Marine Biology, 1984. Fairleigh Dickinson University

KHAJA EAZAZUDDIN

GC/MS VOLATILE LABORATORY SUPERVISOR

PROFESSIONAL QUALIFICATIONS

Mr. Eazazuddin has a solid background in the environmental analytical services field. He has direct bench experience as well as extensive supervisory experience in the analysis of environmental samples by GC/MS.

EXPERIENCE

1988 to Present
GC/MS VOLATILES SUPERVISOR
Enseco East, Somerset, New Jersey

Mr. Eazazuddin is responsible for the supervision of the volatile analytical laboratory. His responsibilities include scheduling; setting up instruments to perform EPA methods and CLP work; and training new staff in the determination of volatiles Purge and Trap. Mr. Eazazuddin operates both HP and Finnigan instrumentation and is responsible for troubleshooting instruments in the laboratory.

1988
GC/MS VOLATILES SUPERVISOR
Princeton Testing

Mr. Eazazuddin was responsible for supervising professional chemists in the analysis of environmental samples for volatile organic compounds by GC/MS. Mr. Eazazuddin gained a working knowledge of the Finnigan Incos 50 and Formaster software.

1986 - 1988
GC/MS CHEMIST,
NY Test Environmental

Mr. Eazazuddin was responsible for analyzing priority pollutants in water and soil by GC/MS. Mr. Eazazuddin's experience included working with Finnigan 5100 and HP-1000 series using Aquarious Software for determining BNA extractable parameters using EPA protocols, method 625 and related client protocols.

1984 -1986
SUPERVISOR
Standard Organic Limited

Mr. Eazazuddin was responsible for the overall operation of the production of sulpha methoxozoles for a major drug manufacturer in India.

EDUCATION

M.S. Chemistry, Bhopal University, India (1983)

DAN SEGAL

SCIENTIST

PROFESSIONAL QUALIFICATIONS

Mr. Segal has over five years experience in environmental analytical chemistry. He has direct bench experience in the analysis and preparation of environmental samples for organic analytes, as well as supervisory experience in a certified gas chromatography laboratory.

EXPERIENCE

1988 to Present
SCIENTIST
Enseco East, Somerset, New Jersey

Mr. Segal is responsible for ensuring that sample holding times and analysis deadlines are met. Mr. Segal also troubleshoots analytical problems and maintains laboratory equipment. He is involved with project management, report preparation and data review.

1987 - 1988
GROUP LEADER, GAS CHROMATOGRAPHY LAB
IT Corporation

Mr. Segal supervised a staff of four chemists in a certified environmental lab. He was responsible for scheduling production, training personnel, and reviewing data. He developed SOP's for analysis, data management, and personnel training, prepared reports and data packages for CLP, NJ Tier, ECRA, and NJPDES projects; and conducted routine GC and HPLC analysis as needed. Mr. Segal was the designated Specialist for PCB and pesticide residue analysis by CLP and NJ Tier protocol.

1985 - 1987
ANALYTICAL CHEMIST/SHIFT SUPERVISOR
IT Corporation

Mr. Segal was responsible for overseeing safety, quality control, and productivity in all areas of the laboratory. He analyzed environmental samples for PCB's, organochlorine pesticides, and volatile organics using EPA-approved GC methods (601, 602, 608). Mr. Segal is experienced in the use of FID, HECD, PID, and ECD as wellas a wide variety of packed and capillary columns. Other duties included analyzing several EPA Appendix VIII compounds by HPLC, and analyzing samples for volatiles and semi-volatiles by GC/MS Methods 624 and 625 using computerized data reduction.

1983 - 1985	LABORATORY TECHNICIAN IT Corporation

Mr. Segal extracted and prepared environmental samples for organic analysis by GC and GC/MS, and for metals analysis by atomic absorption spectrometry. He also performed wet chemical analysis for several inorganic parameters.

EDUCATION

B.S. Plant Physiology, 1985. Cook College, Rutgers University

ROBERT VANZILE

ORGANIC PREP SUPERVISOR

PROFESSIONAL QUALIFICATIONS

Mr. Vanzile has 2 years experience of organic bench level sample preparation and a thorough knowledge of EPA-CLP protocols. Mr. Vanzile has been an active participant in the MDL studies for new laboratory methods such as the 504 (drinking water) and TPH/FID analysis. He oversees the Standards Prep Laboratory in addition to the day and evening shifts in the organic extractions laboratory. Mr. Vanzile is also responsible for the quality control of all solvents, aluminum, florisil, and some standards used throughout the Organic Department. In addition, he is knowledgeable of liquid/liquid, gel permation chromatography, CLP 2/88 and 3/90 protocols, and the screening of semi-volatiles and pesticides.

EXPERIENCE

1990 to Present — ORGANIC PREP SUPERVISOR
Enseco East, Somerset, New Jersey

Responsible for scheduling, TAT and lab capacity, tracking repreps, tracking performance of chemists, tracking rush work progress, tracking leads, scheduling techniques, and follow-ups. Mr. Vanzile also trains all department employees, communicates constantly between lab and administration, researches new technology, tracks process improvements, and department status.

1989 - 1990 — LAB ASSISTANT
Strouds Water Research Center

Responsibilities included: staining bacteria samples, preparing wet slides, determining total bacteria counts, determining living bacteria counts, determining dry weight for bacteria samples.

EDUCATION

B.S. Biology/Ecology, 1990. West Chester University, West Chester, PA.

STEWART WASHINGTON

SAMPLE CONTROL SUPERVISOR

PROFESSIONAL QUALIFICATIONS

As Supervisor, Mr. Washington is responsible for both Sample Control/Bottle Prep Departments, which means that all incoming samples are received and processed within the guidelines of the SOPs. He is responsible for all outgoing bottle orders and to ensure that they have been filled in a timely fashion and a quality manner.

EXPERIENCE

1991 to Present

SAMPLE CONTROL SUPERVISOR
Enseco East, Somerset, New Jersey

Mr. Washington's primary responsibilities are the supervision of the Sample Control staff in the log-in area and in bottle and cooler preparation. He is responsible for ensuring that projects are logged in a timely manner as well as ensuring that cooler shipments are sent out on time.

1987 - 1991

CORPORATE FLEET ADMINISTRATOR
Metpath Inc., Teterboro, New Jersey

Responsible for all corporate fleet vehicles nationwide. Negotiate all lease and rental arrangements with outside vendors, make vehicle selection for corporate requirements and applications. Develop and provide maintenance and repair information in order to assist in the upkeep of fleet vehicles. Develop, maintain, and implement fleet policies, procedures and safety standards nationwide.

Maintain a fleet of 1,100 vehicles with a budget of $3,650,000 annually with economical and cost effective measures. Annual saving of %10.

1986 - 1987

MATERIAL MANAGEMENT ANALYST
Metpath Inc., Teterboro, New Jersey

Responsible for catering, maintaining and refining material management programs in lab operations, and to ensure cost reductions. Inventory control, ordering materials and tracking techniques to ensure maximum material usage; using IBM P.C. Annual savings of $284,000.

1984 -1985	DEPARTMENT MANAGER, DATA ENTRY Des Plaines, IL Direct a 32 person staff of data entry operators in a high volume production department. Input of all client information and results of tests, meeting a twenty-four hour turn around time, scheduling shifts, programming Four Phase Data IV CPU. Development projects - Four Phase vs. Nixdorf Computers ISIS - Integrated Specimen Input System.
1983 - 1984	SHIFT MANAGER, DATA ENTRY Des Plaines, IL
1981 - 1983	SECTION MANAGER, DATA ENTRY Teterboro, New Jersey

PROFESSIONAL ASSOCIATIONS

National Associations of Fleet Administrators

EDUCATION

B.A., Jersey City State College 1977, Jersey City, NJ

APPENDIX B

CURRICULUM VITAE FOR KEY PROJECT PERSONNEL

JOSEPH MINSTER

Senior Project Advisor

CREDENTIALS/REGISTRATION

M.S. Hydrogeology and Engineering Geology, Moscow Geological Institute, USSR 1953
Certified Professional Geologist: AIPG No. 6483
Registered Professional Geologist: Delaware No. 345

PROFESSIONAL AFFILIATIONS

National Water Well Association
Association of Engineering Geologists
American Society of Civil Engineers

FIELDS OF SPECIALIZATION

- Remedial investigations and feasibility studies.
- Ground-water remediation and aquifer restoration.
- Design and installation of slurry cutoff walls.
- Design and installation of construction dewatering, drainage, and seepage control systems.
- Well-field design and installation.
- Rehabilitation of wells.
- Expert testimony.

EXPERIENCE SUMMARY

Mr. Minster has over 30 years of experience in the design and implementation of construction dewatering and ground-water supply systems, hazardous waste remedial investigations (RI), feasibility studies (FS), and ground-water remediation. He has designed and installed slurry walls and other ground-water flow control systems, conducted aquifer contamination assessments, evaluated treatment alternatives, and provided expert testimony. He has extensive international work experience, including projects in the USSR, Bulgaria, Spain, Argentina, and Venezuela.

Since joining Geraghty & Miller, Mr. Minster is directing an RI/FS investigation at a Superfund site in Pennsylvania, a ground-water study on a TCE-contaminated site in southern New Jersey, and investigations of ground-water contamination in a fractured bedrock terrain at a site in northwestern New Jersey.

Prior to joining Geraghty & Miller, Mr. Minster was employed as Assistant Chief Engineer with a major construction dewatering firm and as a senior hydrogeologist with three major environmental consulting firms.

KEY PROJECTS

- Provided hydrogeological and geotechnical consulting to PRP groups on two Superfund sites in Connecticut, the Laurel Park Landfill in Naugatuck and the Beacon Heights Landfill in Beacon Falls. The work included development of cost-effective solutions to modify the ROD, negotiations with USEPA Region I and CTDEP, and review and contribution to the Pre-Design Study.
- Conducted an RI of aquifer contamination in the Brunswick Formation at the Montgomery Township/Rocky Hills Municipal Well Superfund Site, New Jersey.
- Conducted an RI/FS for coal tar contamination and remediation in soil and ground-water at two old coal gasification sites in Long Branch and Atlantic Highlands, New Jersey.
- Provided consulting services on coal tar and fuel oil contamination at the construction site of the new Convention Center/Rail Terminal in Atlantic City, New Jersey.
- Conducted an RI/FS and pilot waste-oil recovery tests at the Pennsylvania Avenue Landfill, Brooklyn, New York, for the New York City Department of Sanitation.
- Performed a ground-water study on the impact of contamination in a bedrock aquifer on a water-supply well for the Township of Fairfield, New Jersey.
- Provided expert testimony and conducted a major study on the feasibility and advisability of remedial measures in a contaminated aquifer and surface water bodies for the Middlesex County Superior Court, New Jersey.
- Analyzed a 17-month effort to remediate an aquifer by means of ground-water recovery, air stripping, and recharging to the aquifer via spray irrigation at a site in Dayton, New Jersey.
- Conducted an on-site study and recommended remedial measures to stop seepage into an alumina shed in Ciudad-Guayana, Venezuela.
- Directed a bench-scale aquifer decontamination study through biodegradation at a site in Kingston, New York.
- Evaluated the feasibility of slurry wall, dewatering, and grouting to minimize seepage from a tailing dam for Rossing Uranium Limited, South Africa.

KEY PROJECTS (Continued)

- Supervised drilling operation and an aquifer pump test, and analyzed the results for a water supply well in Cedar Grove Township, New Jersey.

- Performed the analysis and evaluation of field and laboratory permeability tests and calculated seepage losses from proposed reservoirs at Hackettstown, New Jersey for the New Jersey State Geological Survey.

- Provided a method of calculating horizontal drains in the slopes of an excavation for the Fostago Mine Project, Brazil.

- Evaluated the dewatering operations at Yaphank County Center's pump station in a contractor's claim for Suffolk County, Long Island, New York.

- Served as Technical Reviewer on Class 9 accident liquid pathway assessment for the Wolf Creek Nuclear Generation Station, KG&E Company.

- Served as Technical Reviewer for ground-water section of report, FSAR, Nine Mile Point Nuclear Station, Unit 2, Scriba, New York.

- Designed and provided consulting services and technical supervision for the installation of construction dewatering systems for nuclear power plants, rapid transit tunnels, sewer tunnels, sewage treatment plants, and steel mills. Supervised the design and installation of dewatering system and slurry cutoff wall for a sewage treatment plant in Lincoln Park, New Jersey.

- Supervised drilling operations and well installation; conducted field pump tests; performed analysis of various water supply, dewatering, recharging, pressure relief well systems and their effects on the environment; and conducted field and laboratory geotechnical investigations relating to problems associated with soil mechanics, earthwork, and geochemistry.

- Designed and participated in the construction of the following projects:

    - Water supply by means of radial horizontal collector wells (Ranney type).

    - Vertical and horizontal drains for protection of properties and structures, irrigation, and land reclamation.

    - Various dewatering systems (wells, suction wells, ejectors, wellpoints, horizontal screens, electroosmotic installations).

KEY PROJECTS (Continued)

- Antiseepage barriers for water conservation, reducing flow velocities in foundations and around abutments of dams, for dewatering of excavations and protection of environment (grout curtains, slurry cutoff walls, frozen earth walls, steel sheet piling).
- Soil stabilization by means of sand drains, wick drains, chemical grouting, and electroosmotic installations.
- Conventional piles and large diameter cast in-situ caissons.

9/91

BARBARA A. DOLCE

Senior Scientist

CREDENTIALS/REGISTRATION

B.S. Geology, University of Massachusetts, 1982
M.S. Geology, University of Vermont, 1985
Safety at Hazardous Waste Sites Training, National Water Well Association, 40-Hour Training, 1985
Registered Professional Geologist, State of Tennessee No. TN1229
Certified Professional Geologist: AIPG No. 8279

PROFESSIONAL AFFILIATIONS

Geological Society of America
National Water Well Association
Sigma Xi

FIELDS OF SPECIALIZATION

- Structural analysis and interpretation.
- Fault zone evaluation.
- Ground-water exploration in fractured rock terrains.
- Site investigation health and safety planning.

EXPERIENCE SUMMARY

Ms. Dolce has 6 years of experience in design and implementation of water-supply and hazardous waste investigations. She has been involved in work plan preparation and implementation, field planning and administration, interaction with regulatory agencies and report preparation. Her projects involve CERCLA, NJPDES, and various programs within the New Jersey Department of Environmental Protection (ECRA, wetlands, underground storage tanks).

KEY PROJECTS

- Coordinated and implemented a preliminary field investigation at a hazardous waste site in preparation for remedial investigation/feasibility study. Field activities included ground-water and surface-water level measurements, installation of weirs and measurements of surface-water flow rates, and air sampling.

- Prepared and implemented a work plan for remedial investigation at a hazardous waste site. Elements included coordination with state regulatory agencies; development of protocols for sampling of ground water, surface water, sediment, soil, and air; and specifications for drilling of monitoring wells and exploratory borings. Prepared a report.

KEY PROJECTS (Continued)

- Prepared health and safety plans for investigations at hazardous waste sites.
- Assessed ground-water supply for a new housing development. Study involved compilation of well inventories, review of published hydrogeologic reports and interpretation of geologic maps, analysis of aerial photographs for fracture traces in crystalline bedrock terrain, selection of test drilling locations, and meetings with regulatory agencies and community groups. Conducted test well drilling to evaluate on-site conditions. Prepared design specifications for a production well and conducted a 72-hour pumping test for a ground-water diversion permit application.
- Implemented a monitoring, sampling, and data management program at a fuel-spill site.
- Reviewed data and supervised field work to determine the effect of pumpage of a municipal production well on a nearby lake.
- Designed a monitoring-well network for investigating the impact of a chemical spill on fractured, cavernous limestone. Selected product recovery systems, and prepared compliance monitoring work plan for modification to a NJPDES ground-water discharge permit.
- Supervised installation and testing of a bedrock public-supply production well.
- Supervised monitoring well installation, and carried out soil and ground-water investigations.
- Supervised well rehabilitation in water-supply well field.
- Developed sampling programs and work plans to comply with New Jersey ECRA regulations.
- Prepared a NJPDES discharge to ground-water permit application and supporting documents, including corrective action and compliance monitoring plans.

PUBLICATIONS

Strehle (Dolce), B.A. and Stanley, R.S., 1986. A comparison of fault zone fabrics in northwestern Vermont: Vermont Geological Survey, Studies in Vermont Geology, 30 p., 4 pls.

Strehle (Dolce), B.A., 1985. Deformation Mechanisms and Structural Evolution of Fault Zone Fabrics in Northern Vermont: A Comparative Study: M.S. Thesis, University of Vermont, 323 pp.

Strehle (Dolce), B.A. and Stanley, R.S., 1985. Structural evolution of fault zones and spatial zonation of deformation mechanisms: Geological Society of America Abstracts with Programs, v. 17, p. 64.

Stanley, R.S., Dorsey, R.J., DiPietro, J.A., Tauvers, P.R., Leonard, K.E., and Strehle (Dolce), B.A., 1984. A foreland to hinterland transect in northwestern New England: Geological Society of America Abstracts with Programs, v. 16, p. 64-65.

11/91

LIDYA GULIZIA

Project Scientist
Data Quality Assurance Manager

CREDENTIALS/REGISTRATION

B.S. Microbiology, Rutgers University, 1980

FIELDS OF SPECIALIZATION

- Supervision and administration of environmental laboratories.
- Program management of environmental investigations in laboratories.
- Evaluation of laboratory data.
- Quantitative chemical analysis.

EXPERIENCE SUMMARY

Ms. Gulizia has over 10 years of experience in environmental analysis. Since joining Geraghty & Miller, Inc., Ms. Gulizia is responsible for evaluating data and the capability of laboratories used in support of environmental investigations. Prior to joining Geraghty & Miller, Ms. Gulizia was employed as a project manager at a leading environmental laboratory in New Jersey and worked on federal and state projects for industrial and engineering clients. She has also worked at other leading environmental and toxicology laboratories in California and New Jersey as a program manager and analytical chemist.

KEY PROJECTS

- Participated in administration, marketing and management of large-volume, high-production laboratories and related support services for two environmental laboratories located in California and New Jersey. Tasks included sales promotion, contract review, proposal preparation, staff recruitment and training, identification and allocation of resources, scheduling, tracking and supervision.

- Administered quality assurance/quality control (QA/QC) program for environmental laboratory facility in New Jersey. Responsibilities included monitoring of laboratory operations for adherence to QA/QC program, identifying deficiencies, implementing corrective actions, preparation of laboratory standard operating procedures and performing audits. Maintained laboratory certifications and pursued new accreditations for expansion of laboratory services and capabilities.

- Administered environmental, health and safety program for environmental laboratory facility in New Jersey. Performed safety and hazard communication training for all personnel in compliance with the Resource, Conservation and Recovery Act (RCRA) and the Occupational Health and Safety Act (OSHA) requirements. Managed on-site chemical inventory including hazardous waste and materials. Manifested waste off-site for treatment or disposal. Participated in various facility audits and inspections conducted by local, state and federal agencies.

KEY PROJECTS (Continued)

- Coordinated laboratory operations in support of environmental assessments for federal, state and private sectors. Provided daily and long-term program management on several National Priority List (NPL) site investigations, federal facilities, and both active and closed industrial sites. Evaluated laboratory deliverables for adherence to client requirements and regulatory agencies using the USEPA Contract Laboratory Protocols (CLP), the Department of Energy's (DOE) Hazardous Waste Remedial Actions Program (HAZWRAP), the US Navy Installation Restoration Quality Assurance Program (NEESA) and various state guidelines.

- Performed a preliminary assessment to evaluate overall data quality and compliance to program objectives on an ECRA site in Great Meadows, New Jersey.

- Evaluated environmental data using USEPA Functional Guidelines for data validation for a site in St. Thomas, U.S. Virgin Islands. Assessed laboratory capability to provide analyses in support of drinking water supply investigations.

- Coordinated review of and response to a NJDEP BEECRA data evaluation for an ECRA site in Hudson County, New Jersey. Provided recommendations and justifications for incorporation into future sampling plan revisions.

KEVIN M^{c}GUINNESS

Project Scientist

CREDENTIALS/REGISTRATION

B.S. Geology, State University of New York at Oneonta, 1986.
40-Hour OSHA Training Course.

PROFESSIONAL AFFILIATIONS

Association of Ground Water Scientists and Engineers.

FIELDS OF SPECIALIZATION

- Ground-water.
- Active and inactive industrial facility inspections.
- Exploration and development of ground-water resources.
- Contaminant delineation through soil-gas analysis.
- Remedial design for soil and ground-water contamination.

EXPERIENCE SUMMARY

Mr. M^{c}Guinness has 5 years of experience in hydrogeology and environmental engineering. Since joining Geraghty & Miller, Inc., he has been the project hydrogeologist for the Remedial Investigation and Feasibility Study (RI/FS) of a Superfund site in Pennsylvania. Mr. M^{c}Guinness was previously a hydrogeologist with an environmental consulting firm in River, New York.

KEY PROJECTS

- Participated in the RI/FS of a Superfund site in Pennsylvania as a project hydrogeologist. The project has included the development of the strategy for the remedial program, the implementation of recommendations from the U.S. Environmental Protection Agencies' (USEPA) Focus Feasibility Study for the site, and the generation of the work plan documents.

- Worked on the remedial construction at a New Jersey Superfund site. The project included the delineation of a plume of mixed volatile organics using soil gas, shallow well points, and on-site analysis. The design of a network of recovery wells and of a treatment and recharge system was also part of the remedial program.

- Involved as project hydrogeologist in the development of a master plan for the real estate surrounding a production facility of a major international pharmaceutical corporation. The project included a regional study of ground-water development potential, surface run-off studies, recharge analyses, and studies of critical habitats.

KEY PROJECTS (Continued)

- Managed a project involving the excavation of a petroleum storage tank farm, the subsequent investigation of soil contamination, and the resultant soil remediation for an industrial facility in New York.

- Participated in two 20-site contracts with the New York State Department of Environmental Conservation to investigate sites on the New York State Registry of Inactive Hazardous Waste Sites. Projects included the planning and implementation of investigations, assessments of the resultant data, and recommendations for remediation or site delisting. Investigative tasks included surface geophysical and soil gas surveys, monitoring well installations, landfill test pit excavation conducted at Level B, and buried drum excavations performed at Level B. The sites, which were throughout New York State, included municipal landfills, industrial facilities and two high profile illegal landfills in the New York Metropolitan area.

- Assisted in numerous ground-water supply development projects for planned urban developments in New York. The projects included the assessment of supply potential, well placement, oversight of well installation, confirmatory testing and reporting.

3/92

REKHA DOLAS

Scientist

CREDENTIALS/REGISTRATION

B.S. Microbiology, Shivaji University, India
M.S. Environmental Science (Toxics), New Jersey Institute of Technology, 1991
40-hour OSHA Training Course
Licensed Asbestos Investigator

FIELDS OF SPECIALIZATION

- Data management.
- 40-hour OSHA training instructor.
- Development and implementation of health and safety plans.
- Facility audits.
- Asbestos investigation.

EXPERIENCE SUMMARY

Prior to joining Geraghty & Miller, Ms. Dolas was employed as an industrial hygiene technician for an environmental consulting company and has worked on projects in New Jersey, New York, and Pennsylvania. She was also involved in preparation of proposals, cost estimates, and reports.

KEY PROJECTS

- Coordinated a facility audit in New York. Project included Phase I and Phase II audits involving split-spoon soil sampling and report preparation.

- Developed a Health and Safety Plan for a Superfund site in Pennsylvania. Responsibilities also included plotting fracture traces and results of ground-water chemical analysis on site maps.

- Managed sampling data for a RCRA site in Puerto Rico. Other responsibilities included plotting sampling locations and analyses results on maps and preparation of data tables.

- Worked as a Health and Safety Technician during remediation of hazardous waste ditches and lagoons at a site in New Jersey. Responsibilities included preparation and implementation of a Health and Safety Plan and continuous air monitoring.

3/92

DOUGLAS J. McINNES

Project Scientist

CREDENTIALS/REGISTRATION

B.S. Chemistry, Towson State University, 1988

FIELDS OF SPECIALIZATION

- Analytical laboratory project management of environmental Remedial Investigation/Feasibility Study and monitoring programs, analytical and field quality assurance/quality control programs
- EPA Contract Laboratory Program data validation (USEPA Region III)
- Analysis of multi-media samples for environmental monitoring/remediation and industrial Quality Assurance/Quality Control programs
- Technical and logistical support for field sampling of multi-media samples
- Collection of water, soil, and industrial product samples
- Bench-scale treatability studies of environmental samples
- Small quantity hazardous waste generator inventory and disposal program, regulatory record keeping and reporting
- Health and safety compliance programs

EXPERIENCE SUMMARY

Mr. McInnes has more than ten years experience in analytical laboratories and related programs, including more than six years experience in environmental sample analysis and data validation. Since recently joining Geraghty & Miller in 1990, he has been involved primarily in performing environmental analysis data Quality Assurance/Quality Control assessment, and technical support of the project management staff, including QAPP and field sampling/laboratory analysis document writing.

Currently, Mr. McInnes functions as the Mid-Atlantic Regional Quality Assurance/Quality Control Officer and is in charge of coordinating and implementing the Analytical Quality Assurance/Laboratory Contract Program within the Mid-Atlantic Region. As such, he actively participates in data review and interpretation for the majority of in-house projects, audits analytical laboratories, assists in writing project plans and quality assurance documents, and interfaces with other regional offices for larger and more complicated projects.

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EXPERIENCE SUMMARY (Continued)

In joining Geraghty & Miller, Mr. McInnes brings proficient knowledge of analytical laboratory practices and procedures, including USEPA Contract Laboratory Program and State regulated sample collection, analysis, and reporting. In the past, Mr. McInnes has performed all phases of environmental sample analysis and reporting, including field sample collection, chain-of-custody and traffic report procedures, sample login and tracking, sample preparation techniques, sample analysis, data validation, and final report preparation. As the Laboratory Safety Officer for the analytical laboratory, Mr. McInnes was responsible for planning, writing, and implementing Health and Safety compliance programs, and also for inventory, disposal, and regulatory record keeping for a small quantity generator of hazardous waste.

KEY PROJECTS

- Performed data validation for the USEPA Region III Central Regional Laboratory, as part of the Environmental Services Assistance Team (ESAT) contracted to provide laboratory support and Contract Laboratory Program data validation. Participated in the 1990 data validation training seminar presented by the USEPA Region III Central Regional Laboratory. Served as lecturer and workshop instructor during the three days of the seminar devoted to Contract Laboratory Program organic-data validation.

- Soil gas sample collection and analysis using a Photovac 10S50 field Gas Chromatograph (GC) at various sites. Primary analytes of concern included several of the aromatic volatiles such as benzene, toluene, ethylbenzene, and xylenes (BTEX compounds), and various chlorinated volatile compounds particularly trichloroethylene, tetrachloroethylene, and their associated breakdown products such as 1,2-dichloroethene, and 1,1-dichloroethene.

- Participated in validation of dioxin analysis results for a major industrial client. This validation project was particularly important because only a portion of the analysis data generated was validated. EPA agreed to having only a representative portion of the analytical data validated, resulting in substantial cost reductions for the client, and providing EPA with validated results more quickly.

- Participated in writing or updating Quality Assurance Project Plans (QAPPs) for several clients, concentrating on field sampling and laboratory analysis requirements to best suit the project while meeting any regulatory requirements. Also assisted in writing field sampling plans (FSPs) and health and safety plans (HASPs) for smaller projects.

KEY PROJECTS (Continued)

- Analytical Laboratory Project Manager for a Remedial Investigation/Feasibility Study performed at three Air Force Bases located in Florida and Georgia. Provided technical and logistical support for the collection of soil, sediment, and water samples at these sites, sample login and tracking within the laboratory, data validation and reporting of analytical results. Served as prime contact for the contractor performing the Remedial Investigation/Feasibility Study.

- Analytical Laboratory Project Manager for Remedial Investigation/Feasibility Studies performed for a manufacturer of electronic components and circuit boards, at sites in Colorado and Florida.

- Analytical Laboratory Project Manager for Remedial Investigation/Feasibility Studies performed at aluminum mining and ore reduction sites in the Virgin Islands, and Oregon. Established a field laboratory for the site in Oregon, and helped to develop a spot-test and sample pre-treatment technique for removing matrix interferents (chlorine and sulfide) from cyanide samples prior to sample preservation, approved by USEPA Region X for use at this site. At the beginning of this program, performed many of the cyanide laboratory analyses.

- Analytical Laboratory Project Manager for a study to identify alternative methods of incinerator ash extraction using techniques based on the EP-Tox and TCLP leaching procedures currently employed by EPA. A number of different extraction fluids were evaluated and compared to the standard extraction techniques.

- Analytical Laboratory Project Manager for several small business and industrial clients located in the Baltimore, MD area, for which a wide variety of organic and inorganic analyses were performed.

- Participated in a bench-scale treatability study to evaluate the effectiveness of solidification of soil and sediment samples with limning and cement products, in order to immobilize metals and organic contaminants, including PCB's.

- Planned and wrote documentation of health and safety, and hazardous material handling, storage, and disposal procedures in order to comply with State of Maryland and Howard County (Maryland) regulatory requirements. Implemented and monitored these procedures as Laboratory Safety Officer.