REVISED
SAMPLING, ANALYSIS, AND MONITORING PLAN FOR WELLS TUTU WELLS SITE ST. THOMAS, U.S. VIRGIN ISLANDS

September 1990
Revised September 1991

Prepared for

Tutu Environmental Investigation Committee

Prepared by

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September 27, 1991

Geraghty & Miller, Inc. is submitting this plan on behalf of the Tutu Environmental Investigation Committee for work to be performed at the Tutu Wells Site in St. Thomas, U.S. Virgin Islands. The plan was prepared in conformance with Geraghty & Miller's strict quality assurance/quality control procedures to ensure that the report meets the highest standards in terms of methods used and the information presented. If you have any questions or comments concerning this plan, please contact one of the individuals listed below.

Respectfully submitted,

GERAGHTY & MILLER, INC.

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INTRODUCTION

This Sampling, Analysis, and Monitoring Plan (SAMP) has been prepared for the Tutu Environmental Investigation Committee (TEIC), which is comprised of Texaco Caribbean Inc. (Texaco), Esso U.S. Virgin Islands, Inc. (Esso), and L'Henri, Inc. (O'Henry) by Geraghty & Miller, Inc. for well sampling in the vicinity of the Tutu Wells Site, Anna's Retreat, St. Thomas, U.S. Virgin Islands (USVI). The SAMP was developed to satisfy requirements set forth in the Administrative Order issued on March 22, 1990 to Texaco, Esso, and O'Henry by the U.S. Environmental Protection Agency (USEPA) Region II.

The original SAMP was submitted to the USEPA in September 1990. Three sampling events have been implemented under the original SAMP by Soil Tech Corporation. Geraghty & Miller has documented the sampling activities, coordinated laboratory analyses, validated laboratory data, and prepared reports on the quarterly sampling events and results (Geraghty & Miller, Inc., 1991a; 1991b; 1991c). The SAMP has been revised to (1) document a replacement analytical laboratory and (2) include more accurate descriptions of sampling and analytical procedures. Responding parties have denied any liability or responsibility, and the work to be conducted pursuant to this plan does not constitute any admission that the respondents are liable or responsible for any constituents that may be present in the wells sampled.

OBJECTIVES

The objectives of the SAMP are to identify, quantify, and monitor the occurrence of gasoline constituents and tetrachloroethene (and its breakdown products) in wells in the vicinity of Route 38 within the Tutu Wells Site.

BACKGROUND

The Tutu Wells Site is located in the upper Turpentine Run basin in east central St. Thomas (Figure 1). Various commercial establishments line the major roads in the area. These establishments include the Texaco Tutu service station at the intersection of Highways 38 and 384, the Esso Tutu service station on Highway 38, and O'Henry Dry Cleaners on Highway 38. Private homes and multi-family housing, such as the Virgin Islands Housing Authority (VIHA) buildings, generally occupy the less heavily traveled roads. Several water supply wells are located in the Turpentine Run basin (Figure 2). These wells are operated by the VIHA, water purveyors, and private concerns, and supply water for domestic and commercial purposes.

The Texaco Tutu service station has been in continuous operation since 1964. The station is a retail outlet for gasoline and diesel fuel and also provides mechanical servicing of automobiles. Over the life of the station, fuel has been stored underground with the exception of the period from July 1987 to September 1988 when the fuel storage tanks and piping were replaced with new tanks and piping.

The Esso Tutu service station has been in continuous operations since 1970. The station sells retail gasoline and performs mechanical repairs. The station has two underground storage tanks; one of them was removed from service from August 1987 to June 1989. Fuel has been stored underground over the life of the station except for a brief period in June 1989 when the tanks and piping were removed and replaced with new tanks and piping.

O'Henry Dry Cleaners has been owned and operated by L'Henri, Inc. since 1981. Tetrachloroethene, commonly referred to as perchloroethylene and hence abbreviated as PCE, is used, stored, and handled at the establishment.

A brief reconnaissance of the area conducted by Geraghty & Miller in August 1990 revealed that there are other establishments that represent potential sources of constituents of concern to soil and ground water. These establishments include but may not be limited to the following:

- A Jeep dealership and repair shop.
- The Ramsay Motor dealership and repair shop.
- The LAGA building, which formerly housed a textile processing operation.
- Tillett Garden, where silk screening and pottery manufacturing and glazing are performed.
- The paint store.
- The Fire Station.
- The Vitelco facility.
- Other small repair shops located on Highway 38.
- The sanitary/storm sewer line(s).

The locations of these establishments, with the exception of the sanitary/storm sewer line(s), are shown on Figure 3.

The following information is derived from the USEPA's Administrative Order of March 22, 1990 and other reports prepared by the USEPA and its consultants. Responding parties have not made an independent determination of these facts.

In July 1987, water from the Tillett well was reported to have an unusual odor. Subsequent sampling and analysis of water from that well and other water supply wells in the area by the USEPA Technical Assistance Team (TAT) revealed the presence of volatile organic compounds (VOCs) in the well water.

The compounds detected included gasoline constituents and chlorinated organic compounds. As a result of the presence of these constituents, the USVI Department of Planning and Natural Resources (DPNR) closed 18 wells in the area from July through September 1987. The wells have remained closed and have been sampled quarterly by the USEPA Region II TAT team.

The majority of the quarterly sampling events performed by the TAT team involved analysis of the well water samples using a portable Photovac gas chromatograph (GC). Water samples were sent to a laboratory for chemical analysis on at least two occasions, in October 1987 and in November 1988. During both the October 1987 and November 1988 sampling events, the samples were analyzed for the EPA Target Compound List (TCL) of parameters. Based upon the analytical parameter list, it appears that an earlier sampling event occurred in July 1987, when the wells were first sampled and analyzed for VOCs using EPA Method 8240.

SCOPE OF WORK

The objective of the SAMP is to identify, quantify, and monitor the occurrence of gasoline constituents and PCE and its breakdown products in residential wells in the vicinity of Route 38 within the Tutu Wells Site.

Twenty-five wells have been included in the sampling program. These wells are as follows:

Bryan	Eglin III	Matthias
Dede	Four Winds I	Ramsay
Demitri	Four Winds II	Rodriguez
Dench	Gassett (formerly Hartman I - Bakery)	Smith
Devcon I	Hartman II (Crusher)	Steele
Devcon II	Hartman III (Estate)	Tillett
Eglin I	Harvey	VIHA I
Eglin II	LaPlace	VIHA III

The approximate locations of the wells are shown on Figure 2.

During the initial sampling event and once every year thereafter, the 25 wells will be sampled and submitted for laboratory analyses of the TCL and the Target Analyte List (TAL), with the exception of polychlorinated biphenyls (PCBs), under the Contract Laboratory Program (CLP). TAL analyses will be performed in accordance with the CLP Statement of Work (SOW) for inorganics analysis, as revised in March 1990. TCL analyses, with the exception of VOCs, will be performed in accordance with the CLP SOW for organics analysis, as revised in March 1990. All VOC analyses will be modified in accordance with a modified version of USEPA Method 524.2 Revision 3.0 in order to achieve lower detection limits. USEPA Method 524.2 analysis will be modified in accordance with the methodology described in Appendix A. VOC data reporting and validation will be performed in accordance with the CLP SOW for organics analysis, March 1990, and Method 524.2 Revision 3.0 criteria. Table 1 summarizes the proposed sampling and analysis effort. Table 2 lists the specific compounds and metals which are to be analyzed in support of this project. A Health and Safety Plan for the Tutu Wells Site sampling effort is presented in Appendix B. The HASP (Appendix B) has been prepared to address several tasks that will be performed in a future site investigation. For the purposes of the SAMP field work refer to Task 4: Evacuation and Sampling of Wells in Appendix B.

During the other three quarterly sampling events per year, the 25 wells (or a more limited set of wells, approved by the USEPA) will be sampled and submitted for laboratory analysis of TCL VOCs under CLP using modified USEPA Method 524.2 to achieve lower detection limits. If the validated data from the initial sampling event indicates the presence of TCL semivolatiles, pesticides, or TAL constituents above the detection limit, then samples collected from those wells during subsequent quarterly sampling events will be analyzed for the analyte group detected, in addition to VOCs.

Wells that do not show the presence of VOC parameters of concern for two consecutive quarterly sampling events will not be sampled during subsequent quarterly sampling events. After review of each quarterly sampling results, a list of wells to be removed from the sampling program will be submitted to the USEPA for approval. If VOC parameters of concern are detected in a given well sample, then that well will be sampled until at least two consecutive

sampling events result in non-detection of VOC parameters of concern. Samples will be collected for TCL semivolatile and TAL metal analysis at least once a year. If TCL semivolatile parameters are detected in a given well sample, then that well will be sampled until the semivolatile concentrations are documented to be less than the applicable drinking water standards for at least two consecutive sampling events. If TAL metal or pesticide concentrations are reported above the applicable drinking water standard for a given well sample, then that well will be sampled for the specific metal parameter(s) and/or pesticide(s) until the results of at least two consecutive sampling events indicate that the concentrations are less than the applicable drinking water standards.

However, if semivolatile, pesticide, or TAL concentrations above the detection limit do not pass data validation criteria or if there is reason to suspect that blank or laboratory contamination or matrix interferences have caused the detection of these constituents in the samples, then those wells will not be analyzed in subsequent quarterly sampling events for the analyte group detected. Instead, samples from those wells will be analyzed for TCL VOCs only.

The analytical data will be reviewed after each sampling event to determine the appropriateness of reductions in sampling frequency or complete termination of sampling activities at individual wells. If sampling reduction or termination of sampling a particular well is warranted, such a proposal will be submitted to the USEPA for approval. If any two successive quarterly sampling events indicate that constituents of concern are not detected at concentrations above the detection limit for VOCs or above the applicable drinking water standards for the non-VOC parameters in a particular well, a proposal to terminate sampling of that well will be submitted to the USEPA for approval.

The SAMP has been implemented by Geraghty & Miller and Soil Tech on behalf of TEIC, with oversight by USEPA and USVI-DPNR representatives. The first two sampling events, conducted in September/October 1990 and February 1991, indicated that nine well samples had non-detected results for VOCs of concern (Geraghty & Miller, Inc. 1991a; 1991b). Geraghty & Miller (1991b) recommended that these nine wells be removed from future sampling

efforts. In correspondence dated May 16, 1991 from Ms. Caroline Kwan, USEPA Project Manager to Ms. Ana Gloria Ramos, TEIC Designated Coordinator, the USEPA accepted the recommendation for removal of the nine wells for the third (June 1991) sampling round. Therefore, the following nine wells were not sampled during the third sampling event: Bryan, Dede, Dench, Devcon I, Devcon III, Demitri, Leonard, Rodriguez, and VIHA-III. Results of the June 1991 sampling event were relatively consistent with the results of the first and second sampling events (Geraghty & Miller, Inc. 1991c). However, the cumulative nature of minor problems of quality assurance (QA) and quality control (QC) due to the laboratory subcontractor required the introduction of Enseco-East, Inc. (Enseco) as a replacement laboratory.

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The objective of the QA/QC program is to provide defensible data of known quality. The QA/QC program consists of three parts: the sampling QA/QC program, the analytical Quality Assurance Program Plan (QAPP), and data validation by Geraghty & Miller.

SAMPLING QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The sampling QA/QC objectives are to ensure the reliability and integrity of all data and documentation generated as a part of the monitoring program. Well samples will be collected in accordance with USEPA-approved methods. Also, a Health and Safety Plan (HASP) has been prepared by Geraghty & Miller (see Appendix B). Prior to beginning field activities, all field workers will review the HASP. The HASP (Appendix B) has been prepared to address several tasks that will be performed in a future site investigation. For the purposes of the SAMP field work refer to Task 4: Evacuation and Sampling of Wells in Appendix B. Sampling will be conducted in such a way as to ensure that a water-quality sample representative of the hydrogeologic environment is obtained. Specific sampling protocols are described in Appendix C.

Quality control sampling, sample custody, handling, and data management will be conducted in accordance with USEPA-approved methods. Sampling QA/QC protocols are detailed in Appendix D.

ANALYTICAL QUALITY ASSURANCE PROJECT PLAN

Laboratory analysis of well water will be performed by Enseco Incorporated of Somerset, New Jersey. Enseco routinely participates in laboratory performance evaluations for the USEPA as part of the Water Pollution (WP) program. The laboratory also undergoes quarterly audits by the USEPA as required by the CLP, and has been audited and approved by Geraghty & Miller's own internal laboratory contracting program. Enseco is a United States Department of Agriculture (USDA)-certified laboratory and may accept samples from the USVI.

Project Description

The analytical QAPP details the QA/QC procedures employed to ensure the accuracy, precision, comparability, representativeness, and completeness of analytical services to be provided for this monitoring program.

Project Organization and Responsibility

The organizational chart which delineates organization and responsibilities at Enseco is included in the Enseco QAPP for Environmental Chemical Monitoring, Revision 3.4, April 1991, which is included as Appendix D.

Quality Assurance Objectives

As part of the evaluation component of the QA Program, laboratory results are compared with certain data quality objectives. These objectives, in terms of precision, accuracy, representativeness, completeness, and comparability, may be defined as follows:

- Precision: The agreement or reproducibility among individual measurements of the same property, usually made under the same conditions.

- Accuracy: The degree of agreement of a measurement with the true or accepted value.

- Representativeness: The degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

- Completeness: A measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under correct normal conditions.

- Comparability: An expression of the confidence with which one data set can be compared with another data set in regard to the same property.

The accuracy, precision, and representativeness of data will be functions of the origins of the samples, the procedures used to analyze samples and generate data, and the specific sample matrices involved in each project. Quality control practices utilized in the evaluation of these data quality objectives include the preparation, collection, and analysis of blanks, replicates, spikes, standards, check samples, calibrations, and recoveries.

Table 3 lists the precision, accuracy, and completeness objectives as defined for this project.

Sampling Procedures

Enseco will not perform any sample collection as a part of the SAMP. Sampling procedures are described in Appendix C.

Sample Custody

Field Sample Custody

Sample custody procedures outside the laboratory are discussed in the Sampling QA/QC Program section of this SAMP and in Appendix D.

Laboratory Sample Custody

Chain-of-custody originates as samples are collected. Chain-of-custody documentation accompanies samples as they are moved from the field to the laboratory with shipping information and appropriate signatures indicating custody changes along the way.

Laboratory chain of custody is initiated as samples are received and signed for on the Geraghty & Miller chain-of-custody form by the sample custodian at Enseco. The sample custodian documents the condition of the sealed sample shipment cooler on the chain-of-custody form. The sample label information is checked against the chain-of-custody record and proper container and preservative procedures as detailed in Table 4 are verified.

The samples are then logged in by assigning laboratory identification numbers. The sample log-in record will include the sample identification, date of receipt, sample condition, the laboratory identification number, sample preparation, and sample distribution. The samples are secured in a refrigerator maintained at approximately 4°C prior to preparation and analysis. Documentation of samples signed in and out of the central storage facility for analysis in the Enseco laboratory is recorded using Enseco's Internal Chain of Custody and Sample Custody Forms (Figures 4 and 5). After analysis, extracts and any remaining samples are held in the central storage area for 30 days after project completion to await disposal.

Samples at Enseco are kept within secure areas during all stages of custody, including the periods of time spent in preparation, analysis, and storage. The laboratory area is designated

as a secure area and the doors are kept locked at all times and only authorized personnel are allowed to enter the secure area. Visitors to the laboratories must be accompanied by Enseco staff members.

Calibration Procedures and Frequency

Instrument calibration procedures and frequency for organics analysis will be conducted in accordance with the methodology described in the CLP SOW for organics analysis, March 1990, and Method 524.2 Revision 3.0 for VOC analysis. Calibration procedures and frequency for inorganics analysis will be conducted in accordance with the methodology described in the CLP SOW for inorganics analysis, March 1990.

Analytical Procedures

Enseco will analyze TCL semivolatile organic compounds and pesticides in accordance with the methods detailed in the USEPA CLP SOW for organics analysis, March 1990, with revisions dated December 1990 and February 1991. TCL VOCs will be analyzed in accordance with a modified version of USEPA Method 524.2 in order to achieve lower detection limits. USEPA Method 524.2 analysis will be modified in accordance with the methodology described in Appendix A. TAL inorganic constituents will be analyzed for in accordance with the methods detailed in the USEPA CLP SOW for inorganics analysis, March 1990. Table 5 summarizes the analytical methods to be employed.

Data Reduction, Validation, and Reporting

Data reduction, validation, and reporting are examined in depth as part of the Enseco QA Plan dated April 1991, Section 10. This plan is attached as Appendix E.

Internal Quality Control and Quality Assurance

For this project, the internal quality control practices will include the following samples, analyzed one per batch of 20 samples, of the same matrix received by the laboratory:

One Matrix Spike Sample

One Matrix Spike Sample Duplicate (organics only)

One Matrix Duplicate (inorganics only)

One Method Blank

Laboratory Fortified Blanks (Method 524.2 analyses; per calibration sequence)

In addition, the following will also be required:

Surrogate Standards: To be added to every organic sample analyzed. The control limits are those listed in Table 6.

Performance and System Audits

This section is examined in detail in the Enseco QAPP dated April 1991, Section 12, included in Appendix E.

Preventative Maintenance

This section is examined in detail in the Enseco QAPP dated April 1991, Section 13, included in Appendix E.

Procedures to Assess Data Precision, Accuracy, Representativeness, Comparability, and Completeness

Specific routine procedures to assess data precision, accuracy, representativeness, comparability, and completeness are examined in the Enseco QAPP dated April 1991, Section 14, included in Appendix E.

Corrective Action

This section is examined in detail in the Enseco QAPP dated April 1991, Section 15, included in Appendix E.

Quality Assurance Reports to Management

This section is examined in detail in the Enseco QAPP dated April 1991, Section 16, included in Appendix E.

INDEPENDENT DATA VALIDATION

Geraghty & Miller will validate the entire data set, independently of the laboratory. Data validation will be performed in accordance with the USEPA Standard Operating Procedures (SOP) No. HW-2, February 1989 for inorganics and the USEPA SOP No. HW-6, March 1990 for organics. In brief, the data will be reviewed for compliance with the QC criteria based on the spike, duplicate, and blank results provided by the laboratory. The data will be evaluated for its precision, accuracy, completeness, representativeness, and comparability. If any data omissions or out-of-control data points are identified, they will be discussed with the laboratory and accounted for or corrected. A summary of the data validation findings will be included in each sampling report. The qualifications of the data validator are provided in Appendix D.

DATA SUBMISSION

A data package will be prepared and submitted to the USEPA Region II after the analytical results are received and validated from each quarterly sampling event. The package will include tabulated data, a figure showing the sampling locations, and the complete laboratory data package. The laboratory data package for organic data will include the sample data summary package and the sample data package, as described in the CLP SOW for organics analysis, March 1990, in Exhibit B, Section II, Items C and D. The laboratory data package for inorganic data will include the sample data package as described in the CLP SOW for inorganic analysis, March 1990, in Exhibit B, Section II, Item D. The data validation summaries and CLP data forms from each sampling event will be submitted to the USEPA.

PROJECT MANAGEMENT

A clear understanding of project team responsibilities and project schedule are essential to the timely and efficient completion of any sampling program. Maintaining open lines of communication between all parties is equally important, particularly for the completion of this potentially problematic sampling and analysis program. The following sections describe project personnel responsibilities, the project schedule, and procedures for notification to the USEPA Region II.

PROJECT TEAM RESPONSIBILITIES

The project will be overseen by the TEIC Designated Coordinator and will be implemented by qualified representatives of Soil Tech and Geraghty & Miller. Specific project team responsibilities are as follows:

Tutu Environmental Investigation Committee

The designated coordinator (Ana Gloria Ramos) is responsible for overseeing the implementation of the Administrative Order and will make all final decisions regarding technical matters. The designated coordinator will act as the primary communicator for the respondents and their technical consultants with the USEPA and will review and approve all documents prior to submission.

Soil Tech

The project coordinator (Jose C. Agrelot) is responsible for the overall technical adequacy of the sampling and the performance of the sampling in conformance with the scope of work.

The sampling team leader (Alberto Barrera) is responsible for coordination of each sampling event, management of field activities, conformance of sampling activities, and conformance of sampling activities with the scope of work.

The health and safety officer (Alberto Barrera) is responsible for implementing the specific health and safety directives detailed in the HASP. The HASP (Appendix B) has been prepared to address several tasks that will be performed in a future site investigation. For the purposes of the SAMP field work refer to Task 4: Evacuation and Sampling of Wells in Appendix B.

The sampling field team (Fernando Zavala and Alberto Barrera) are responsible for implementating sampling activities in accordance with the scope of work.

The project electrician (Guillermo Gonzalez) is responsible for determining safe usage of well pumps and for making adjustments to existing systems, where applicable, for sampling activities.

The project officer (Daniel Nachman) is responsible for the overall technical adequacy of the SAMP and conformance with the scope of work.

The project manager (Thomas V. Danahy) is responsible for coordinating the sampling, analysis, and data validation functions of the project and for overseeing preparation of the quarterly reports.

The project QA/QC manager (Juan Garcia) is responsible for providing independent review of project documents and reports.

The data validator (Cameron S. Dunnan) is responsible for reviewing the laboratory data for compliance with the quality objectives and for preparing the data validation findings.

PROJECT SCHEDULE

Three sampling events have been implemented at the Tutu Wells Site from September 1990 to June 1991 in accordance with the original SAMP (Geraghty & Miller, Inc. 1990). Data validation and report preparation were performed prior to each subsequent sampling event.

Due to slow laboratory turnaround, data validation and final report preparation has previously required approximately 3 months to complete. Geraghty & Miller and Enseco will attempt to limit this process to no more than 2 months.

This revised SAMP will become effective with the fourth sampling event which is scheduled to begin October 1, 1991. The fifth sampling event is tentatively scheduled for the week of February 10, 1991.

The analytical data will be reviewed after each sampling event to determine the appropriateness of reductions of sampling frequency or complete determination of sampling activities. If sampling reduction or termination of sampling certain wells is warranted, such a proposal will be submitted to the USEPA for approval. If any two successive sampling events indicate that constituents of concern are not detected at concentrations above the detection limit, a proposal to terminate sampling will be submitted to the USEPA for approval.

The results of each sampling event will be available for data validation approximately 4 to 5 weeks after the samples are received by the laboratory. The analytical results will be submitted to the USEPA Region II within 4 to 6 weeks after the receipt of all of the laboratory data.

NOTIFICATION TO USEPA

The designated coordinator will notify the USEPA Region II of all on-site activities to be performed at least 15 days in advance. Any significant deviations in the work plan will be communicated to the USEPA Region II verbally and in writing within 5 days.

REFERENCES

Geraghty & Miller, Inc. 1990. Sampling, Analysis, and Monitoring Plan for Wells, Tutu Wells Site, St. Thomas,, U.S. Virgin Islands. Prepared for Tutu Environmental Investigation Committee, September 1990.

Geraghty & Miller, Inc. 1991a. First Sampling Report, September 1990, Tutu Wells Site, St. Thomas, U.S. Virgin Islands. Prepared for Tutu Environmental Investigation Committee, January 1991.

Geraghty & Miller, Inc. 1991b. Second Sampling Report, February 1991, Tutu Wells Site, St. Thomas, U.S. Virgin Islands. Prepared for Tutu Environmental Investigation Committee, May 13, 1991.

Geraghty & Miller, Inc. 1991c. Third Sampling Report, June 1991, Tutu Wells Site, St. Thomas, U.S. Virgin Islands. Prepared for Tutu Environmental Investigation Committee, September 1991.

USEPA 1988. Methods for the Determination of Organic Compounds in Drinking Water, Revision 3.0. EPA-600/4-88/039, as Modified by the Methodology Described in Appendix A.

USEPA 1990a. USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Concentration, Revision December 1990 and February 1991. USEPA Contract Laboratory Program, Washington, D.C.

USEPA 1990b. USEPA Contract Laboratory Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration. USEPA Contract Laboratory Program, Washington, D.C.

TABLES

Table 1. Summary of Proposed Sampling and Analysis Effort, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, US Virgin Islands.

Matrix	Number of (a) Residential Well Samples	Field Replicate Samples	Equipment (b) Blank Samples	Trip (c) Blank Samples	Water (d) Blank Samples	Total (e) Samples	Test Parameters (f)
Ground Water	25	2	3		1	35	TCL VOCs (Modified EPA Method 524.2 (g)), TCL semivolatiles and pesticides, TAL metals and cyanide.
				4		4	TCL VOCs (Modified EPA Method 524.2) (g).
Total	25	2	3	4	1	39	

VOC Volatile Organic Compounds
TCL Target Compound List.
TAL Target Analyte List.

(a) One matrix spike/matrix spike duplicate (MS/MSD) will be analyzed for organics for every 20 ground-water samples analyzed for organics. One duplicate and one spike sample will be analyzed for metals and cyanide for every 20 ground-water samples analyzed for metals and cyanide.

(b) One equipment blank sample will be collected on every day that sampling occurs for which sampling equipment is used. Accordingly, the number listed is an estimate. Equipment blank samples will be analyzed for every parameter analyzed for in ground-water samples on that day.

(c) One trip blank sample will be submitted for laboratory analysis on every day that sampling occurs. Accordingly, the number listed is an estimate.

(d) One blank sample of the water to be used for equipment blanks and decontamination will be analyzed each quarter. The water blank sample will be analyzed for every parameter analyzed for that quarter.

(e) The total number of samples is an estimate because the number of blank samples is estimated.

(f) Sampling and analysis will be performed as summarized in this table on an annual basis. For the three remaining quarterly sampling events each year, samples will be analyzed for VOCs (using EPA Method 524.2), and for other TCL or TAL analyte groups if such compounds occur above the detection limit. However, if other TCL or TAL concentrations above the detection limit do not pass data validation criteria or if there is reason to suspect that blank or laboratory contamination or matrix interferences have caused the detection of these constituents in the samples, then those samples will not be analyzed for the other TCL or TAL analyte groups in the three remaining quarterly sampling events each year.

(g) EPA Method 524.2 analysis will be modified in accordance with the methodology described in Appendix A.

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Table 2. Project Analyte List and Contract Required Quantitation Limits, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

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

ug/L Micrograms per liter.

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

PR00801/tab2

Table 2. Project Analyte List and Contract Required Quantitation Limits, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Island.

	Target Compound List	CAS Number	Quantitation Limits* Water (ug/L)
SEMIVOLATILES			
1.	Phenol	108-95-2	10
2.	bis (2-Chloroethyl) ether	11-44-4	10
3.	2-Chlorophenol	95-57-8	10
4.	1,3-Dichlorobenzene	541-73-1	10
5.	1,4-Dichlorobenzene	106-46-7	10
6.	Benzyl alcohol	100-51-6	10
7.	1,2-Dichlorobenzene	95-50-1	10
8.	2-Methylphenol	95-48-7	10
9.	2,2-Oxybis(1-chloropropoane)	108-60-1	10
10.	4-Methylphenol	106-44-5	10
11.	N-Nitroso-di-n-dipropylamine	621-64-7	10
12.	Hexachloroethane	67-72-1	10
13.	Nitrobenzene	98-95-3	10
14.	Isophorone	78-59-1	10
15.	2-Nitrophenol	88-75-5	10
16.	2,4-Dimethylphenol	105-67-9	10
17.	Benzoic acid	65-85-0	50
18.	bis (2-Chloroethoxy) methane	111-91-1	10
19.	2-4-Dichlorophenol	120-83-2	10
20.	1,2,4-Trichlorobenzene	120-82-1	10
21.	Naphthalene	91-20-3	10
22.	4-Chloroaniline	106-47-8	10
23.	Hexachlorobutadiene	87-68-3	10
24.	4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10
25.	2-Methylnaphthalene	91-57-6	10
26.	Hexachlorocyclopentadiene	77-47-4	10
27.	2,4,6-Trichlorophenol	88-06-2	10
28.	2,4,5-Trichlorophenol	95-95-4	50
29.	2-Chloronaphthalene	91-58-7	10
30.	2-Nitroaniline	88-74-4	50
31.	Dimethylphthalate	131-11-3	10
32.	Acenaphthylene	208-96-8	10
33.	2,6-Dinitrotoluene	606-20-2	10
34.	3-Nitroaniline	99-09-2	50
35.	Acenaphthene	83-32-9	10
36.	2,4-Dinitrophenol	51-28-5	50
37.	4-Nitrophenol	100-02-7	50
38.	Dibenzofuran	132-64-9	10
39.	2,4-Dinitrotoluene	121-14-2	10
40.	Diethylphthalate	84-66-2	10
41.	4-Chlorophenyl-phenyl ether	7005-72-3	10
42.	Fluorene	86-73-7	10
43.	4-Nitroaniline	100-01-6	50
44.	4,6-Dinitro-2-methylphenol	534-52-1	50
45.	N-Nitrosodiphenylamine	86-30-6	10
46.	4-Bromophenyl-phenylether	101-55-3	10

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

Table 2. Project Analyte List and Contract Required Quantitation Limits, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

Target Compound List	CAS Number	Quantitation Limits* Water (ug/L)
SEMIVOLATILES (Continued)		
47. Hexachlorobenzene	118-74-1	10
48. Pentachlorophenol	87-86-5	50
49. Phenanthrene	85-01-8	10
50 Carbazole	86-74-8	10
51. Anthracene	120-12-7	10
52. Di-n-butylphthalate	84-74-2	10
53. Fluoranthene	206-44-0	10
54. Pyrene	129-00-0	10
55. Butylbenzylphthalate	85-68-7	10
56. 3,3-Dichlorobenzidine	91-94-1	20
57. Benzo(a)anthracene	56-55-3	10
58. Chrysene	218-01-9	10
59. bis(2-Ethylhexyl)phthalate	117-81-7	10
60. Di-n-octylphthalate	117-84-0	10
61. Benzo(b)fluoranthene	205-99-2	10
62. Benzo(k)fluoranthene	207-08-9	10
63. Benzo(a)pyrene	50-32-8	10
64. Indeno(1,2,3-cd)pyrene	193-39-5	10
65. Dibenz(a,h)antracene	53-70-3	10
66. Benzo(g,h,i)perylene	191-24-2	10

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

#PR00801/Tab2b

Table 2. Project Analyte List and Contract Required Quantitation Limits, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

	Target Compound List	CAS Number	Quantitation Limits* Water (ug/L)
PESTICIDES			
1.	alpha-BHC	319-84-6	0.05
2.	beta-BHC	319-85-7	0.05
3.	delta-BHC	319-86-8	0.05
4.	gamma-BHC (Lindane)	58-89-9	0.05
5.	Heptachlor	76-44-8	0.05
6.	Aldrin	309-00-2	0.05
7.	Heptachlor epoxide	1024-57-3	0.05
8.	Endosulfan I	959-98-8	0.05
9.	Dieldrin	60-57-1	0.10
10.	4,4'-DDE	72-55-9	0.10
11.	Endrin	72-20-8	0.10
12.	Endosulfan II	33213-65-9	0.10
13.	4,4-DDD	72-54-8	0.10
14.	Endosulfan sulfate	1031-07-8	0.10
15.	4,4'-DDT	50-29-3	0.10
16.	Methoxychlor	72-43-5	0.5
17.	Endrin ketone	53494-70-5	0.10
18	Endrin Aldehyde	7421-36-3	0.10
19.	alpha-Chlordane	5103-71-9	0.5
20.	gamma-Chlordane	5103-74-2	0.5
21.	Toxaphene	8001-35-2	1.0

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

#PR00801/tab2con

Table 2. Project Analyte List and Contract Required Quantitation Limits, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

	Target Analyte List	Contract Required* Detection Limit Water (ug/L)
1.	Aluminum	200
2.	Antimony	60
3.	Arsenic	10
4.	Barium	200
5.	Beryllium	5
6.	Cadmium	5
7.	Calcium	5000
8.	Chromium	10
9.	Cobalt	50
10.	Copper	25
11.	Iron	100
12.	Lead	3
13.	Magnesium	5000
14.	Manganese	15
15.	Mercury	0.2
16.	Nickel	40
17.	Potassium	5000
18.	Selenium	5
19.	Silver	10
20.	Sodium	5000
21.	Thallium	10
22.	Vanadium	50
23.	Zinc	20
24.	Cyanide	10

* 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 organics analysis, March 1990, Exhibit E.
The detection limits for samples may be considerably higher depending on the sample matrix.

#PR00801/tab2c

Table 3. Precision, Accuracy, and Completeness Objectives, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

Fraction	Matrix Spike Compound/Element	Water*		Completeness
		% R	% RPD	
VOA	1,1-Dichlorethene	61-145	14	100%
VOA	Trichlorethene	71-120	14	100%
VOA	Chlorobenzene	75-130	13	100%
VOA	Toluene	76-125	13	100%
VOA	Benzene	76-127	11	100%
SV-BN	1,2,4-Trichlorobenzene	39-98	28	100%
SV-BN	Acenaphthene	46-118	31	100%
SV-BN	2,4-Dinitrotoluene	24-96	38	100%
SV-BN	Pyrene	26-127	31	100%
SV-BN	N-Nitroso-di-n-propylamine	41-116	38	100%
SV-BN	1,4-Dichlorobenzene	36-97	28	100%
SV-A	Pentachlorophenol	9-103	50	100%
SV-A	Phenol	12-110	42	100%
SV-A	2-Chlorophenol	27-123	40	100%
SV-A	4-Chloro-3-methylphenol	23-97	42	100%
SV-A	4-Nitrophenol	10-80	50	100%
Pest.	Lindane	56-123	15	100%
Pest.	Heptachlor	40-131	20	100%
Pest.	Aldrin	40-120	22	100%
Pest.	Dieldrin	52-126	18	100%
Pest.	Endrin	56-121	21	100%
Pest.	4,4'-DDT	38-127	27	100%
CN	CN	75-125	20	100%

VOA Volatile Organic Analysis.
SV-BN Semivolatile Base-Neutral Extractables.
SV-A Semivolatile Acid Extractables.
Pest. Pesticides.
* These limits are for advisory purposes only (as noted in CLP SOW 3/90).
% R Percent Recovery.
% RPD Relative Percent Difference.

#PR00801/TAB3.WK1

Table 4. Requirements for Sample Containers, Preservation, and Holding Times, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

Test Parameter	Number of Containers Per Sample	Container	Preservation	Maximum Holding Time
Volatile Organic Compounds	2 (c)	40–Milliliter glass with Teflon–lined septum and open–hole caps	Cool to 4 degrees C 1:1 HC1 to pH<2	14 days from time of sampling. (a)
Semivolatile Organic Compounds and Pesticides	4 (c)	1–liter glass, amber with teflon–lined cap	Cool to 4 degrees C	7 days from time of sampling to extraction; 40 days after extraction.
Metals	1 (d)	1–liter polyethylene with polyethylene cap	Cool to 4 degrees C HNO to pH<2	180 days from time of sampling. (b)
Cyanide	1 (d)	1–liter polyethylene with polyethylene cap	Cool to 4 degrees C NaOH to pH >12	14 days from time of sampling.

NA Not applicable; will be tested in the field immediately upon sample retrieval using field instruments.
(a) If sample acidification causes effervescence, the sample will not be acidified but will be cooled to 4 degrees C. In this event, the holding time is 7 days from the time of sampling.
(b) For mercury, the holding time is 28 days from the time of sampling.
(c) Triple volume will be collected for matrix spike/matrix spike duplicate (MS/MSD) analysis for organics.
(d) Double volume will be collected for matrix spike/matrix duplicate (MS/MD) analysis for inorganics.

#PR[illegible]TAB4.WK1

Table 5. Summary of Analytical Methods, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

Test Parameter	Method Reference	Method Description
TCL Volatile Organic Compounds	Modified 524.2 (a)	Purge and trap, gas chromatography/mass spectrometry.
TCL Semivolatile Organic Compounds	CLP SOW, 3/90 (b)	Solvent extraction, gas chromatography/mass spectrometry.
TCL Pesticides	CLP SOW, 3/90 (b)	Solvent extraction, gas chromatography/electron capture detection.
TAL Metals	CLP SOW, 3/90 (c)	Inductively coupled plasma/graphite furnace atomic absorption spectrophotometry/ manual cold vapor method.
Cyanide	CLP SOW, 3/90 (c)	Manual distillation/manual spectrophotometric determination.
Temperature, pH, Specific Conductance	N/A	Tested in the field immediately upon sample retrieval using field instruments.

TCL Target Compound List.
TAL Target Analyte List.
NA Not applicable.

(a) USEPA 1988. Methods for the Determination of Organic Compounds in Drinking Water, Revision 3.0. EPA –600/4–88/039, as modified by the methodology described in Appendix A.

(b) USEPA 1990a. USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi–Media, Multi–Concentration, Revision December 1990 and February 1991. USEPA Contract Laboratory Program, Washington, DC.

) USEPA, 1990b. USEPA Contract Laboratory Statement of Work for Inorganic Analysis, Multi–Media, Multi–Concentration. USEPA Contract Laboratory Program, Washington, DC.

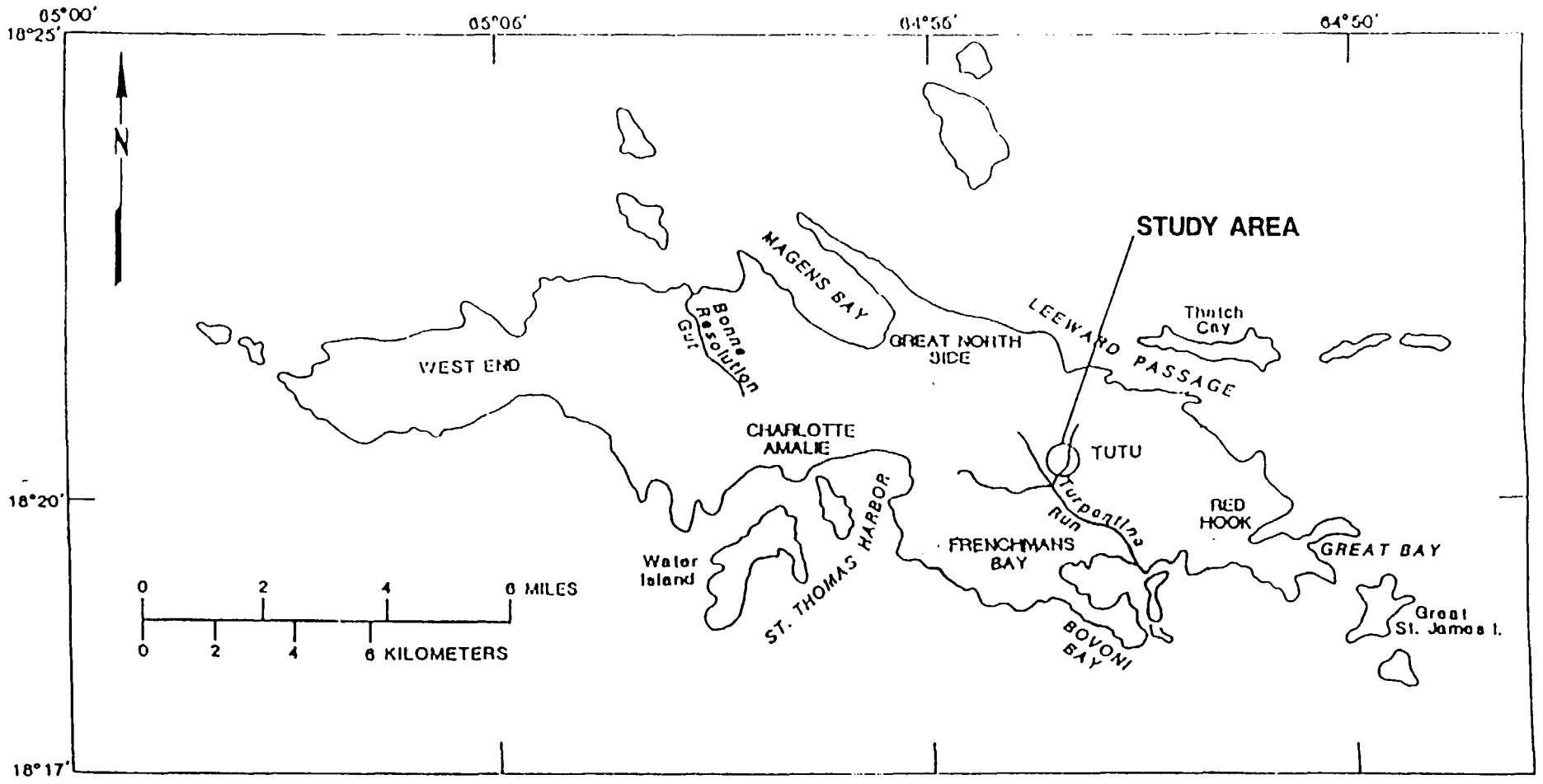
Table 6. Surrogate Spike Control Limits*, Tutu Wells Site Sampling, Analysis, and Monitoring Plan, St. Thomas, U.S. Virgin Islands.

Fraction	Surrogate Compound	Water % R
VOA	d4–1,2–Dichloroethane	76–114
VOA	4–Bromofluorobenzene	86–115
VOA	d8–Toluene	88–110
SV–BN	d5–Nitrobenzene	35–114
SV–BN	d4–1,2–Dichlorobenzene	20–130**
SV–BN	d14–Terphenyl	33–141
SV–BN	2–Fluorobiphenyl	43–116
SV–A	d4–2–Chlorophenol	20–130**
SV–A	2–Flurophenol	21–110
SV–A	2,4,6–Tribromophenol	10–123
SV–A	d6–Phenol	10–94
Pest.	Tetrachloro–m–xylene	60–150**
Pest.	Decachlorobiphenyl	60–150**

* From CLP SOW dated 3/90.
** Laboratory optional surrogate only; no action limits at this time.
VOA Volatile Organic Analysis.
SV–BN Semivolatile Base–Neutral Extractables.
SV–A Semivolatile Acid Extractables.
Pest. Pesticides.
% R Percent Recovery.

#PR00801/TAB6.WK1

FIGURES



SUBJECT

STUDY AREA,

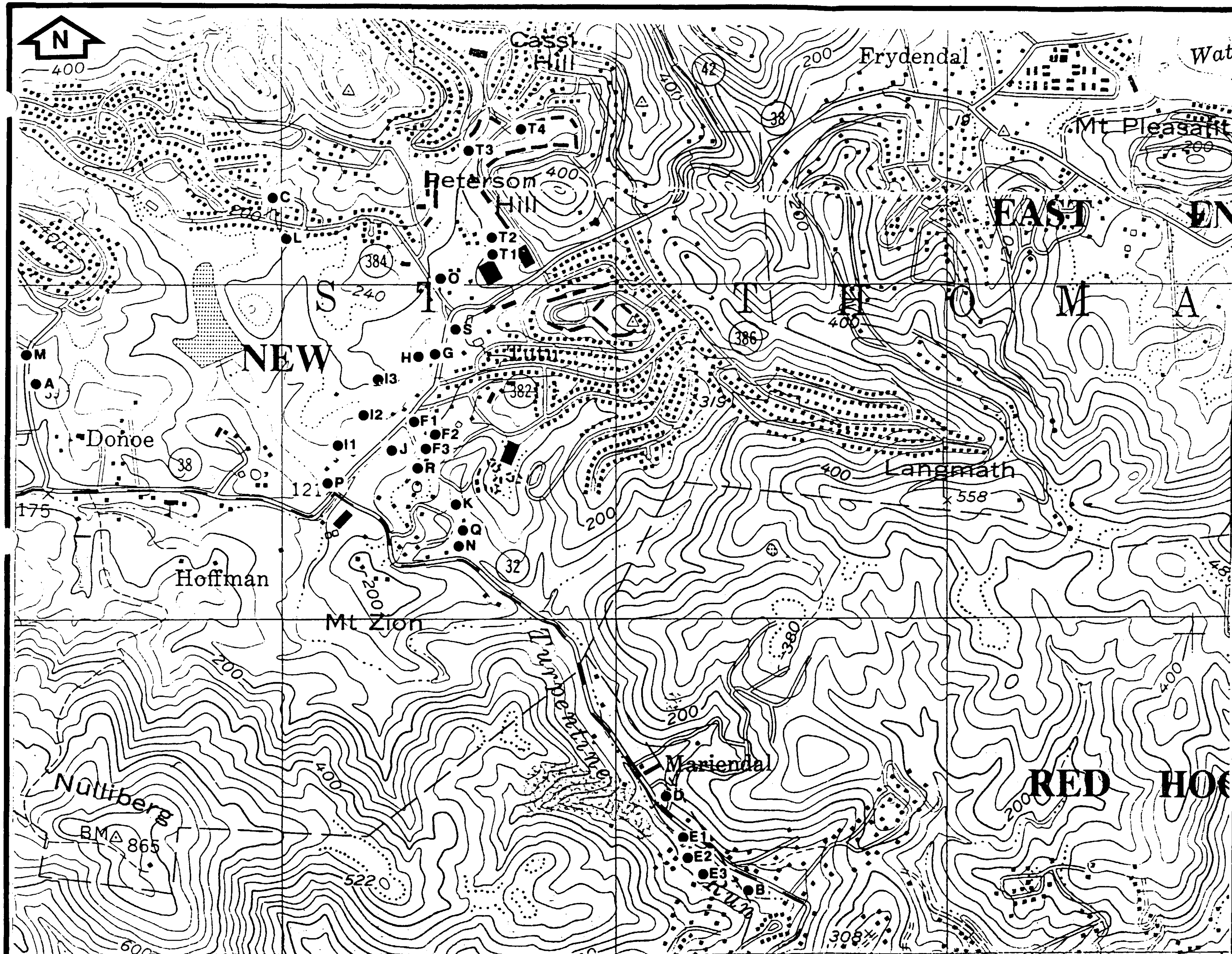
TUTU WELLS SITE SAMPLING, ANALYSIS, AND MONITORING PLAN,

ST. THOMAS, U.S. VIRGIN ISLANDS

PREPARED FOR

TEIC

Geraghty & Miller, Inc.	COMPILED BY: DANAHY PREPARED BY: CALDERON PROJECT MGR: DANAHY	SCALE: SHOWN DATE: 9/91	FIGURE: 1



0 1000 2000 3000

SCALE FEET

SOURCE: USGS QUADRANGLE EASTERN ST.THOMAS,V.I.(1954)

LEGEND

●	RESIDENTIAL WELL
A	BRYAN
B	DEDE
C	DEMITRI
D	DENCH
E1	DEVCON I
E2	DEVCON II (ALTERNATE)
E3	DEVCON III
F1	EGLIN I
F2	EGLIN II
F3	EGLIN III
G	FOUR WINDS I
H	FOUR WINDS II
I1	GASSETT
I2	HARTMAN II
I3	HARTMAN III
J	HARVEY
K	LaPLACE
L	LEONARD
M	LOCKHART (ALTERNATE)
N	MATTHIAS
O	RAMSEY
P	RODRIGUES
Q	SMITH
R	STEELE
S	TILLETT
T1	VIHA I
T2	VIHA II (ALTERNATE)
T3	VIHA III
T4	VIHA IV (ALTERNATE)

SUBJECT

WELL SAMPLING LOCATIONS, TUTU WELLS SITE SAMPLING ANALYSIS, AND MONITORING PLAN, ST. THOMAS, U.S. VIRGIN ISLANDS

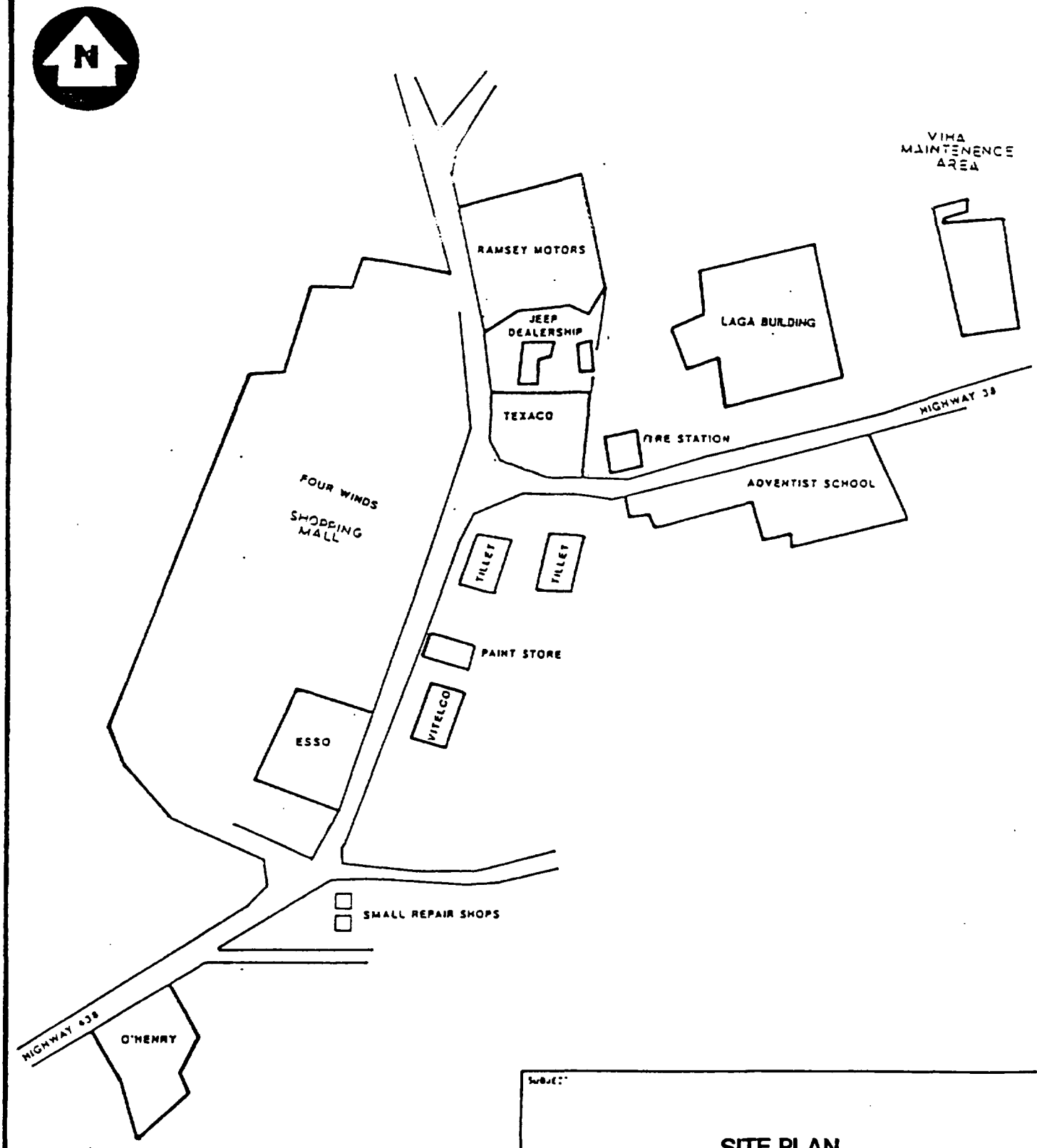
PREPARED FOR

TEIC

Geraghty & Miller, Inc.

COMPILED BY DA
PREPARED BY PA
PROJECT MGR DA

TUT 002 0729



SUBJECT:

SITE PLAN
TUTU WELLS SITE SAMPLING, ANALYSIS, AND MONITORING PLAN, ST. THOMAS, U.S. VIRGIN ISLANDS

PREPARED FOR

T TUT 002 0730

Geraghty & Miller, Inc.	COMPILED BY: DANAHY	SCALE: SHOWN	FIGURE: 3
	PREPARED BY: PADULA	DATE: 9/91	
	PROJECT MGR: DANAHY		

Enseco
A Corning Company

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	INORGANICS METALS PREP	INORGANICS WET CHEM	INORGANICS WET CHEM
		ALKALINITY_____	AMMONIA(NH_3)_____
	METALS_____	ACIDITY_____	*NITRATE(NO_3)_____
VO***_____	CORROS_____	*BOD_____	*NITRITE(NO_2)_____
DAI_____	IGNIT/FLASH_____	CHLORIDE_____	NO_3-NO_2_____
ABN_____	REACT CN/S_____	*RES.CHLORINE_____	TON**_____
HERBICIDES_____	EPTOX METS_____	COD_____	TKN_____
PEST/PCB_____	EPTOX ORG_____	*COLOR/ODOR_____	*pH_____
TPHC-IR_____	TCLPV_____	CONDUCTIVITY_____	PHENOL_____
FINGERPR._____	TCLPC_____	*Cr^{+6}_____	SULFATE(SO_4)_____
OIL/GREASE_____	TCLPM_____	TOT.CYANIDE_____	*SULFITE(SO_3)_____
		*DISS.O_2_____	SULFIDE(SO_2)_____
		*FECAL COLIFORM_____	*SET.SOLIDS_____
		FLUORIDE_____	TS_____
COMPOSITING_____		*MBAS_____	TSS_____
RADIOLOGICAL_____		*ORTHO PHOS_____	TDS_____
% WATER_____		TOTAL PHOS_____	TOC_____
OTHER_____			TOX_____
			*TOTAL COLIFORM_____
			*TURBIDITY_____

*** Sample aliquots for volatile organic analysis are stored in the GC/MS refrigerat
**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

TUT 002 0731

GERAGHTY & MILLER, INC. Environmental Services

ENSECO INCORPORATED INTERNAL CHAIN OF CUSTODY

FIGURE 4

SAMPLE CUSTODY

PROJECT NO.	SAMPLE NUMBERS	STORAGE LOCATION	BOTTLE CODE	ANALYSIS INITIAL	TO LAB DATE / TIME	S.CONTROL INITIAL	RETURN DATE / TIME	S.CONTRO INITIAL

TUT 002 0752

GERAGHTY & MILLER, INC.
Environmental Services

ENSECO INCORPORATED
SAMPLE CUSTODY FORM

FIGURE
5

APPENDIX A

ADDITIONAL QUALITY CONTROL REQUIREMENTS FOR METHOD 524.2 ANALYSIS

APPENDIX A

ADDITIONAL QUALITY CONTROL REQUIREMENTS FOR METHOD 524.2 ANALYSIS

1. The parameter list for this site is the TCL. All method requirements must be followed for these compounds.

2. All samples and reanalyses are to be analyzed within holding times (i.e., 7 days from date of collection if sample is unpreserved; 14 days from date from collection when sample is preserved).

3. Sample batch is 20 samples maximum.

4. Detection limit determination must be performed for all analytes prior to start of sample collection. The lab must use the Method Detection Limit (MDL) determination procedures stated in Section 10.3 of Method 524.2. All results must be provided to Geraghty & Miller's Rochelle Park, New Jersey office. Include the following for each analyte: concentration spiked into blank water, concentrations obtained for each seven or more replicates, standard deviation, mean concentration of replicates, and the student t value used in the calculation. This information must enable the reviewer to regenerate the laboratory's calculations of the detection limit.

5. A five point initial calibration must be performed preceding sample analysis. It has been shown that the following five concentrations often yield results which meet the suggested QC criteria: 4, 10, 20, 30, and 40 ug/l. The lab may use these or may extend their calibration range, however, all QC criteria must be adhered to for each analyte. Previously, trichloroethene was detected in site samples up to 1500 parts per billion (ppb).

6. The continuing calibration standard must be analyzed prior to sample analysis and once per 12 hours in order to verify a valid initial calibration. The absolute areas of the quantitation

ions of the internal standard and surrogates must not have decreased more than 30% from the areas measured in the most recent continuing calibration check, or by more that 50% from the areas measured during the initial calibration (per Section 9.3.4 of Method 524.2). The response factor (RF) for each analyte and surrogate in the continuing calibration check must be within 30% of the mean value measured in the initial calibration (per Section 9.3.5 of Method 524.2). If this criteria is exceeded for the parameters of concern at the Tutu site, a new calibration must be performed. The parameters of concern at the Tutu site include trichloroethene, tetrachloroethene, dichloroethene, vinyl chloride, benzene, toluene, ethyl benzene and xylenes. Cadmium is also a parameter of concern in the Eglin well samples.

7. A laboratory fortified blank at a concentration of 1 ug/l for each analyte must be analyzed immediately following each continuing calibration. The accuracy for this standard must be between 80% - 120% recovery. (Exception for methylene chloride, acetone, 2-butanone and 2-hexanone, the accuracy must be between 50 - 150%). If this accuracy cannot be achieved, the problem must be located and corrected, then the instrument must be recalibrated prior to sample analysis.

8. The Mass Spectrometer (MS) tune, using bromofluorobenzene (BFB), must be verified at the beginning of each 12 hour period of analysis and all samples must be injected within this 12 hour period.

9. A lab method blank must be analyzed prior to the samples. The lab method blank must be shown to be free of contamination. Failure to obtain method blank values less than 1 ug/l requires that all samples prepared with that method blank be reprepared and reanalyzed for the affected parameters. Exceptions for blank values for methylene chloride (less than 2 ug/L), and ketones (less than 5 ug/L) will be allowed.

10. All samples, blanks, duplicates, and calibration standards must be spiked with the three surrogates and three internal standard compounds stated in Organic Low Medium (OLM) 01

(3/90 CLP SOW) at the specified concentrations. Reanalysis is required if one or more percent recoveries (%RS) as stated in the OLM 01 (3/90 CLP SOW) are exceeded.

11. The primary and secondary ions listed in the OLM 01 (3/90 CLP SOW) for organics must be used for identification of the TCL parameters not listed in Method 524.2.

12. A laboratory generated mass spectrum must be provided for all compounds detected above and below the detection limit.

13. All calibration and analytical procedures given in Method 524.2 whether presented as optional or required, must be followed unless stated otherwise in this Appendix.

14. Up to ten volatile organic compounds (not on the TCL) of greatest apparent concentration shall be tentatively identified via a forward search of the NBS mass spectral library as described in the OLM 01 (3/90 CLP SOW) for organics. Only tentatively identified compounds (TICs) with a peak area >40% of the nearest internal standard are to be reported.

15. If the USEPA Regional Project Manager (RPM) requests the Monitoring and Management Branch (MMB) to audit a certain percentage of the data validation effort of Geraghty & Miller, and EPA-CLP type deliverables package must be made available to the MWB. This will also include a detailed example calculation that clearly demonstrates the manner in which the final results were derived. Where applicable, each component of the calculation must be explained (eg. if the calculation includes a dilution factor, it must be clear how and why each dilution occurred). The laboratory must supply any and all information required to reproduce, during an EPA data validation, all results reported.

APPENDIX B

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN
TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

September, 1991

Prepared for

Tutu Environmental Investigation Committee

Prepared by

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

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HEALTH AND SAFETY PLAN
TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

INTRODUCTION

This Health and Safety Plan (HASP) has been prepared by Geraghty & Miller, Inc. for the Tutu Service Station Investigation to be conducted by the Tutu Environmental Investigation Committee (TEIC) at Anna's Retreat, St. Thomas, U.S. Virgin Islands (USVI). TEIC is comprised of representatives of Texaco Caribbean Inc. (Texaco) and Esso Virgin Islands, Inc. (Esso). The Tutu Service Station Investigation will be performed in accordance with the scope of work detailed in the Tutu Service Station Investigation Work Plan, St. Thomas, USVI (Geraghty & Miller 1991a).

The HASP has been prepared for the purpose of providing protocols that will minimize the potential for exposure to chemical constituents and for accidental injury to workers during investigatory activities. Anyone else such as responding parties', contractors, subcontractors, clients and visitors should review and adhere to this HASP. Copies of the HASP will always be onsite. All workers entering the site must first review the HASP and sign the Health and Safety Review Form (Figure 1).

BACKGROUND

The Tutu site is located in the upper Turpentine Run basin in east central St. Thomas. Various commercial establishments line the major roads in the area. These establishments include the Texaco Tutu service station at the intersection of Highways 38 and 384 and the Esso Tutu service station on Highway 38 (Figure 2). Private homes and multi-family housing, such as the Virgin Islands Housing Authority (VIHA) buildings, generally occupy the less heavily traveled roads. Both the Texaco Tutu service station and the Esso Tutu service station are retail outlets for gasoline and private mechanical servicing of automobiles. Additionally, the Texaco Tutu service station sells diesel fuel.

A brief reconnaissance of the area, performed by Geraghty & Miller in September 1990, revealed that there are other establishments which represent potential sources of constituents of concern to soil and ground water. These establishments include but may not be limited to the following:

- A Jeep dealership and repair shop.
- The Ramsey Motor dealership and repair shop.
- The LAGA building, which formerly housed a textile processing operation.
- Tillett Garden, where silk screening and pottery manufacturing and glazing are performed.
- O'Henry dry cleaners.
- The paint store.
- The Fire Station.
- The Vitelco facility.
- Other small repair shops located on Highway 38.
- The sanitary/storm sewer line(s).

The locations of these establishments, with the exception of the sanitary/storm sewer line(s), are shown on Figure 3.

Sampling and laboratory analysis of residential and commercial wells in the area by the U.S. Environmental Protection Agency (USEPA) Technical Assistance Team (TAT) in 1987 and 1988 indicated the presence of some volatile organic compounds (VOCs) in ground water. In September 1990, February 1991, and June 1991, sampling and analysis of supply wells in the Tutu area was conducted by Geraghty & Miller and Soil Tech in accordance with a USEPA-approved work plan (Geraghty & Miller 1991b; 1991c; 1991d).

BASIS FOR HEALTH AND SAFETY DIRECTIVES

INVESTIGATION TASKS

The objectives of the Tutu Service Station Investigation are to delineate the potential sources, the horizontal and vertical extent, and potential migration pathways of petroleum hydrocarbon products in soil and ground water in the vicinity of Route 38 within the Tutu Wells Site. The USEPA is also concerned about chlorinated hydrocarbon compounds (i.e., tetrachloroethene and its breakdown products) which have been detected in ground water in the Tutu area (Geraghty & Miller 1991b; 1991c; 1991d). To assist the USEPA in evaluating the Tutu area, the TEIC has agreed to install deep monitoring wells (i.e., screened below the water table) and analyze all soil and ground-water samples for target compound list (TCL) volatile organic compounds (VOCs), which include petroleum hydrocarbon constituents and chlorinated hydrocarbons. To achieve this, the following tasks will be performed as a part of the investigation:

Task 1: Soil sampling of borings and monitoring wells.
Task 2: Performance of borehole geophysical surveys.
Task 3: Well installation and development of monitoring wells.
Task 4: Evacuation and sampling of monitoring wells.
Task 5: Performance of a pumping test.
Task 6: Free product investigation.
Task 7: Potential free product recovery.

A detailed discussion of these tasks are presented in the Work Plan (Geraghty & Miller 1991a).

POTENTIAL HAZARDS EVALUATION

Physical hazards which may be encountered during the investigation include those associated with (1) the operation of drilling rigs (2) the proximity of motor vehicle traffic and (3) heat stress.

Potential chemical hazards may occur as a result of contact with site constituents of concern. The following exposure pathways have been identified:

- Dermal contact with ground water, cuttings, and soils, or with equipment which has been in contact with those media.
- Inhalation of vapors associated with constituents of concern.
- Ingestion of ground water or soil which contains constituents of concern.

Constituents of concern which have been detected in site ground water and soil vapor are provided in Table 1. The time-weighted average (TWA) Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs) for each constituent are shown in Table 2.

AIR MONITORING

Air monitoring will be conducted during each field activity to ensure that the crew is adequately protected from potential chemical hazards. A photoionization detector (PID), such as an HNu will be used to detect volatile organic compounds (VOCs) in air in the parts per million (ppm) range. The HNu will be calibrated on a daily basis and all calibration records will be kept on site. If high humidity interferes with the sensitivity of the PID, a flame-ionization detector (FID) equipped organic vapor analyzer (OVA) will be used instead. An OVA will be kept onsite as a back-up for the HNu. To confirm the presence of specific compounds, Draeger tubes and a portable gas chromatograph (GC) will be used. An explosimeter will also be available to detect the presence of flammable/explosive gas.

HNU CALIBRATION PROCEDURES

An HNu Systems Model 81-HW101-100 or Model PI-101 photoionization detector with 10.2 electron-volt lamp will be used on a semi-continuous basis to monitor the breathing zone of workers during drilling and sampling activities.

The instrument will be calibrated every day prior to initiating activities. The calibration gas will consist of a mixture of isobutylene and air. The calibration procedure is as follows:

- A battery check will be performed to ensure that there is sufficient charge in the battery.
- The function switch will be turned to the "standby" position. The "zero adjustment" knob will then be adjusted so that the instrument reading is 0 parts per million (ppm).
- Fit the tip of the HNu 8-inch extension probe into the tubing from the calibration gas container.
- Open the valve of the calibration gas container until there is a slight flow of gas.
- Adjust the span on the HNu so that the instrument reading is the same as the calibration gas concentration.
- If the adjusted span setting is below the manufacturer's recommendations, appropriate maintenance will be performed.

Each time the instrument is calibrated the following information will be recorded: serial number of the instrument, time and date, span setting, instrument response, weather conditions, and the name of the person who performed the calibration.

OVA CALIBRATION PROCEDURES

High humidity may cause reduced sensitivity of the HNu due to condensation of water vapor on the ultraviolet lamp. Exposure of the HNu to abrupt changes in temperature or humidity should be avoided to minimize the effect of condensation. Due to convenient operational handling, the HNu is the preferred field instrument. However, if reduced sensitivity is suspected (i.e., poor detection of known VOC sources or low span setting required for calibration) then the OVA should be utilized. An OVA unit and calibration gas will be kept onsite at all times as an alternative air monitoring device. The OVA will be calibrated as follows:

- Open the "H2Tank Valve" and check the reading on the "H@ Tank Pressure" indicator. Approximately 150 psi of pressure is needed for each hour of operation.

- Open the "H2 Supply Valve" approximately 1/2 to 1 turn and check the reading on the "H2 Supply Pressure" indicator. The reading should be about 10 PSI

- Electronic bias adjustments should be made in accordance with the manufacturer's instructions.

- Leave CALIBRATE switch on X10 position and use CALIBRATE ADJUST (zero) knob to adjust meter reading to 4 ppm.

- Place CALIBRATE switch in X1 position and, using trimpot R-31 on circuit board, adjust meter reading to 4 ppm. (See Figure 4-1).

- Move CALIBRATE switch to X10 position again . Use CALIBRATE ADJUST (zero) knob to adjust meter to a reading of 40 ppm.

- Move CALIBRATE switch to X100 position and use trimpot R-33 on circuit board to adjust meter reading to 40 ppm.

- Move CALIBRATE switch to X10 position and use CALIBRATE ADJUST (zero) knob to adjust meter reading to zero.

- Unit is now balanced from range to range, calibrated to methane, and ready to be placed in normal service.

- Depress the ignitor button and listen for the "pop" as the hydrogen ignites.

- Introduce a methane sample of known concentration and adjust trimpot R-32 on the circuit board so that the meter reads equivalent to the known sample./

- The OVA is now ready for use.

- The OVA will be calibrated every day before use.

- The calibration gas will consist of a mixture of methane and air.

- The battery power will be checked.

- Move the "Instr" switch to the on position and allow five minutes for warm up.

- o Turn the "pump" switch to the on position.
- o Move the "Calibrate: switch to 10X.
- o Adjust the "Calibrate Adjust" knob so that the instrument meter reading is zero.
- o Place the instrument in an upright position and check the "sample Flow Rate" indicator. Indication should be approximately 2 units.

ACTION LEVEL

Based on the existing site history and the maximum level of contaminants detected in ground-water samples, the following action level has been established for upgrading the level of protection for the workers. For each individual task, a PID will be available to determine the presence of VOCs. An action level of 1 ppm above background for a sustained period of five minutes in the worker's breathing zone has been chosen based on the presence of benzene and vinyl chloride. The workers breathing zone will be sampled and analyzed for benzene and vinyl chloride using Draeger tubes. If the Draeger tubes confirm the presence of either benzene or vinyl chloride exceeding 1 ppm, work will be temporarily stopped and continued air monitoring will be performed. If the VOCs are vented and the air monitoring readings are below the action level, work will resume. However, if the levels continue to exceed 1 ppm above background, the level of personal protective equipment (PPE) will be upgraded to Level C.

While in Level C protection, if HNu readings exceed 10 ppm above background regular monitoring with Draeger tubes for vinyl chloride will be performed. If the level of vinyl chloride in the breathing zone exceeds 10 ppm, work will stop until the VOCs are vented. Work will resume when the levels fall to less than 10 ppm of vinyl chloride. If total volatile readings exceed 50 ppm for a sustained period exceeding 5 minutes, then workers

in Level C will stop work and allow the VOCs to vent. Work will resume once total VOCs fall below 50 ppm and vinyl chloride values are below 10 ppm.

An action level for flammable/explosive gases will also be used. If the reading on an explosimeter shows 10% lower explosive limit (LEL), the area will be continuously monitored with an explosimeter. If the reading shows 20% LEL, work will stop and the work area will be evacuated.

LEVELS OF PROTECTION

The anticipated level of personnel protection is discussed for each task to be performed. A description of the personal protective equipment is provided in the next section.

Task 1 - Soil Sampling of Borings and Monitoring Wells

Level D protection has been selected for this task, based on the current knowledge of contaminant levels. However, if air monitoring results exceed the action level, then the level of protection will be upgraded to level C.

Task 2 - Performance of Borehole Geophysical Surveys

Level D protection has been selected for this task based on current knowledge of contaminant levels and the fact that this task will cause minimal disturbance to the ground water. However, if the air monitoring indicates that the action level has been exceeded, then the level of personal protective equipment (PPE) will be upgraded to level C.

Task 3 - Well Installation and Development of Monitoring Wells

Level D protection has been chosen for this task. If, however, the air monitoring results indicate elevated levels of VOC's above 1 ppm for a sustained period of 5 minutes in the breathing zone, then the level of protection will be upgraded to level C with chemical resistant suits. If air monitoring indicates a decrease of VOCs below the action level, the level of protection may be downgraded to level D.

Task 4 - Evacuation and Sampling of Monitoring Wells

This task will be done in level D of protection, accompanied by air monitoring using a photoionization detector (PID) such as a HNu. If the action level is exceeded, the level of protection will be upgraded to level C.

Task 5 - Performance of a Pumping Test

Level D has been chosen for this task which will be upgraded to level C whenever the air monitoring indicates that the action level of 1 ppm has been exceeded.

Task 6 - Free Product Investigation

Level D will be primarily used accompanied by semi-continuous air monitoring if the air monitoring results exceed the set action levels of 1 ppm, the level of protection will be upgraded to level C with a full-face air-purifying respirator and organic vapor cartridges in combination with a particulate filter.

Task 7 - Potential Free Production Recovery

This task will be done in level D of personal protective clothing. However, this will be upgraded to level C if the air monitoring shows that the set action level has been exceeded.

PERSONAL PROTECTIVE EQUIPMENT

Level D and Level C protection are described below.

Level D Protection

A basic modified Level D work uniform will be worn by all personnel working in on-site areas. This work uniform will consist of the following clothing:

- o Hard hat
- o Steel-toed and shanked boots (rubber boots or leather workboots)
- o Work gloves (when handling site media)
- o Disposable coveralls (woven Tyvek) for protection of work clothes are optional
- o Safety glasses, goggles, or face shield (optional)
- o Disposable ear plugs, noise reduction rating (NRR) of 35 decibels (optional)

If there is potential for dermal contact, personnel will wear the following clothing:

- o Disposable coveralls (woven or chemical-resistant Tyvek suits) taped at the ankles
- o Inner vinyl gloves and/or outer neoprene or nitrile gloves taped at wrists (when sampling or handling potentially contaminated materials)

Level C Protection

- o Chemical resistant (Saran or PVC-coated) Tyvek suits taped at the ankles
- o Inner vinyl gloves and outer nitrile gloves taped at the wrists
- o Hard hat
- o Steel-toed and shanked chemical resistant boots (rubber boots or rubber boots over leather workboots)
- o Full-face respirator with organic vapor cartridges
- o Safety glasses, goggles, or face shield (optional)

The following rules apply to respiratory protection:

- o Respiratory protection will be in compliance with OSHA, 29 CFR 1910.134.

- o Only properly cleaned, maintained, National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA)-approved, positive pressure full-face respirators will be used onsite.

- o Air-purifying cartridges will be replaced daily at a minimum; immediately upon any signs of breakthrough (odors, physical effects, etc.) or at the Site Safety Officer's direction.

- o No employee shall be assigned to tasks requiring Level C protection, if based upon the health examination, the physician has determined that the employee will be unable to function normally wearing a respirator or that the safety or health of the employee may be compromised.

RESPONSIBILITIES

Proper implementation of the HASP and the prevention of injury and exposure of site workers depends upon participation of all project workers. Open communication between site workers, supervisors and managers regarding health and safety issues is essential to the plan.

A definition of the responsibilities of the project team with respect to health and safety issues is provided below.

The Project Health and Safety Officer is responsible for the technical coordination of the health and safety program including medical and training program requirements, hazard assessments, air monitoring, personal protective equipment, and field implementation. The Project Health and Safety Officer will interact with the Project Manager and the Site Safety Officer concerning any changes in the site characterization and HASP requirements.

The Site Safety Officer is responsible for the daily supervision and monitoring of field activities to ensure that all work is performed in accordance with the HASP protocols. The Site Safety Officer reports directly to the Project Health and Safety Officer and will refer all safety-related questions to him. The Site Safety Officer will notify the Project Health and Safety Officer and the Project Manager as soon as possible after any exposure incidents, accidents or emergencies.

The Field Team Members are responsible for implementing the HASP under the supervision of the Site Safety Officer.

The Project Manager is responsible for ensuring that all project workers abide by the requirements set forth in the HASP. The Project Manager will discuss any changes in the site characterization and health and safety plan requirements with the Project Health and Safety Officer and the Site Safety Officer.

WORK ZONES AND SITE CONTROL

EXCLUSION ZONES

Exclusion zones are defined as areas where the potential exists for worker exposure to contaminated materials. Exclusion zones will be designated by the Site Safety Officer based on the guidelines in this plan. Movement into and out of these zones will be controlled. Personnel entering or working within these zones will wear the designated protective equipment and perform environmental monitoring. Personnel and equipment exiting these zones will be decontaminated in accordance with the procedures described in this plan.

All personnel working on-site areas outside of the Support Area will be required to wear a basic modified Level D work uniform. Exclusion Zones within which additional protective clothing and/or environmental monitoring may be required include a minimum of 20 feet around all drilling and sampling activities.

CONTAMINATION REDUCTION ZONES

Contamination reduction zones will be delineated by the Site Safety Officer for personnel and equipment. Decontamination of personnel and equipment will be performed in these zones. Personnel will wear appropriate Level D clothing while decontaminating equipment. Movement into and out of these zones will be controlled.

THE SUPPORT AREA

The support area is considered a clean area where no special protective gear is required. The support area will be delineated in an area considered to be free of contamination.

Access to controlled work areas shall be limited to authorized persons. Visitors must present proper identification and certification of training, and comply with all aspects of the HASP when in these areas.

GENERAL WORK PRACTICES

GENERAL WORK RULES

General work rules to be employed on-site are as follows:

- Field work will be conducted only during daylight hours unless adequate lighting is provided.

- No eating, drinking, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material, will be allowed in Exclusion or Contamination Reduction Zones. Smoking materials (matches, lighters) and other ignition sources will be forbidden in these zones.

- Contact lenses will not be worn in Exclusion or Contamination Reduction Zones. All field personnel requiring corrective lenses must provide their own prescription glasses and lenses which may be fitted into the respirator masks.

- No jewelry which interferes with protective clothing fit or respirator seals will be worn.

- No beards, sideburns, or mustaches will be allowed which interfere with respirator mask seals. The Site Safety Officer will determine if facial hair presents an interference. Respirator mask seals will be checked by positive and negative pressure tests by each wearer each time it is used.

- Frequent and regular inspections of the site, materials, and equipment used during the field investigation will be conducted by the Site Safety Officer. Machinery, tools, material, and equipment and work practices that are judged unsafe, or not in compliance with OSHA or other applicable standards shall be removed or replaced or the work practices corrected. Equipment and machinery will only be operated by employees qualified by training and/or experience. (Figure 8, Field Audit Checklist)

- Containers will be moved with the proper equipment and will be secured to prevent dripping or loss of control during transport.

- Personnel will avoid contact with potentially contaminated substances. Walking through puddles or mud, kneeling on the ground, etc., will be avoided whenever possible.

- The buddy system, wherein personnel will maintain contact will be observed at all times in the Exclusion Zones. A uniform hand signal to be used by all personnel in the event of an emergency will be instituted.

- Field personnel will monitor each other for signs of chemical exposure. Indications of adverse affects include the following:

  Changes in complexion and skin discoloration.
  Changes in coordination.
  Changes in demeanor.
  Excessive salivation and pupillary response.
  Changes in speech pattern.

- Field personnel will be cautioned to inform each other and the Site Safety Officer if adverse affects are felt. These affects may include the following:

Headaches
Dizziness
Nausea
Blurred vision
Cramps
Irritation of eyes, skin, or respiratory tract

- Health and safety related aspects of the field activities will be documented. The documentation will include any instances of potential chemical exposure, and also the lack thereof.

DRILLING OPERATIONS

Practices to be employed in connection with drilling operations are as follows:

- Before drilling, the existence of underground utilities must be investigated and the location of any pipelines, electric lines, etc. must be determined. The appropriate utility companies will be contacted. Prior to the start of drilling, the Utilities And Structures Checklist shown on Figure 4, will be completed.

- Drilling will not be performed in any areas where overhead power lines or telephone lines may present a hazard.

- No drilling activities will be permitted during periods of thunderstorms and lightning.

- Ambient air quality in the breathing zone around the drilling rig will be monitored continuously during all drilling activities.

- o Workers will be constantly alert to the potential presence of obstructions during drilling operations. If an obstruction is encountered, work will stop immediately and the Project Manager and Project Health and Safety Officer will be notified.

DECONTAMINATION PROCEDURES

EQUIPMENT

Decontamination of large equipment (drill rigs and associated equipment) will be performed at a specified cleaning station. Cleaning will consist of soap and water wash and potable water rinse using a steam cleaning unit. Any parts of the rig which are encrusted with dirt and mud or are suspected of having been splashed with materials at a sampling station (test boring) will be washed prior to moving to the next borehole location. Drill rigs will be fully decontaminated prior to and between borings at each new boring location. Drill rigs will be fully decontaminated prior to leaving the site.

All reusable non-dedicated sampling equipment (spatulas, trowels, core barrel sampler, bailers, split spoons) will be decontaminated in accordance with the protocols specified in the Work Plan, initially, between each use for sampling, and prior to leaving the site.

The required decontamination procedure for all sampling equipment is:

a. Wash and scrub with low phosphate detergent.
b. Tap water rinse.
c. Rinse with 10% $HN0_3$ ultrapure.
d. Tap water rinse.
e. An acetone only rinse or a methanol followed by hexane rinse (solvents must be pesticide grade or better).

f. Thorough rinse with deionized demonstrated analyte free water.

g. Allow to air dry.

h. Wrap in aluminum foil for transport.

PERSONNEL

Personnel decontamination stations will be set up as appropriate at the edge of the Exclusion Zones and/or the Support Area. The procedure is as follows:

1. Place equipment and/or samples in designated area;
2. Wash boots using detergent solution; followed by a potable water rinse;
3. Wash and rinse outer gloves as above and remove;
4. Remove disposable coveralls (if used) and place in proper container;
5. Remove hard hat and respirator (if used) and store in appropriate place.
6. Removal disposable inner gloves (if used) and place in proper container;
7. Wash hands and face with water and hand soap.

Respirators will be washed daily after use in warm water and mild detergent and sanitized in accordance with manufacturer instructions. They will be inspected regularly for cracks and dents, and stored in a clean plastic bag.

Personnel will shower as soon as possible after leaving the site at the end of the work day.

SAMPLE CONTAINERS

The exterior of the sample containers will be decontaminated by immersing in the bottle up to the neck in a detergent solution followed by a potable or distilled water rinse. Solvents will not be used to wash sample containers.

EMERGENCY RESPONSE PLAN

The Site Safety Officer will inform all field personnel of emergency and evacuation procedures. The route to the hospital and written directions are provided on Figure 5. Prior the start of field activities, the route to the hospital will be driven by the Site Safety Officer.

All personnel will be aware of the location of the nearest accessible telephone before beginning work activities. Local and nationwide emergency numbers are listed on Table 3. The phone list will be provided to all field personnel and posted, if practicable, next to the telephone.

The Site Safety Officer will designate a safety station where first aid and contingency equipment will be kept and will inform all field personnel of the location of this station. The following first aid and contingency equipment will be available:

- o First aid kit
- o American National Red Cross First Aid Handbook
- o Type A, B, and C fire extinguishers
- o Potable water

Additionally, an eyewash station will be available within 10 feet of each Exclusion Zone and Contamination Reduction Zone.

In the event of an injury requiring treatment, the person will be taken to the hospital. In an emergency, first aid will be given and the ambulance company and hospital will be called immediately. Medical and paramedical organizations (i.e., hospital, ambulance service, police and fire departments) will be notified in advance that the project is to begin.

Any injuries or accidents will be thoroughly documented on the appropriate form. A sample Injury Report and Vehicle Accident Report Form are provided on Figures 6 and 7, respectively. The following people will be notified as soon as possible in the event of a personnel exposure incident, accident or emergency:

Project Health and Safety Officer	Alberto Colberg	(809) 725-6735
Site Safety Officer	Ruben Ponciano	(809) 725-6735
Project Manager	Thomas V. Danahy	(201) 909-0700
Project Coordinator	Jose C. Agrelot	(809) 792-8900
Designated Coordinator	Ana Gloria Ramos	(809) 792-2920
Project Officer	Daniel A. Nachman	(201) 909-0700

HEALTH MONITORING AND FIELD PROTOCOLS

HEALTH MONITORING PROGRAM

Geraghty & Miller and Soil Tech participate in a Health Monitoring Program with occupational health specialists. Geraghty & Miller and Soil Tech employees receive yearly physicals consisting of the following:

- Personal, family and environmental history
- Hands-on physical examination
- Snellen's eye examination
- Hearing test
- Respirator clearance (EKG and pulmonary function) for those involved in Levels C and B work

MOTOR VEHICLE HAZARDS

Motor vehicle traffic poses a potential hazard to site workers, particularly at some of the boring and well locations situated in the service station lots and parking lots. At these locations, orange traffic cones will be placed around the work area to mitigate the potential hazard.

HEAT STRESS

Heat stress may be of concern depending upon the ambient temperature and humidity. The task being performed, and the level of personal protection in use also influence the degree of heat stress imposed upon workers. Symptoms of heat stress include the following, in order of increasing seriousness:

- Heat rash
- Heat cramps (muscle spasms; pain in the hands, feet and abdomen)
- Heat exhaustion (pale, cool, moist skin; heavy sweating; dizziness)
- Heat stroke (red, hot, dry skin; lack of perspiration; nausea; dizziness and confusion; strong rapid pulse; coma)

Heat stroke can result in serious injury or death; immediate action must be taken cool down a worker exhibiting these symptoms.

The following measures should be implemented to prevent heat stress if conditions warrant:

- Provide adequate liquids to replace lost body fluids and electrolytes lost from perspiration. Replacement fluids can be a 0.1 percent saltwater solution, commercial mixes such as Gatorade or Quick Kick, or a combination of these and fresh water. Encourage workers to drink more than thirst requires.

- Establish a work regimen that will provide adequate rest and cooling down periods. This may require adjusting work schedules, and/or rotating personnel.

- Take breaks in an air conditioned (preferably) or a shaded rest area. Remove all impermeable protective garments during rest periods.

- Inform all personnel of the importance of adequate rest, acclimatization, and proper diet.

- In temperatures above 70°F, personnel using Level C will be monitored via heart rate and oral temperature at rest periods. If the heart rate exceeds 110 beats per minute or oral temperature is above 99.6°F, subsequent work periods are shortened by one-third. Repeat if necessary once only or remove from work site for rest and medical attention. Do not allow personnel to work in protective coveralls if oral temperature exceeds 100.6°F.

TRAINING

BASIC TRAINING

Geraghty & Miller and Soil Tech employees attend a 40-hour health and safety training course and refresher training which satisfies the training requirements of OSHA, 29 CFR 1910.120. Subcontractors will be required to provide documentation stating that their employees have been trained in accordance with OSHA requirements.

SITE-SPECIFIC TRAINING

Prior to starting the field activities, all (Geraghty & Miller, Soil Tech, and subcontractor) personnel will attend an onsite training session by the Site Safety Officer. The topics of this session will include the following:

- o Reading and understanding the HASP
- o Site history
- o Constituents of concern
- o Hazard recognition
- o Environmental monitoring procedures
- o Personnel and equipment decontamination
- o Emergency procedures
- o Respirator use
- o First aid
- o Heat stress

TAILGATE SAFETY MEETINGS

The Site Safety Officer will hold daily tailgate safety meetings. Attendance by the field team members and subcontractor personnel working onsite that day will be mandatory. Health and safety concerns and procedures specific to that day's tasks will be discussed and questions answered. A Tailgate Safety Meeting record shown on Figure 8, will be completed daily.

TVD:gv
#PR01301/H&SPLAN

REFERENCES

Geraghty & Miller, Inc. 1991a. Tutu Service Station Investigation Work Plan. Prepared for the Tutu Environmental Investigation Committee, May 29, 1991.

_____. 1991b. First Sampling Report, September 1990, Tutu Wells Site Quarterly Sampling, St. Thomas, U.S. Virgin Islands. Prepared for the Tutu Environmental Investigation Committee, January 1991.

_____. 1991c. Second Sampling Report, February 1991, Tutu Wells Site Quarterly Sampling, St. Thomas, U.S. Virgin Islands. Prepared for the Tutu Environmental Investigation Committee, May 13, 1991.

_____. 1991d. Third Sampling Report, June 1991, Tutu Wells Site Quarterly Sampling, St. Thomas, U.S. Virgin Islands. Prepared for the Tutu Environmental Investigation Committee, September 1991.

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TABLES

Table 1. Maximum Concentrations of Previously Detected VOCs, Tutu Service Station Investigation, Health and Safety Plan, St. Thomas, U.S. Virgin Islands.*

Ground Water	Concentrations (PPB)
1,2-Dichloroethene	280
Trichloroethene	72
Tetrachloroethene	1500
Benzene	32
Vinyl Chloride	17
Toluene	44
Acetone	22
1,1,2-Trichloroethane	5
Air	
Total Volatile Organic Compounds (PID reading during evacuation of Tillett Well 2/6/91)	24 PPM

* Based upon Geraghty & Miller (1991b; 1991c;1991d) sampling reports.
PPB Parts per billion.
PPM Parts per million.
PID Photoionization detector.

Table 2. Current Occupational Airborne Contaminants Standards and Guidelines, Tutu Service Station Investigation, Health and Safety Plan, St. Thomas, U.S. Virgin Islands.

	ACGIH		OSHA	
	TLV - TWA	TLV - STEL	PEL	STEL
1,2 Dichloroethene	200	-	200	-
Trichloroethene	50	200	50	200
Tetrachloroethene	50	200	25	-
Benzene$_{A2}$	10	-	1	-
Vinyl Chloride$_{A1}$	5	-	1	-
Toluene	100	150	100	150
Acetone	750	1,000	750	1,000
1,1,2 - Trichloroethane (Skin)	10	-	10	-

All values are in parts per million (ppm).

ACGIH	American Conference of Governmental Industrial Hygienists, 1990-91.
OSHA	Occupational Safety and Health Administration, 1989.
TLV	Threshold Limit Value.
PEL	Permissible Exposure Limit.
TWA	8 Hour Time Weighted Average.
STEL	15 Minute Short Term Exposure Limit.
A1	Confirmed Human Carcinogen.
A2	Suspected Human Carcinogen.
-	Level not established.

Skin - This notation refers to the potential contribution to the overall exposure by the cutaneous route including mucous membrane and eye, either by airborne or by direct contact with the substance.

Table 3. Emergency Telephone Numbers, Tutu Service Station Investigation, Health and Safety Plan, St. Thomas, U.S. Virgin Islands.

Fire Department	(809) 921
Ambulance	(809) 922
Hospital	(809) 776-8311
Police Department	(809) 915
USEPA Caribbean Field Office	(809) 729-6951
USVI Department of Planning and Natural Resources	(809) 774-3320

#PR01301/TAB7.WK1

FIGURES

FIGURE 1

HEALTH AND SAFETY REVIEW FORM
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS

GERAGHTY & MILLER, INC.
Environmental Services

PROJECT NUMBER: _____

HEALTH AND SAFETY REVIEW FORM

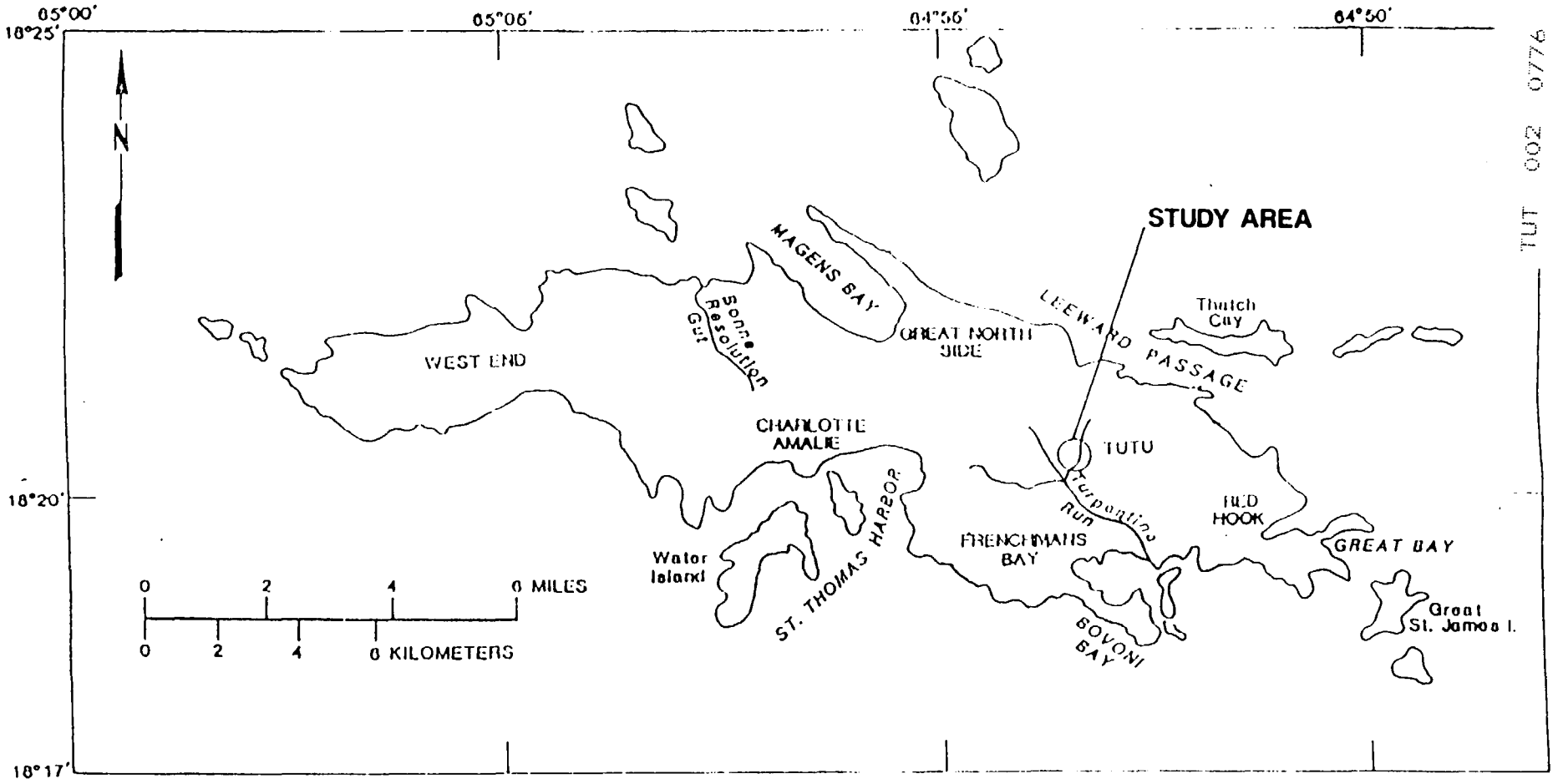
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS

I acknowledge that I have reviewed the above Health and Safety Plan (HASP). I understand the levels of personal protection that may be required by the HASP and I agree to the follow the requirements of the HASP.

NAME (Please Print)	COMPANY	SIGNATURE	DATE

FIGURE 2

TURPENTINE RUN BASIN
TUTU SERVICE STATION INVESTIGAITON
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS



TURPENTINE RUN BASIN
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN.
ST. THOMAS,U.S. VIRGIN ISLANDS

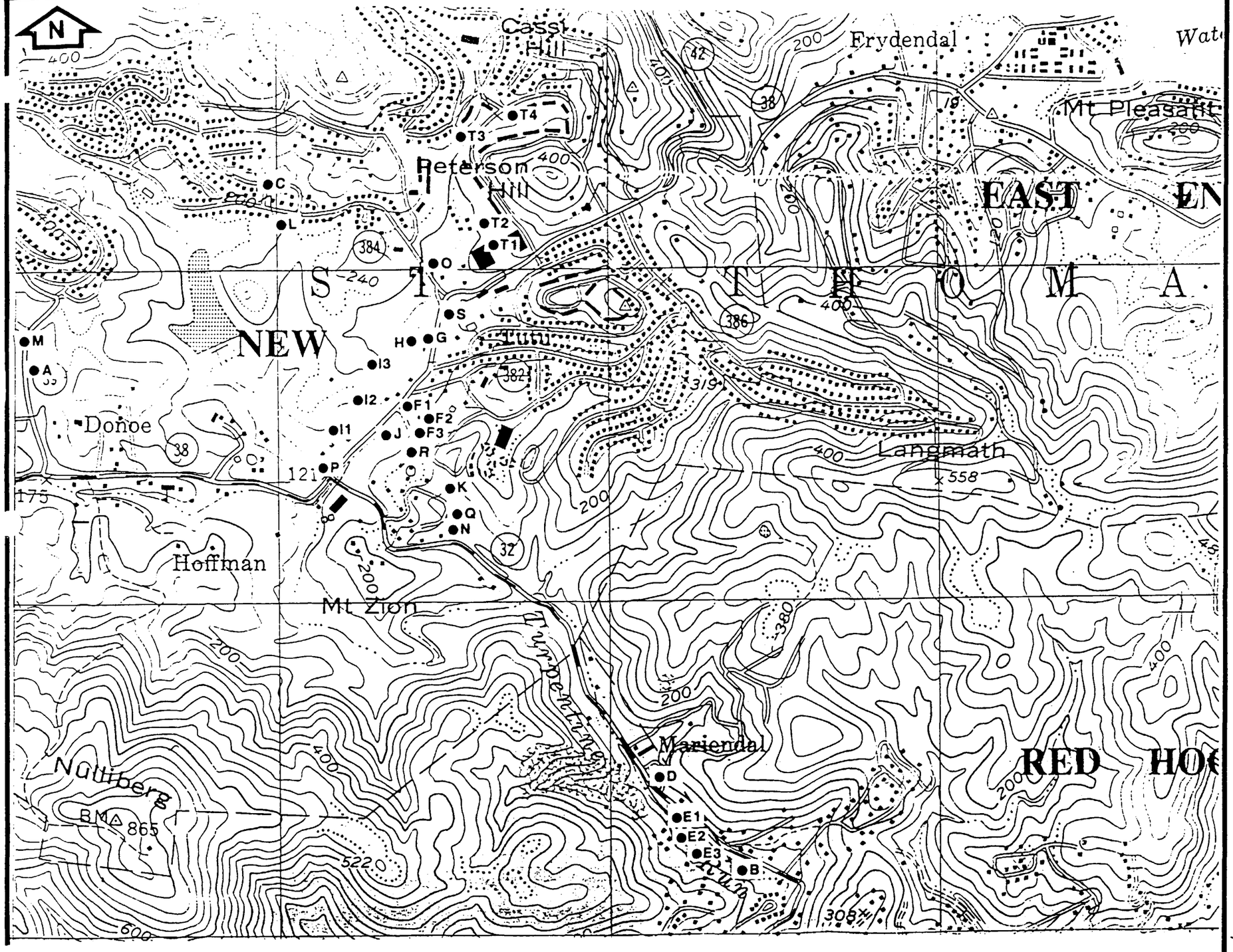
PREPARED FOR

TEIC

Geraghty & Miller, Inc.	COMPILED BY NACHMAN PREPARED BY MESSINGER PROJECT MGR FINDLAY	SCALE SHOWN DATE 2/90	FIGURE 2

FIGURE 3

SITE PLAN
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS



SOURCE: USGS QUADRANGLE EASTERN ST.THOMAS,V.I.(1954)

LEGEND

●	RESIDENTIAL WELL
A	BRYAN
B	DEDE
C	DEMITRI
D	DENCH
E1	DEVCON I
E2	DEVCON II (ALTERNATE)
E3	DEVCON III
F1	EGLIN I
F2	EGLIN II
F3	EGLIN III
G	FOUR WINDS I
H	FOUR WINDS II
I1	GASSETT
I2	HARTMAN II (CRUSHER)
I3	HARTMAN III (ESTATE)
J	HARVEY
K	LaPLACE
L	LEONARD
M	LOCKHART (ALTERNATE)
N	MATTHIAS
O	RAMSEY
P	RODRIGUES
Q	SMITH
R	STEELE
S	TILLETT
T1	VIHA I
T2	VIHA II (ALTERNATE)
T3	VIHA III
T4	VIHA IV (ALTERNATE)

SUBJECT

SITE PLAN

TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN,
ST. THOMAS, U. S. VIRGIN ISLANDS

PREPARED FOR

TEIC

Geraghty & Miller, Inc.

COMPILED BY | PREPARED BY | PROJECT MGR | SCALE | FIGURE

TUT 002 0778

FIGURE 4

UTILITIES AND STRUCTURES CHECKLIST
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS.

GERAGHTY & MILLER, INC.
Environmental Services

UTILITIES AND STRUCTURES CHECKLIST

Project: _____ Prepared by: _____

Location: _____ Date: _____

Instructions. This checklist has to be completed by a G&M staff member as a safety measure to insure that all underground utility lines, other underground structures as well as above-ground power lines are clearly marked out in the area selected for boring or excavation. **DRILLING OR EXCAVATION WORK MAY NOT PROCEED UNTIL LINES ARE MARKED AND THIS CHECKLIST HAS BEEN COMPLETED.** Arrangements for underground utility markouts are best made at the time of the preliminary site visit to allow client and/or utility company sufficient time. Keep completed checklist and maps onsite; send copy to Project Manager.

Assignment of Responsibility. Client is responsible for having underground utilities and structures located and marked. Preferably, the utilities themselves should mark out the lines.

Drilling or Excavation Sites. Attach a map of the property showing the proposed drilling or excavation site (or if sites are widely separated, several maps) clearly indicating the area(s) checked for underground utilities or underground structures and the location of above-ground power lines.

Utilities and Structures

Type	Not Present	Present	How Marked?[1]
Petroleum products line			
Natural gas line			
Steam line			
Water line			
Sewer line			
Storm drain			
Telephone cable			
Electric power line			
Product tank			
Septic tank/drain field			
Overhead power line			

1) Flags, paint on pavement, wooden stakes, etc.

Name and affiliation of person who marked out underground lines or structures.

_____ NAME _____ ORGANIZATION _____ PHONE

Emergency Procedures

Persons at site or facility to contact in case of emergency

1. _____ Phone _____

2. _____ Phone _____

Fire Dept.: Phone _____ Ambulance: Phone _____

Utility: Phone _____ Utility: Phone _____

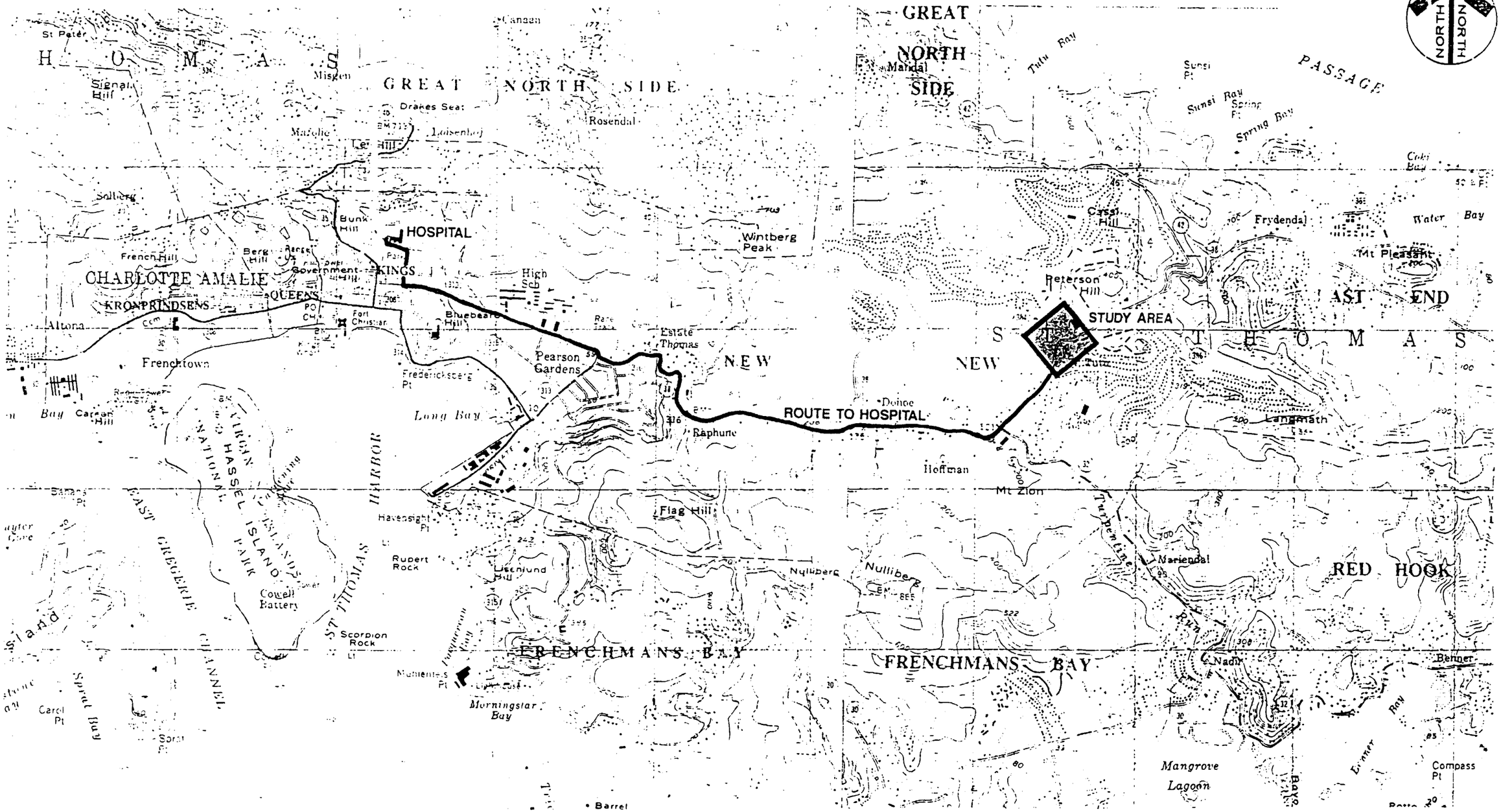
Utility: Phone _____ Utility: Phone _____

Directions to nearest hospital (describe or attach map).

FIGURE 5

ROUTE TO HOSPITAL
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS

DRAFTER: PADULA
VGR.: DANAHY
COMPILER: DANAHY
CAD FILE: NON-CAD
FILE NO.:
PROJCT. NO.: PR00801
DATE: MAY91



GERAGHTY & MILLER, INC.
Environmental Services

ROUTE TO HOSPITAL
TUTU SERVICE STATION INVESTIGATION HEALTH AND SAFETY PLAN, ST. THOMAS, U. S. VIRGIN ISLANDS

PREPARED FOR: TUTU ENVIRONMENTAL INVESTIGATION COMMITTEE

FIGURE 5

FIGURE 6

INJURY REPORT FORM
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS

Bureau of Labor Statistics
Supplementary Record of
Occupational Injuries and Illnesses

U.S. Department of Labor

This form is required by Public Law 91-596 and must be kept in the establishment for 5 years. Failure to maintain can result in the issuance of citations and assessment of penalties.

Case or File No

Form Approved
O M B No 1220 0029

Employer

1. Name

2. Mail address *(No. and street, city or town, State, and zip code)*

3. Location, if different from mail address

Injured or Ill Employee

4. Name *(First, middle, and last)* | Social Security No

5. Home address *(No. and street, city or town, State, and zip code)*

6. Age | 7. Sex *(Check one)* Male ☐ Female ☐

8. Occupation *(Enter regular job title, not the specific activity he was performing at time of injury.)*

9. Department *(Enter name of department or division in which the injured person is regularly employed, even though he may have been temporarily working in another department at the time of injury.)*

The Accident or Exposure to Occupational Illness

If accident or exposure occurred on employer's premises, give address of plant or establishment in which it occurred. Do not indicate department or division within the plant or establishment. If accident occurred outside employer's premises at an identifiable address, give that address. If it occurred on a public highway or at any other place which cannot be identified by number and street, please provide place references locating the place of injury as accurately as possible.

10. Place of accident or exposure *(No. and street, city or town, State, and zip code)*

11. Was place of accident or exposure on employer's premises? Yes ☐ No ☐

12. What was the employee doing when injured? *(Be specific. If he was using tools or equipment or handling material, name them and tell what he was doing with them.)*

13. How did the accident occur? *(Describe fully the events which resulted in the injury or occupational illness. Tell what happened and how it happened. Name any objects or substances involved and tell how they were involved. Give full details on all factors which led or contributed to the accident. Use separate sheet for additional space.)*

Occupational Injury or Occupational Illness

14. Describe the injury or illness in detail and indicate the part of body affected *(E.g., amputation of right index finger at second joint, fracture of rib, lead poisoning, dermatitis of left hand, etc.)*

15. Name the object or substance which directly injured the employee *(For example, the machine or thing he struck against or which struck him, the vapor or poison he inhaled or swallowed, the chemical or radiation which irritated his skin, or in cases of strains, hernias, etc., the thing he was lifting, pulling, etc.)*

16. Date of injury or initial diagnosis of occupational illness | 17. Did employee die? *(Check one)* Yes ☐ No ☐

Other

18. Name and address of physician

19. If hospitalized, name and address of hospital

Date of report | Prepared by | Official position

OSHA No. 101 (Feb. 1981)

TUT 002 0784

FIGURE 7

VEHICLE ACCIDENT REPORT FORM
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS.

Figure 7. Vehicle Accident Report Form

Tutu Service Station Investigation Health and Safety Plan,

St. Thomas, USVI

Date Claim Submitted _____ Agent _____

VEHICLE OPERATOR _____ Drivers License No. _____
Phone No. _____ S.S. No. _____
Address _____ City _____
Employer _____ Facility _____
DESCRIBE VEHICLE DAMAGE: _____

Vehicle No. _____ Year _____ Make _____ Model _____ Plate No. _____
OTHER PARTIES' NAME: _____
Address _____
Phone No. _____ Drivers License No. _____ S.S. No. _____
OWNER'S NAME: (Check if same as driver ___) _____
Address _____ City _____
Phone No. _____
OWNER'S INSURANCE CARRIER: _____ Policy No. _____
Address _____ City _____
DESCRIBE VEHICLE DAMAGE: _____

Plate No. _____ Year _____ Make _____ Model _____

INJURED PARTIES

(A Supervisor's Injury Report Form must be completed if a GLM employee is involved.)

1. Name _____ Phone No. _____
   Address _____ City _____
   Employer's Name & Address _____
2. Name _____ Phone No. _____
   Address _____ City _____
   Employer's Name & Address _____

WITNESSES:

1. Name _____ Phone No. _____
   Address _____ City _____
   Employer's Name & Address _____
2. Name _____ Phone No. _____
   Address _____ City _____
   Employer's Name & Address _____

DESCRIPTION OF ACCIDENT: DATE: ___/___/___ TIME: _____

_____
_____
_____ (continue on reverse side)
_____

LOCATION OF ACCIDENT: _____
_____ City _____
POLICE OFFICER'S NAME: _____ DEPT: _____
Report Prepared By _____ _____ Date ___/___/___
Name Printed Signature

FIGURE 8

TAILGATE SAFETY MEETING FORM
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS

TAILGATE SAFETY MEETING

Prepared by _____

Client _____ Project _____

Date _____ Project Number _____

Work Location _____

Type of Work to be Done _____

SAFETY TOPICS PRESENTED

Chemical Hazards _____

_____

Physical Hazards/Underground Utilities _____

_____

Protective Clothing/Equipment _____

_____

Special Equipment _____

Emergency Procedures _____

_____

Hospital/Clinic _____ Phone ( )_____

Paramedic Phone ( )_____

Hospital Address _____

Other _____

ATTENDEES

NAME PRINTED	SIGNATURE
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Meeting Conducted By _____ _____

Name Printed Signature

Note: This tailgate safety form must be completed daily.

FIGURE 9

FIELD AUDIT CHECKLIST
TUTU SERVICE STATION INVESTIGATION
HEALTH AND SAFETY PLAN
ST. THOMAS, U.S. VIRGIN ISLANDS.

GERAGHTY & MILLER, INC.
HEALTH AND SAFETY
FIELD AUDIT CHECKLIST

YES	NO	DOCUMENTATION
___	___	Has a Health and Safety Plan (HASP) been prepared for this program?
___	___	Is a HASP on-site and readily available?
___	___	Is a Health and Safety Logbook in use?
___	___	Have subcontractors and Geraghty & Miller staff been given a pre-startup safety briefing and have the personnel signed the acknowledgement form in the Logbook?
___	___	Are other job-specific records being maintained, as outlined in the HASP (OSHA 101, training records, etc.)?
___	___	Are monitoring equipment calibrations and readings being properly measured and recorded?
___	___	Have any changes in the HASP been recorded?

REMARKS:

YES	NO	HEALTH AND SAFETY MONITORING - PROTECTION LEVELS
___	___	Is atmospheric monitoring being performed in accordance with the HASP (OVA, TIP, LEL, etc.)?
___	___	Is monitoring being performed at designated time intervals?
___	___	Are monitoring results being properly recorded in the Health and Safety Logbook?
___	___	Are action (upgrade/downgrade) levels being followed by field personnel?
___	___	Are monitoring instruments being properly calibrated at designated time intervals?
___	___	Does the atmospheric monitoring program appear adequate and capable of indicating the presence of contaminants at the site?

REMARKS-ACTION:

YES	NO	PERSONAL PROTECTIVE EQUIPMENT - PPE
___	___	Is the appropriate, designated PPE being worn for each work task by field personnel?
___	___	Is all required safety equipment readily available?
___	___	Does the safety equipment used by subcontractor meet HASP requirements?
___	___	Does the PPE appear appropriate for the contaminant level(s) encountered?
___	___	Are used PPE properly disposed of or adequately decontaminated?
___	___	Are reusable PPE free from contamination once decontamination has been completed? Reusable PPE may not be appropriate in certain highly contaminated situations, or when specific types of contaminants may be encountered. Refer to the site-specific HASP.
___	___	Is stress monitoring being performed in accordance with the HASP and generally accepted practice?

REMARKS-ACTION:

YES	NO	SITE CONTROL
___	___	Have exclusion zones or work areas been established around the work areas, as described in the HASP?
___	___	Are established zones sufficient to prevent the migration of contaminated media beyond these areas?
___	___	Is a clearly defined contamination reduction corridor for decontamination in existence at the work area?
___	___	Are designated decontamination procedures being employed?
___	___	Is decontamination effective in removing contaminants and preventing the spread of contaminated media?

REMARKS-ACTION:

YES	NO	SAFE WORK PRACTICES
___	___	Is the buddy system employed, and is it encouraged by project management?
___	___	An eyewash station, fire extinguisher, and first-aid kit should be present on each site. Are they available?
___	___	Are restrictions on the use of food, tobacco, or beverages in work/exclusion zone(s) being followed?
___	___	Are field personnel washing at lunch and shift changes?
___	___	Is all equipment kept in a safe, operating condition?
___	___	Are safety glasses or goggles in use during all field activities not requiring a respirator?
___	___	Are hard hats being worn, where required?
___	___	Are steel toe and shank and/or chemical protective boots being worn for designated work tasks, as specified in the HASP?
___	___	Are any slip-trip-fall or impalement hazards present, which have not been addressed?
___	___	Are appropriate clearances being maintained between drilling equipment and overhead power lines?
___	___	Are noise monitoring and hearing protection provisions being implemented?
___	___	To the extent possible, are good housekeeping practices being implemented?
___	___	Is a map to the hospital and a list of emergency telephone numbers conspicuously posted or available?

REMARKS-ACTIONS:

YES	NO	ENCLOSED SPACES/TRENCHES/PITS
___	___	Are enclosed spaces, pits, etc. fully characterized for oxygen deficiency, combustible gasses, and toxic gasses?
___	___	Are pits/trenches greater than 5 feet deep properly shored or sloped per OSHA 29 CFR 1910 Subpart P regulations?
___	___	Are PPE requirements for enclosed space entry being properly employed per the HASP?
___	___	Are properly equipped backup personnel on-site during enclosed space activities?

REMARKS-ACTIONS:

YES	NO	OTHER
___	___	If there is potential for spillage of contaminated media, has a spill prevention plan been prepared with the HASP, and are spill prevention/cleanup equipment available?
___	___	If underground storage tanks (USTs) are being removed, have the USTs been properly purged of combustible vapors prior to removal?
___	___	Have the displaced combustible vapors been vented through a stack extending 12 feet above the work area, per API Recommended Practice 1604?
___	___	Are combustible gas measurements being performed during UST venting and removal activities?

APPENDIX C

WELL SAMPLING PROCEDURES

APPENDIX C

WELL SAMPLING PROCEDURES

Twenty-five wells along Route 38 within the Tutu Wells Site will be initially sampled and analyzed for TCL and TAL constituents with the exception of PCBs during the initial sampling event. During subsequent quarterly sampling events, samples from the 25 wells will be submitted for laboratory analysis of TCL VOCs. If the validated data from the initial sampling event indicates the presence of TCL semi-volatiles, pesticides, or TAL constituents above the detection limit, then samples collected from those wells during subsequent quarterly sampling events will be analyzed for the analyte group detected, in addition to TCL VOCs.

- **PREPARATION FOR SAMPLING**

  - The location of the well relative to the nearest road, the house, and other visible structures will be sketched and described. The location of septic systems, any work shops, and/or other potential constituent sources will be carefully noted, sketched, and described.

  - The well and the piping system will be examined, sketched, and described. The sketch and description will include the type of pump and treatment systems, if present; any holding tanks; the piping material and solder, if possible; and the location of the sampling point.

  - The well will be sampled as close to the pump as possible. It may be necessary to temporarily disconnect the pump from the piping to the point of use to ensure that the sample is collected before the water passes through a holding tank or treatment. Permission to disconnect the piping or to effect any other plumbing changes must be received in writing from the owner or resident. After sampling, the system will be restored immediately to its original configuration.

- **SAMPLING PROCEDURE**

  - For wells sampled from the tap, the pump, faucet, or outside tap will be run at full capacity to purge the well prior to collecting the sample. At least one well volume will be evacuated, if this calculation can be made from the information available. If the well volume cannot be estimated, the well will be pumped for a minimum of 15 minutes. The temperature, pH, and specific conductance of the discharge water will be measured at intervals no greater than 5 minutes in length during purging. If it is determined that one or more of these parameters continues to change after the evacuation of a well volume or at the end of 15 minutes, the purge time will be extended until stabilization occurs.

- After the purge process, the flow rate will be reduced, and the samples will be collected directly into the sample containers. Sampling personnel will wear surgical gloves during handling of the containers. The gloves will be disposed after sampling is finished at each location.

- For wells sampled from the well head, at least one well volume will be evacuated prior to sample collection using a Teflon™ bailer, centrifugal pump, or submersible pump. The method of evacuation used will depend on well diameter, depth to water, and well head access. Temperature, pH, and specific conductance will be measured initially and after the removal of each well volume. If one or more of these parameters continues to change after the evacuation of one well volume, evacuation will continue until stabilization occurs.

- For wells sampled from the well head, samples will be collected using a Teflon™ bailer. Samples will be poured directly from the bailer into the sample containers. Bailer cord will consist of stainless steel wire, Teflon™ coated wire, or polypropylene monofilament.

- Bailers and bailer cord will be decontaminated prior to use by washing with laboratory-grade detergent (Micro™ or equivalent); rinsed with tap water; rinsed with ultra-pure grade 10% nitric acid (when metals are being analyzed for); rinsed with tap water; rinsed with pesticide-grade methanol; rinsed with pesticide-grade hexane; allowed to air dry; rinsed with demonstrated analyte free deionized water; allowed to air dry; wrapped in aluminum foil until use.

- Pumps which are to be used for well evacuation (other than pumps which are permanently installed in the well) will be decontaminated prior to each use by washing in tap water mixed with laboratory grade detergent. The detergent-water mix will be run through the pump to decontaminate the internal components. Next the pump will be washed/pumped with tap water, followed by a final wash/pump with deionized water.

- Samples to be analyzed for VOCs will be collected first. Samples will be preserved immediately upon collection. VOC samples will be acidified with ultra pure grade 1:1 hydrochloric acid (HCl) to pH <2. Metal samples will be acidified with ultra pure grade concentrated nitric acid (HNO_3) to pH <2. Metals samples will not be filtered. In order to determine if VOC and metals samples are acidified to pH <2, a third portion of sample of equal volume will be acidified and its pH tested using pH paper. Acidification will be performed by adding the acid drop by drop until a pH of 2 or less is attained. An equal number of drops of acid will then be added to the sample to be submitted to the laboratory. If acidification of the VOC test sample causes effervescence, the sample will not be acidified, but will be cooled to 4°C.

- Sample containers will be labeled prior to sample collection. The following information will be recorded on each sample label:

  - Project name
  - Sample identification
  - Sample matrix
  - Requested analysis
  - Chemical preservation and pH achieved (if applicable)
  - Date and time of sample collection
  - Sampler's signature

- **FIELD ANALYSES**

  - After the laboratory containers are filled, approximately 0.5 gallon of sample will be collected in a clean, unpreserved glass container and its color, odor, and appearance will be noted. The pH, temperature, and specific conductance of the sample will be measured.

  - Temperature will be measured immediately after collection of the sample with a mercury-filled Celsius thermometer in order to calibrate the pH and specific conductance meters.

  - pH will be measured with a glass hydrogen-ion electrode against a reference electrode of known potential by means of pH meter. Calibration of the pH meter will be completed before analysis with two buffer solution standards bracketing the sample pH (nominal pH values of 4 and 7, or 7 and 11). The probe will be lowered into the sample and gently stirred to allow equilibration before the reading is taken.

  - Specific conductance will be measured with a battery-powered specific conductance meter. The probe will be lowered into the sample and the reading will be immediately taken.

  - The field analyses and sample descriptions will be recorded on a Geraghty & Miller, Inc. Water Sampling Log (attached).

  - All parts of the field instrumentation which come in contact with the sample must be cleaned initially and between samples with a stream of deionized or distilled water.

GERAGHTY & MILLER, INC.
Ground-Water Services

WATER SAMPLING LOG

Project/No. _____ Page _____ of _____

Site Location _____

Site/Well No. _____ Coded/ Replicate No. _____ Date _____

Weather _____ Time Sampling Began _____ Time Sampling Completed _____

EVACUATION DATA

Description of Measuring Point (MP) _____

Height of MP Above/Below Land Surface _____ MP Elevation _____

Total Sounded Depth of Well Below MP _____ Water-Level Elevation _____

Held _____ Depth to Water Below MP _____ Diameter of Casing _____

Wet _____ Water Column in Well _____ Gallons Pumped/Bailed Prior to Sampling _____

Gallons per Foot _____

Gallons in Well _____ Sampling Pump Intake Setting (feet below land surface) _____

Evacuation Method _____

SAMPLING DATA/FIELD PARAMETERS

Color _____ Odor _____ Appearance _____ Temperature _____ °F/°C

Other (specific ion; OVA; HNU; etc.) _____

_____

Specific Conductance, umhos/cm _____ pH _____

Sampling Method and Material _____

Constituents Sampled	Container Description From Lab ____ or G&M ____	Preservative

Remarks _____

Sampling Personnel _____

WELL CASING VOLUMES

GAL./FT.							
	1-¼" = 0.06	2" = 0.16	3" = 0.37	4"
	1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6"

TUT 002 0798

APPENDIX D

SAMPLING QUALITY ASSURANCE/QUALITY CONTROL PROTOCOLS

APPENDIX D

SAMPLING QUALITY ASSURANCE/QUALITY CONTROL PROTOCOLS

The objective of the sampling quality assurance/quality control (QA/QC) program is to ensure the reliability and integrity of all data and documentation generated as a part of the monitoring program. Major elements of the program are quality control sampling, sample custody and handling, and data management.

- **QUALITY CONTROL SAMPLING**

- **FIELD REPLICATE SAMPLES**

  - One field replicate water sample will be collected and analyzed for every ten water samples submitted to the laboratory. Care will be taken to ensure that each sample and sample replicate pair can be compared as a homogeneous sample split in two.

  - Each field replicate sample will be given a fictitious sample identification so that it is not identified in the laboratory as a replicate sample.

- **BLANK SAMPLES**

  - One equipment blank sample will be collected on every day that sampling occurs for which sampling equipment is used. The equipment sample will be analyzed for every parameter analyzed for on that day in accordance with the CLP SOWs for Organics and Inorganics Analysis. The equipment blank sample will be collected by pouring deionized water over the bailer so that the rinsate flows directly into the sample container(s).

  - One trip blank sample will be submitted to the laboratory for every day on which sampling occurs. Trip blank samples will be prepared at the beginning of each day that sampling occurs and will accompany the samples collected on a given day. Trip blank samples will be analyzed for volatile organic compounds (VOCs) in accordance with modified Method 524.2 Revision 3.0 for the 3/90 CLP Organics Volatile Target Compound List (TCL). Trip blank samples will be prepared in an identical manner to sample preparation for VOC analysis.

- **SPIKE SAMPLES**

  - One matrix spike/matrix spike duplicate (MS/MSD) will be analyzed for organics for each sample delivery group. Since all 25 samples will be collected and submitted to the laboratory within 14 calendar days, one MS/MSD sample will be analyzed for every 20 ground-water samples analyzed for organics.

  - A triple sample volume of organics analysis will be collected for each MS/MSD analysis.

- One duplicate and one spike sample will be analyzed for metals for each sample delivery group. Since all 25 samples will be collected and submitted to the laboratory within 14 calendar days, one duplicate and spike sample will be analyzed for every 20 ground-water samples analyzed for metals.

- A double sample volume of inorganics will be collected for each MS/MD analysis.

• **WATER BLANK SAMPLES**

- One blank sample of the water to be used for equipment blanks and decontamination will be analyzed each quarter. The water blank sample will be analyzed for every parameter analyzed for each quarter.

• **SAMPLE CUSTODY**

- The sampling team will be responsible for maintaining custody of the samples until they are delivered to the courier for shipment to the laboratory. All samples shipped to the laboratory will be accompanied by the Geraghty & Miller Chain-of-Custody Record (attached). The Chain-of-Custody Record will be completed in the field; the original form will accompany the shipment and a copy will be retained in the field project file. The Chain-of-Custody form will include the project name and the signatures of the sampling team members who participated in collecting the samples. The following information for each sample container will be listed on the Chain-of-Custody form:

  - Sample identification.
  - Sample matrix.
  - Requested analysis.
  - Chemical preservation and pH achieved (if applicable).
  - Date and time of sample collection.

- The original Chain-of-Custody Record form will be placed in a plastic bag and taped to the underside of the lid of the cooler.

- Samples will be placed in a clean, dry, undamaged cooler such that there is sufficient packaging material (vermiculite and/or bubble wrap) to prevent bottle breakage. Sufficient ice will be placed in each cooler to ensure that sample temperature is maintained at approximately 4°C until arrival at the laboratory. Ice will be placed in double Ziplock plastic bags. The ice-filled bags will be distributed in the cooler evenly, in order to ensure that all samples are maintained at approximately 4°C. The cooler will be sealed by wrapping nylon-reinforced packing tape entirely around it.

- To provide a means of detecting any potential tampering during shipment, all shipment containers (coolers) will be affixed with signed Geraghty & Miller sample seals (attached). Two seals will be affixed to each cooler, on opposite ends.

- The courier service utilized for sample shipment and the number which identifies each shipment will be recorded on the chain-of-custody form. A receipt from the courier service, or copy of the airbill which identifies each shipment, will be retained in the field project file. Samples will be shipped to the laboratory daily. Shipment will be arranged such that samples arrive at the laboratory within 24 hours of collection.

- **DATA MANAGEMENT**

  - Field data and documentation will be recorded in serialized sheets for every day during which activities occur at the site.

  - Field procedures, measurements, and observations will be described in sufficient detail, so as to enable others to reconstruct the events.

  - The project manager will maintain all project documentation in a central project file. This file will include the following items:

    - Project plans and specifications.
    - Field data and documentation.
    - Chain-of-Custody documentation.
    - Sample identification documents.
    - Laboratory data packages.
    - Data review notes
    - Report notes and calculations
    - Final maps and drawings

- **SAMPLE CONTAINER QUALITY CONTROL**

  - To document the quality of sample containers, containers will be proven clean by analysis for each quarterly sampling event in accordance with the CLP Sample Bottle Repository (SBR) Statement of Work (SOW). Sample bottle analysis will be performed by either Enseco Incorporated upon I-Chem Series 200 sample bottles or by I-Chem upon their Series 300 sample bottles or Eagle Pitcher upon their Level I sample bottles.

  - Results of the bottle blank analyses will be provided to USEPA Region II prior to each quarterly sampling event.

GERAGHTY & MILLER, INC.
Environmental Services

Laboratory Task Order No.________

CHAIN-OF-CUSTODY RECORD

Page______ of______

Project Number ______________________

Project Location ______________________

Laboratory ______________________

Sampler(s)/Affiliation ______________________

____

SAMPLE IDENTITY	Code	Date/Time Sampled	Lab ID	SAMPLE BOTTLE / CONTAINER DESCRIPTION										TOTAL

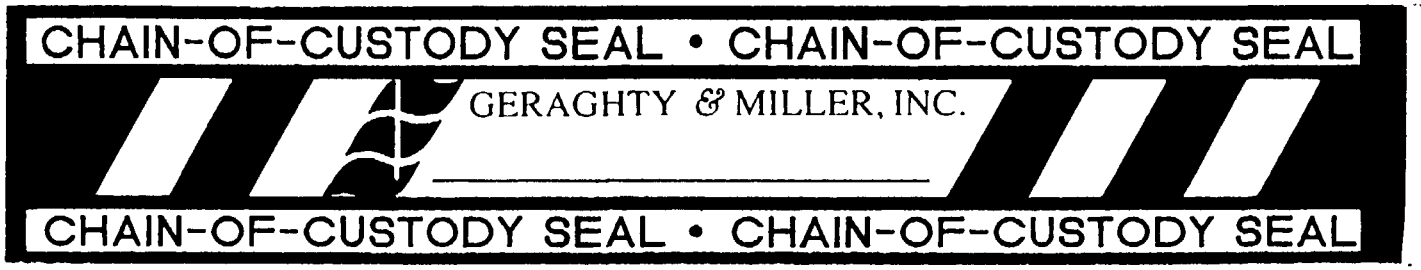
Sample Code: L = Liquid; S = Solid; A = Air

Total No. of Bottles/ Containers ______

Relinquished by: ______________ Organization: ______________
Received by: ______________ Organization: ______________ Date___/___/___ Time______ Seal Intact? Yes No N/A

Relinquished by: ______________ Organization: ______________
Received by: ______________ Organization: ______________ Date___/___/___ Time______ Seal Intact? Yes No N/A

Special Instructions/Remarks: ____


CHAIN-OF-CUSTODY SEAL • CHAIN-OF-CUSTODY SEAL
GERAGHTY & MILLER, INC.
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APPENDIX E

ENSECO INCORPORATED QUALITY ASSURANCE PROGRAM PLAN FOR ENVIRONMENTAL CHEMICAL MONITORING, REVISION 3.4, APRIL 1991

ENSECO INCORPORATED
QUALITY ASSURANCE
PROGRAM PLAN
FOR
ENVIRONMENTAL CHEMICAL MONITORING

Prepared by:
Enseco Incorporated
2200 Cottontail Lane
Somerset, NJ 08875

Revision 3.4
April 1991

Approval:

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President

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1. INTRODUCTION

Enseco Incorporated (Enseco) is the largest and most experienced environmental testing laboratory in the United States. The environmental component of Enseco consists of the combined resources of:

- Enseco-Erco Laboratory in Cambridge, Massachusetts,
- Enseco-East in Somerset, New Jersey,
- Enseco-Rocky Mountain Analytical Laboratory in Denver, Colorado,
- Enseco-Houston in Houston, Texas,
- Enseco-California Analytical Laboratory in Sacramento, California,
- Enseco-CRL in Garden Grove, California,
- Enseco-El Monte in El Monte, California,
- Enseco-Santa Maria in Santa Maria, California,
- Enseco-Ventura in Ventura, California, and
- Enseco-Mobile Laboratories headquartered in Garden Grove, California.

Addresses and telephone numbers for these Enseco laboratories are listed in Table 1-1.

This document describes the Enseco Quality Assurance policies and procedures related to chemical monitoring for environmental pollutants.

TABLE 1-1

ENSECO LABORATORY LOCATIONS

Enseco-California Analytical Laboratory
2544 Industrial Boulevard
West Sacramento, CA 95691
(916) 372-1393
Facsimile (916) 372-1059

Enseco-CRL
7440 Lincoln Way
Garden Grove, CA 92641
(714) 898-6370
Facsimile (714) 891-5917

Enseco-East
2200 Cottontail Lane
Somerset, NJ 08875
(201) 469-5800
Facsimile (201) 469-7516

Enseco-El Monte
9537 Telstar Avenue #118
El Monte, CA 91731
(818) 442-8400
Facsimile (818) 442-3758

Enseco-Erco Laboratory
205 Alewife Brook Parkway
Cambridge, MA 02138
(617) 661-3111
Facsimile (617) 354-5258

Enseco-Houston
1420 East North Belt Suite 120
Houston, TX 77032
(713) 987-9767
Facsimile (713) 987-9769

Enseco-Mobile Laboratories
7440 Lincoln Way
Garden Grove, CA 92641
(714) 898-6370
Facsimile (714) 891-5917

Enseco-Rocky Mountain Analytical Laboratory
4955 Yarrow Street
Arvada, CO 80002
(303) 421-6611
Facsimile (303) 431-7171

Enseco-Santa Maria
2325 Skyway Drive, Suite K
Santa Maria, CA 93455
(805) 922-2776
Facsimile (805) 922-5897

Enseco-Ventura
2810 Bunsen Avenue, Unit A
Ventura, CA 93003
(805) 650-0546
Facsimile (805) 650-0756

Enseco, Inc. (Corporate Office)
2200 Cottontail Lane
Somerset, NJ 08875
(201) 469-5800
Facsimile (201) 469-6257

2. QUALITY ASSURANCE POLICY

Enseco is committed to providing quality environmental analytical services to both the public and private sectors. To ensure the production of scientifically sound, legally defensible data of known, documentable and verifiable quality, an extensive Quality Assurance (QA) program has been implemented within Enseco. This program relies on clearly defined objectives, well-documented procedures, a comprehensive audit system, and management support, both Corporate and Divisional, for its effectiveness.

3. PURPOSE AND SCOPE OF DOCUMENT

Purpose

This QA Program Plan presents an overview of the essential elements of the Enseco QA program. Enseco has modeled this plan along EPA guidelines as outlined in "Interim Guidelines and Specifications for Preparing Quality Assurance Program Plans," QAMS-004/80, December 29, 1980 and "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80, February, 1983. Both of these documents have been issued by the Office of Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. Environmental Protection Agency (U.S. EPA). Elements above and beyond those specified in these two documents have been included in this QA Program Plan in order to completely describe the Enseco QA/QC system.

Scope

The Enseco QA program is designed to control and monitor the quality of data generated in Enseco laboratories. The program has four key elements.

- Demonstrating laboratory capability by providing information which documents the overall qualifications of the laboratory to perform environmental analyses;
- Controlling laboratory operations by establishing procedures which measure laboratory and instrument performance on a daily basis;
- Measuring matrix effects to determine the effect of a specific matrix on method performance, and
- Reporting appropriate QC information with the analytical results to enable the end-user to assess the quality of the data.

The specific procedures involved in implementing each aspect of the Enseco program are described in this document. An overview of these QC procedures, along with the section number in which each is discussed, is given in Table 3-1.

The QA/QC policies and procedures described herein are designed to eliminate systematic errors and minimize the occurrence of other errors. However, no QA program, regardless of how elaborate, can eliminate all errors which may occur during an analysis. The QA program forms the framework for minimizing errors and identifying and correcting those errors which do occasionally occur. These QA/QC policies and procedures must be coupled with the professional judgment of the technical staff in interpreting the events surrounding the generation of the final result to ensure that quality data is consistently produced, and decisions and corrective actions are fully documented.

In many instances, Enseco participates with its clients in the preparation and evaluation of project-specific Quality Assurance Project Plans (QAPjP). Typically the elements of the Enseco QAPP are incorporated into these documents. In some instances other requirements may be specified. Each QAPjP must be reviewed and approved by the QA Director of the Enseco facility entering into the client agreement to assure that minimum standards of quality exist by which the work can be evaluated as to its scientific and legal integrity. The QA Director must assure that both the analytical testing objectives and regulatory requirements of the project are met. All requirements in a QAPjP which do not meet the minimum requirements as stated in the Enseco QAPP must be approved by the Corporate Director of QA. In the presence of an approved QAPjP, Enseco laboratories must follow the specific requirements of that project plan which supersedes the Enseco QAPP for any work explicitly associated with that QAPjP.

Table 3-1

ELEMENTS OF QA PROGRAM PLAN

Evaluation Criteria	Operational Elements	Section of QA Plan
LABORATORY QUALIFICATIONS	Facilities/equipment/staff	*
	Written SOPs for all laboratory procedures, including:	17
	Sample custody	7
	Calibration procedures	8
	Analytical procedures	9
	Data validation	10
	Documented QA program	1-15
	Laboratory certifications	12
LABORATORY PERFORMANCE	Check samples	12
	Method blanks	11
	Calibration data/calibration verification	8
	Method detection limits	14
MATRIX EFFECTS	Matrix spike/matrix duplicate/ matrix spike duplicate analyses	11
	Sample surrogate recoveries	11
	Standard additions	11
	Field blanks	11
	Method detection limits (determined with specific sample matrix)	11
DATA REPORTING	Data reduction and validation	10
	Data reporting	10
	Reporting Limits	14

* Described in a separate document available from Enseco.

4. DEFINITION OF TERMS

Quality Assurance (QA): the total integrated program for assuring the reliability of data generated in the laboratory.

Quality Control (QC): the routine application of specific, well-documented procedures to ensure the generation of data of known and accepted quality, thus fulfilling the objectives of the QA program.

Quality Assurance Program Plan (QAPP): an assemblage of management policies, objectives, principles, and general procedures outlining the techniques by which the laboratory produces data of known and accepted quality.

Standard Operating Procedure (SOP): a detailed, written description of a procedure designed to systematize and standardize the performance of the procedure.

Quality Assurance Project Plan (QAPjP): an assemblage of detailed procedures describing how the laboratory will generate data that meet the Data Quality Objective (DQOs) of a specific project.

Legally Defensible Data: data which are supported by a QAPP and documentation adequate to reconstruct the analytical process. Legal defensibility is not dependent on the level of deliverables.

Holding Time: the period of time during which a sample can be stored after collection and preservation without significantly affecting the accuracy of the analysis.

Sample Delivery Acceptance: the point in time at which Enseco determines that it can proceed with the analytical work. Sample delivery acceptance follows receipt and inspection of the samples and complete definition of analyses required.

Initiate Preparation: the point in time at which the separation of organic extractable compounds or metals from the sample matrix by solvent extraction or acid digestion is begun.

Initiate Analysis: the point in time at which the sample, extract or digestate is introduced into an instrument or process which complies with the SOP for analysis of the parameter of interest.

5. RESPONSIBILITIES AND AUTHORITIES

Executing an effective QA program in a large and complex multi-laboratory system demands the commitment and attention of both management and staff. The QA effort at Enseco is administered by the Director of Quality Assurance and Technology who manages the Corporate Quality Assurance Office. The Director of QA and Technology reports directly to the President and has the responsibility for overseeing and regulating all laboratory functions (see Figure 5-1). The Corporate QA Director reports to the Director of QA and Technology and has the responsibility of the day-to-day functions of the QA office. The QA Office operates independently of all areas generating analytical data to ensure complete objectivity in the evaluation of laboratory operations.

The implementation of the QA program within each individual Enseco laboratory is administered by the Division QA Director. The QA Director reports to both the Corporate QA Director and to the General Manager, who manages the laboratory. In addition, all scientists within the organization play a vital role in assuring the quality of their work. We believe that the success of Enseco is dependent upon the continued commitment of all within the organization to a strong and viable QA Program. The responsibilities and levels of authority within the organization are described below.

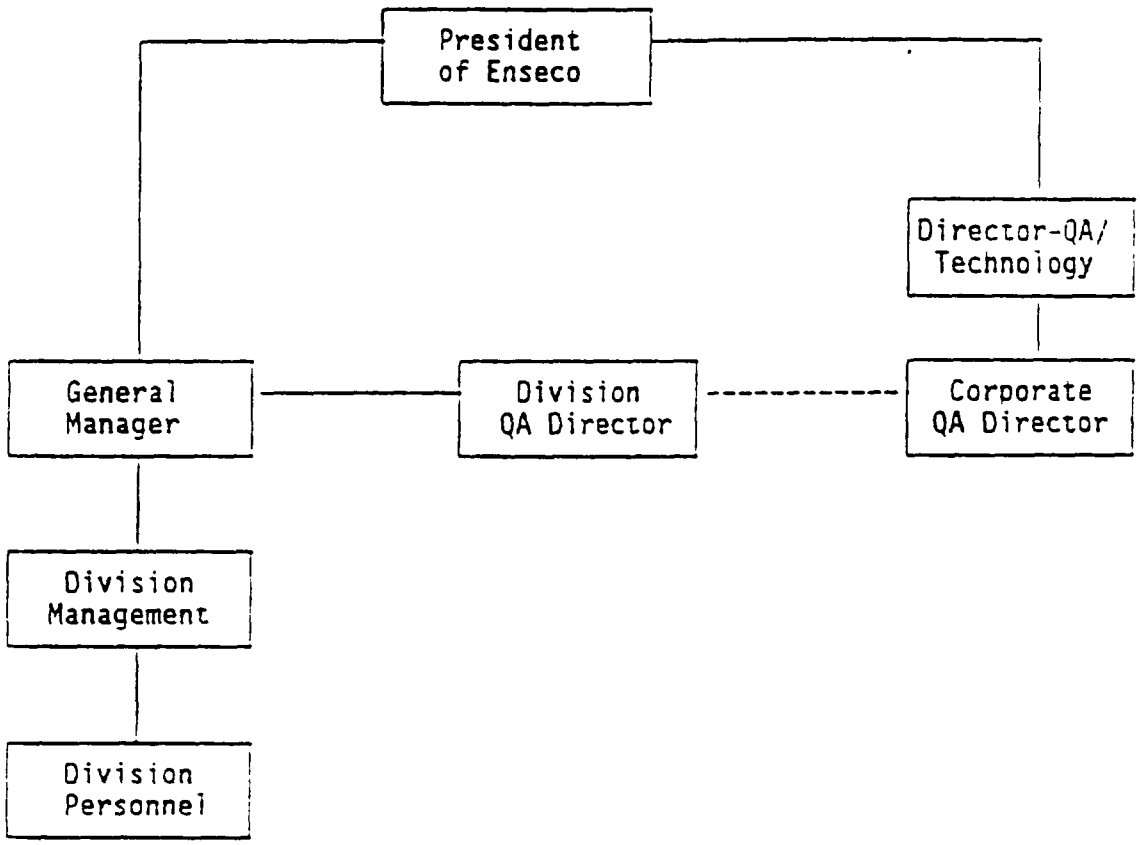
Corporate Quality Assurance Office

Members

The QA effort within Enseco is directed by the Corporate QA Director under the management of the Director of Quality Assurance and Technology to carry out the responsibilities of the department.

Figure 5-1

ENSECO QA ORGANIZATIONAL CHART



Responsibilities

The Corporate QA Director under the direction of the Director of QA and Technology is responsible for:

- Developing and implementing a Corporate QA program that ensures that all data generated in Enseco laboratories are scientifically sound, legally defensible, and of known precision and accuracy;
- Monitoring the QA Plan to ensure compliance with QA objectives in all Enseco laboratories;
- Developing and implementing new QA procedures within the corporation to improve data quality;
- Conducting audits and inspections of all Enseco laboratories on a regular basis, reporting the results of those audits to management, and applying corrective actions as needed to ensure compliance with the Enseco QA Plan;
- Coordinating the distribution of Performance Evaluation (PE) samples to all Enseco laboratories on a routine basis, evaluating the results of those samples, reporting to management, and applying corrective actions as needed to ensure that all Enseco laboratories are able to generate data that meet the data quality objectives defined in the QA Plan;
- Establishing databases that accurately reflect the performance of each of the Enseco laboratories;
- Directing Division QA Directors in the implementation of the Enseco QA Plan within individual facilities;
- Chairing the Enseco QA Committee, a working committee which includes all of the Division QA Directors and deals with QA issues on an ongoing basis;
- Coordinating certification programs within Enseco;
- Conducting seminars on QA issues for both clients and laboratory staff; and
- Promoting sound QA practices within the environmental regulatory and analytical communities.

Authority

Both the Director of QA and Technology and the Corporate QA Director have the authority on issues dealing with data quality and have the authority to require that procedures be amended or discontinued, or analyses suspended or repeated. The Director of QA and Technology and the Corporate QA Director have the authority to suspend or terminate employees on the grounds of dishonesty, incompetence, or repeated non-compliance with QA procedures. In addition, these Corporate Directors have the authority to overrule decisions and actions of the Division QA Directors and must approve the termination or transfer of any Division QA Director. The authority of the Corporate QA Director and the Director of QA and Technology comes directly from the President of Enseco.

Divisional Quality Assurance Departments

Members

Each Divisional QA Department is managed by a QA Director. The QA Director reports directly to the General Manager and indirectly to the Corporate QA Director. The QA Director is supported by a QA staff within the laboratory.

Responsibilities

The Division QA Director is responsible for:

- Implementing Enseco QA policies;
- Monitoring the implementation of the QA Plan within the laboratory to ensure complete compliance with QA objectives;
- Conducting in-house audits to identify potential problems and ensure compliance with written SOPs:

- Performing statistical analyses of QC data and establishing databases that accurately reflect the performance of the laboratory;

- Prescribing and monitoring corrective actions;

- Serving as the in-house client representative on all project inquiries involving data quality issues;

- Monitoring the preparation and verification of analytical standards;

- Assisting chemists in the writing of SOPs;

- Reporting the status of the laboratory QA program to the Corporate QA Director with formal and informal communications;

- Maintaining records and archives of all QC data, PE results, audit comments, and customer inquiries concerning data quality;

- Assuring that the laboratory staff has access to current SOPs;

- Monitoring laboratory performance in the areas of holding times, turn-around times, and meeting contractual obligations;

- Conducting seminars on QA issues for clients and laboratory staff;

- Preparing QA Project Plans when needed;

- Assisting the Corporate QA office in the writing of QA policies and procedures;

- Serving as a member of the Enseco QA Committee: and

- Auditing subcontractors.

Authority

The Division QA Director is the final authority within each laboratory on all issues dealing with data quality. He/she has the authority to require that procedures be amended or discontinued or analyses suspended or repeated. He/she can make recommendations to the General Manager and the Corporate Director of QA regarding suspension or termination of employees for incompetence or non-compliance with QA procedures. The authority of the Division QA Director comes directly from the Corporate Director of QA.

Divisional Management

Members

The managers and supervisors who direct the analytical work at each laboratory are directly responsible for ensuring that all employees reporting to them are complying with the Enseco QA Plan.

Responsibilities

Laboratory management is responsible for:

- Actively supporting the implementation of the Enseco QA Plan within the laboratory;
- Maintaining accurate SOPs and enforcing their use in the laboratory;
- Maintaining a work environment that emphasizes the importance of data quality; and
- Providing management support to the Corporate and Divisional QA departments.

Authority

The managers and supervisors of the laboratory have the authority to accept or reject data based on compliance with well-defined QC criteria. In addition, managers and supervisors, with the approval of the QA department, can accept or reject data that fall outside of established QC guidelines if, in their judgment, there are technical reasons which warrant the acceptance or rejection of the data. These circumstances must be well documented and any need for corrective action identified by the incident must be defined and initiated. The authority of the laboratory management comes directly from the President of Enseco and the General Manager.

Divisional Personnel

Members

All laboratory personnel involved in the generation and reporting of data have a responsibility to understand and follow the Enseco QA Plan.

Responsibilities

Laboratory personnel are responsible for:

- Having a working knowledge of the Enseco QA Plan;
- Ensuring that all work is generated in compliance with the Enseco QA Plan;
- Performing all work according to written SOPs;
- Ensuring that all documentation related to their work is complete and accurate; and
- Providing management with immediate notification of quality problems.

Authority

Laboratory personnel have the authority to accept or reject data based on compliance with well-defined QC criteria. The acceptance or rejection of data that fall outside of established QC guidelines must be approved by laboratory management and the QA department. The authority of the laboratory personnel flows from the General Manager.

6. SAMPLING PROCEDURES

The generation of quality data begins with the collection of the sample, and therefore the integrity of the sample collection process is of concern to the laboratory. Samples must be collected in such a way that no foreign material is introduced into the sample and no material of interest escapes from the sample prior to analysis. To ensure sample integrity, the following must be considered:

- Samples must be collected in appropriate containers. In general, glass containers are used for organic parameters and polyethylene containers for inorganic/metal parameters (see Appendix I);
- The sample containers must be properly cleaned to ensure that the sample is not contaminated during the collection process;
- Samples must be preserved appropriately to minimize the loss of materials of interest due to adsorption, chemical or biological degradation, or volatilization (see Appendix I);
- Appropriate volumes of sample must be collected to ensure that the required detection limits can be met and quality control samples can be analyzed (see Appendix I); and
- Samples must be properly shipped to the laboratory, in the appropriate time frame, to ensure that holding times for the analyses can be met (see Appendix I).

Sample Containers and Preservatives

Enseco can assist in the sample collection process by providing consultation and assistance to clients designing sampling programs. Also Enseco can make available to the client sample containers that are properly cleaned and preserved for use in sample collection. Enseco has had its coolers, sample containers and packaging methods independently tested to demonstrate that Department of Transportation standards are met. Appropriate containers and preservatives, and minimum sample volumes required for analyzing routine organic, metal, and conventional parameters are listed in Appendix I.

Holding Times

EPA has established holding time requirements for some analyses. These holding time requirements are listed in Appendix I, along with container and preservative requirements. As indicated in Appendix I, holding time requirements differ depending on the regulatory program. Enseco follows the holding times given in SW-846, Update I, Federal Register, October 26, 1984 or Methods of Chemical Analysis of Water & Waste, based on the method source, unless otherwise instructed by the client. CLP holding times are followed when CLP protocols are requested by the client. Other holding times can be honored if special arrangements are made with the laboratory.

Enseco is obligated to initiate preparation and/or analysis of the sample within holding times if sample delivery acceptance occurs within 72 hours of sampling or before one-half of the holding time period has expired, whichever is less. (See Section 4 for definition of above terms.)

On occasion, a sample must be reanalyzed to comply with this QA Program Plan. If this reanalysis is conducted outside of the holding time, the laboratory will be considered to have fulfilled its obligation to meet holding times if the first preparation and/or analysis was initiated within the prescribed holding time.

Sample Disposition

All soil samples, sample extracts, and aqueous samples that meet Federal or applicable State definitions as a hazardous waste are incinerated at a RCRA Part B permitted facility or returned to the client. Empty sample containers are disposed of by shredding and incineration. An alternate procedure for disposal of empty containers involves triple rinsing the container, blanking out the label and disposal as a solid waste. Sample disposition procedures meet Federal and State regulations.

7. SAMPLE CUSTODY

Upon receipt by Enseco, samples proceed through an orderly processing sequence specifically designed to ensure continuous integrity of both the sample and its documentation.

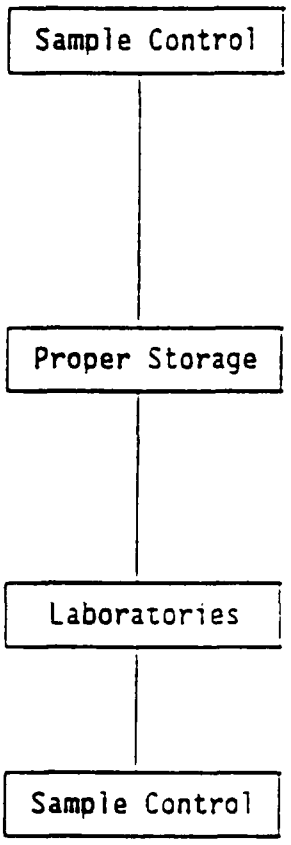
All samples are received by Enseco's Sample Control Group and are carefully checked for label identification, and completed, accurate chain-of-custody records. Photographs document the condition of samples and each sample is then assigned a unique laboratory identification number through a computerized Laboratory Information Management System (LIMS) that stores all identifications and essential information. The LIMS system tracks the sample from storage through the laboratory system until the analytical process is completed and the sample is returned to the custody of the Sample Control Group for disposal. This process is summarized in Figure 7-1. Access to all Enseco laboratories is restricted to prevent any unauthorized contact with samples, extracts, or documentation.

An example of the Enseco Chain-Of-Custody Record used to transmit samples from the client to the laboratory is given in Figure 7-2. The Chain-Of-Custody Record (Interlaboratory Analysis Form) used to transmit samples between laboratories within Enseco is given in Figure 7-3.

Sample bottles provided to the client by Enseco are transmitted under custody.

Figure 7-1

ENSECO SAMPLE PROCESSING FLOW CHART



* Check and document physical condition of sample
* Verify documentation and parameter assignment
* Log into LIMS
* Send acknowledgement letter to client

* Store sample according to preservation guidelines
* Transfer sample to lab with proper documentation

* Document analytical work
* Return unused samples to Sample Control

* Return sample to client or arrange for sample disposal

Enseco
A Corning Company

Rocky Mountain Analytical Laboratory
4955 Yarrow Street
Arvada, CO 80002
303/421-6611 FAX: 303/431-7171

N OF CUSTODY

LIENT

COMPANY

SITE

DER

SAMPLE SAFE™ CONDITIONS

PACKED BY

SEAL NUMBER

SEAL INTACT UPON RECEIPT BY SAMPLING COMPANY

CONDITION OF CONTENTS

SEALED FOR SHIPPING BY

INITIAL CONTENTS TEMP °C

SEAL NUMBER

SAMPLING STATUS ☐ Done ☐ Continuing Until

SEAL INTACT UPON RECEIPT BY LAB ☐ Yes ☐ No

CONTENTS TEMPERATURE UPON RECEIPT BY LAB °C

TE	TIME	SAMPLE ID/DESCRIPTION	SAMPLE TYPE	# CONTAINERS	ANALYSIS PARAMETERS	REMARKS

TUT 002 0830

CUSTODY TRANSFERS PRIOR TO SHIPPING

ELIN) BY (SIGNED)	RECEIVED BY (SIGNED)	DATE	TIME

SHIPPING DETAILS

DELIVERED TO SHIPPER BY

METHOD OF SHIPMENT

AIRBILL NUMBER

RECEIVED FOR LAB

SIGNED

DATE/TIME

ENSECO PROJECT NUMBER

Figure 7.3

ERLABOR TORY
AIN OF CUSTODY

ENSECO
A Corning Company

PAGE OF

O

ITION

EXPORT ID

ANALYTICAL REQUESTS

SAMPLE CONDITION UPON RECEIPT

SEND RESULTS TO

ATTENTION

COMMENTS

TEST PRICE

SUBTOTAL

DISCOUNT / SURCHARGE

TOTAL

WRITTEN RESULTS REQUIRED BY (DATE)

VERBAL/FAC RESULTS REQUIRED BY (DATE)

PO No

Q.C. ☐ STANDARD ENSECO ☐ CLP PROTOCOL ☐ PROJECT SPECIFIC

SAMPLE DISPOSAL ☐ ENSECO ☐ RETURN TO CLIENT ☐ PHONE

DETECTION LIMITS ☐ COMMON PRODUCTS ☐ OTHER*

HOLDING TIMES ☐ ENSECO ☐ EPA-CLP ☐ TIER ☐ OTHER*

RAW DATA COPIES NEEDED ☐ YES ☐ NO

CUSTODY SEALS INTACT ☐ YES ☐ NO ☐ WET WEIGHT ☐ DRY WEIGHT

RELINQUISHED DATE / TIME

RECEIVED DATE / TIME

TUE 08:21 2002 TEBO

8. CALIBRATION PROCEDURES AND FREQUENCY

Standard/Reagent Preparation

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical operations. Enseco continually monitors the quality of reagents and standard solutions through a series of well-documented procedures.

Primary reference standards and standard solutions used by Enseco are obtained from the National Institue of Standards and Technology, an EPA Cooperator Supplier, or other reliable commercial sources to ensure the highest purity possible. All standards and standard solutions are catalogued to identify the supplier, lot number, purity/concentration, receipt/preparation date, preparer's name, method of preparation, expiration date, and all other pertinent information.

Standard solutions are validated prior to use. Validation procedures can range from a check for chromatographic purity to verification of the concentration of the standard using a standard prepared at a different time or obtained from a different source. Stock and working standards are checked regularly for signs of deterioration, such as discoloration, formation of precipitates, or change in concentration. Care is exercised in the proper storage and handling of standard solutions, and all containers are labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation).

Reagents are examined for purity by subjecting an aliquot or subsample to the analytical method in which it will be used; for example, every lot of dichloromethane (for organic extractables) is analyzed for undesirable contaminants prior to use in the laboratory

Instrument Calibration and Tuning

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity to meet established reporting limits. Each instrument is calibrated with standard solutions appropriate to the type of instrument and the linear range established for the analytical method. The frequency of calibration and calibration verification and the concentration of calibration standards are determined by the manufacturer's guidelines, the analytical method, or the requirements of special contracts.

Gas Chromatography/Mass Spectrometry (GC/MS)

Each day prior to analysis of samples, the instrument is tuned with bromofluorobenzene (BFB) for volatile compounds and decafluorotriphenylphosphine (DFTPP) for semivolatile compounds or other tune criteria as specified by the method used. No samples are analyzed until the instrument has met the tuning criteria of the method.

In general, the instrument is then calibrated for all target compounds. An initial calibration curve is produced to define the working range to establish criteria for identification. This initial calibration is evaluated on a daily basis to ensure that the system is within calibration. If the daily standard does not meet the established criteria, the system is recalibrated.

Chromatography

The field of chromatography involves a variety of instrumentation and detection systems. While calibration standards and acceptance criteria vary depending on the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply uniformly. Each chromatographic system is calibrated prior to performance of analyses. Initial calibration consists of determining the working range, establishing limits of detection, and establishing retention time windows. The calibration is checked on a daily basis to ensure that the system remains within specifications. In addition, continuing calibrations are performed at frequencies required by the method used. If the calibration checks do not meet established criteria, corrective action is taken which may include recalibration and reanalysis of samples. The procedures include examination of instrument performance and analysis information, consultation with the Supervisor and a decision path to determine if recalibration and reanalysis of samples back to the previous acceptable calibration check is warranted.

Metals

Metals analysis basically involves two types of analytical instrumentation: inductively coupled argon plasma emission spectroscopy (ICP), and atomic absorption spectroscopy (AA).

Each ICP is calibrated prior to any analyses being performed using criteria prescribed in the CLP protocol. The calibration is then verified using standards from an independent source. The working 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, one of which is a calibration blank. The calibration is monitored throughout the day by analyzing a Continuing Calibration Blank (CCB) and a Continuing Calibration Verification standard (CCV). If the verification standard does not meet established criteria, corrective action must be performed. The procedures include examination of instrument performance and analysis information, consultation with the Supervisor and a decision path to determine if recalibration and reanalysis of samples back to the previously acceptable calibration check is warranted.

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 the 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. The calibration is then verified on an ongoing basis with a calibration blank and a midpoint calibration standard. If the ongoing calibration standard does not meet established acceptance criteria, corrective action must be performed. The procedures include examination of instrument performance and analysis information, consultation with the Supervisor and a decision path to determine if recalibration and reanalysis of samples back to the previously acceptable calibration check is warranted. All samples are spiked to verify the absence of matrix effects or interferences. The method of standard additions or sample dilution is used when matrix interferences are present.

Wet Chemistry

The field of conventional, non-metals analysis (wet chemistry) involves a variety of instrumental and wet chemical techniques. While calibration and standardization procedures vary depending on the type of system and analytical methodology required for a specific analysis, the general principles of calibration apply universally. Each system is calibrated prior to analyses being conducted. Calibration consists of defining the working range by use of a series of standard solutions, establishing limits of detection, and identifying potential interferences. The calibration is checked on an ongoing basis to ensure that the system remains within specifications. If the ongoing calibration check does not meet established criteria, corrective action must be performed. The procedures include examination of instrument performance and analysis information, consultation with the Supervisor and a decision path to determine if recalibration and reanalysis of samples back to the previous acceptable calibration check is warranted. Continuing calibrations are not performed for non-instrumental methods such as Total Dissolved Solids.

9. ANALYTICAL PROCEDURES

Most analyses performed by Enseco are driven by regulatory concerns. Therefore, methods used at Enseco predominantly originate from regulatory agencies. Generally the methods used are those specified by the U.S. EPA and other federal agencies, state agencies, and professional organizations, as provided in the following references:

- Current EPA (CLP) protocols for the analysis of organic and inorganic hazardous substances including chlorinated dioxins and furans.
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act," 40 CFR, Part 136.
- "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020 (revised March, 1983 or subsequent revision).
- "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," EPA-600/4-82-057 (July, 1982).
- "Test Methods for Evaluating Solid Waste" (SW-846), 2nd Edition (revised), Update I (1984), Update II (1985), 3rd Edition (1986), Update I (1989), Office of Solid Waste and Emergency Response, U.S. EPA.
- "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985) and 17th Edition (1989) American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington, DC (1985).
- "Official Methods of Analysis," 14th Edition, Association of Official Analytical Chemists, Arlington, VA (1984).
- "Methods for the Determination of Organic Compounds in Finished Drinking Water and Raw Source Water," U.S. EPA, Environmental Monitoring and Support Laboratory - Cincinnati (September, 1986 or subsequent revision).
- "Annual Book of ASTM Standards," Volumes 11.01 and 11.02, American Society for Testing and Materials (ASTM), Philadelphia, PA (1987).
- "Techniques of Water Resources Investigations of the United States Geological Survey (USGS), Book 5, Laboratory Analysis," USGS, Washington, DC (1979).

The choice of method is dependent on the objectives of the study in terms of qualitative certainty, quantitative sensitivity, precision and accuracy, the type of matrix to be analyzed, and the regulatory program. Each method used routinely is documented in the form of an SOP. The SOP contains detailed instructions concerning both the use and the expected performance of the method. Enseco may deviate from standard methodologies if necessary or appropriate due to the nature or composition of the sample, based on the reasonable judgment of Enseco. Any deviations will be made consistent with recognized standards of the industry and/or this QA Program Plan. Any deviations from published methodology are documented and explained in the SOP. A complete description of the contents of laboratory SOPs is given in Section 17.

Before any methods are routinely used to generate analytical data, the method is validated. Validation criteria consist of:

- Method selection by a senior staff member;
- Documentation of the method in an SOP. This includes a summary of the method, detailed description of the analytical procedure, calculations, reporting formats, safety concerns, and special remarks;
- Testing of the method to verify detection limits and linear range, establish reporting limits and precision and accuracy criteria; and
- Establishment of data acceptance criteria that must be approved by a senior staff member and the Divisional QA Director.

10. DATA REDUCTION, VALIDATION, AND REPORTING

Data Reduction and Validation

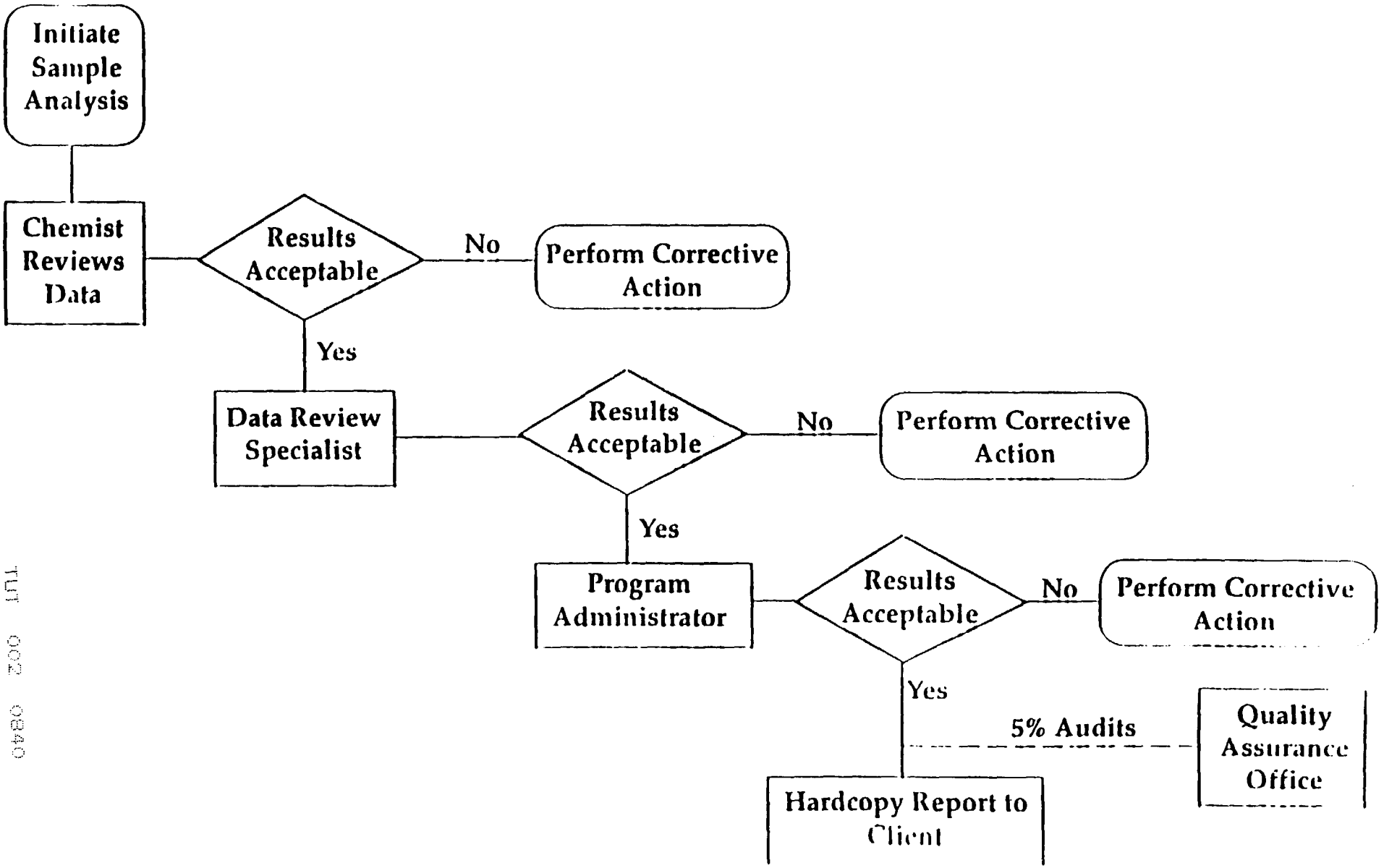
All analytical data generated within Enseco laboratories are extensively reviewed prior to report generation to assure the validity of the reported data. The data validation process consists of data generation, reduction, and three levels of documented review, as described below (also see Figure 10-1). In each stage, the review process is documented by the signature of the reviewer and the date reviewed.

The analyst who generates the analytical data has the prime responsibility for the correctness and completeness of the data. All data are generated and reduced following protocols specified in laboratory SOPs. Each analyst reviews the quality of his or her work based on an established set of guidelines. The analyst reviews the data package to ensure that:

- Sample preparation information is correct and complete;
- Analysis information is correct and complete;
- The appropriate SOPs have been followed;
- Analytical results are correct and complete;
- QC samples are within established control limits;
- Blanks are within appropriate QC limits;
- Special sample preparation and analytical requirements have been met; and
- Documentation is complete (e.g., all anomalies in the preparation and analysis have been documented, anomaly forms are complete; holding times are documented, etc.).

Figure 10-1

Data Validation Scheme



The data reduction and validation steps are documented, signed and dated by the analyst. This initial review step, performed by the analyst, is designated Level 1 review. The analyst then passes the data package to an independent reviewer, who performs a Level 2 review.

Level 2 review is performed by a supervisor or data review specialist 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; anomaly forms are complete; 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 archive.

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 bench sheet. 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 bench sheet. The process continues until no errors are found or until the data package has been reviewed in its entirety.

An important element of 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. Errors that are found are documented and transmitted to the appropriate supervisor. The cause of the errors is then addressed with additional training or clarification of procedures to ensure that quality data will be generated at the bench.

Level 2 data review is also documented and the signature of the reviewer and the date of review recorded. The reviewed data are then approved for release and a final report is prepared.

Before the report is released to the client, the data are reviewed for completeness and to ensure that the data meet the overall objectives of the project. This review is labeled Level 3 review and is typically done by the Program Administrator.

Each step of this review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of the data is essential in ensuring that data of high quality are generated consistently.

In addition to the three levels of review discussed above, 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 bench sheet. 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 bench sheet. The process continues until no errors are found or until the data package has been reviewed in its entirety.

Data Reporting

A variety of reporting formats, from computerized data tables, to complex reports discussing regulatory issues, to a CLP-deliverables package, are available. In general, Enseco reports contain:

General Discussion: Description of sample types, tests performed, any problems encountered and general comments are given.

Analytical Data: Data are reported by sample or by test. 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.

Laboratory Performance QC Information: The results (Percent Recovery and Relative Percent Difference) of the Laboratory Control Samples analyzed with the project are listed, together with the control limits. Also, the analytical results for method blanks generated during analysis of organic and metals parameters are given.

Matrix-Specific QC Information: Results of any sample duplicates, matrix spikes, matrix spike duplicates or other project-specific QC requested by the client are also reported.

Methodology: Reference for analytical methodology used is cited.

Custom Services: Special services including data interpretation, special consultation, and raw data packages (when requested) are included.

11. INTERNAL QC CHECKS

The Enseco QA/QC program monitors data quality with internal QC checks. Internal QC checks are used to answer two questions:

1) Are laboratory operations "in control," (i.e., operating within acceptable QC guidelines), during data generation?

2) What effect does the sample matrix have on the data being generated?

The first question is answered by Laboratory Performance QC. Laboratory performance QC is based on the use of a standard, control matrix to generate precision and accuracy data that are compared, on a daily basis, to control limits. This information, in conjunction with method blank data, is used to assess daily laboratory performance.

The second question is addressed with Matrix-Specific QC. Matrix-Specific QC is based on the use of an actual environmental sample for precision and accuracy determinations and commonly relies on the analysis of matrix spikes, matrix duplicates, and matrix spike duplicates. This information, supplemented with field blank results, is used to assess the effect of the matrix and field conditions on analytical data.

Laboratory Performance QC is provided as a standard part of every routine Enseco analysis. Matrix-Specific QC is available as an option to the client and should be specified based on the types of matrices to be analyzed and the Data Quality Objectives (DQOs) and regulatory requirements of the project. A complete discussion of the Enseco Internal QC Check program follows.

Laboratory Performance QC Program

Laboratory Performance QC is performed for every routine Enseco analysis to demonstrate that laboratory operations are "in control". The main elements of Laboratory Performance QC are:

- The analysis of Laboratory Control Samples, which include Duplicate Control Samples (DCS), Single Control Samples (SCS), and method blanks, and
- The use of calibration standards to assure that both qualitative identification and quantitative measurements are within control limits.

The Laboratory Control Sample program is discussed below. Please refer to Section 8 of this manual for a discussion of calibration procedures.

Laboratory Control Samples (LCS)

Laboratory Control Samples (LCS) are well-characterized, laboratory generated samples used to monitor the laboratory's day-to-day performance of routine analytical methods. Three types of LCS are routinely analyzed: Duplicate Control Samples (DCS), Single Control Samples (SCS), and method blanks. Certain LCS (DCS, SCS) are used to monitor the precision and accuracy of the analytical process, independent of matrix effects. Other LCS (method blanks) are used to identify any background interference or contamination of the analytical system which may lead to the reporting of elevated concentration levels or false positive data. Each of these LCS are described below.

The results of the LCS are compared to well-defined laboratory acceptance criteria to determine whether the laboratory system is "in control." Controlling lab operations with LCS (as opposed to matrix spike/matrix spike duplicate samples), offers the advantage of being able to differentiate quality problems due to laboratory procedural errors from those due to matrix effects. As a result, procedural errors can be identified and corrected by the analyst at the bench, without waiting for extensive senior level review or costly and time-consuming reanalysis of the sample.

Duplicate Control Samples (DCS)

Duplicate Control Samples (DCS) are used to monitor the precision and accuracy of the analytical system on an on-going basis. Each DCS consists of a standard, control matrix that is spiked with a group of target compounds representative of the method analytes. A DCS pair is analyzed for every 20 samples processed by the method. DCS are analyzed with environmental samples to provide evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision.

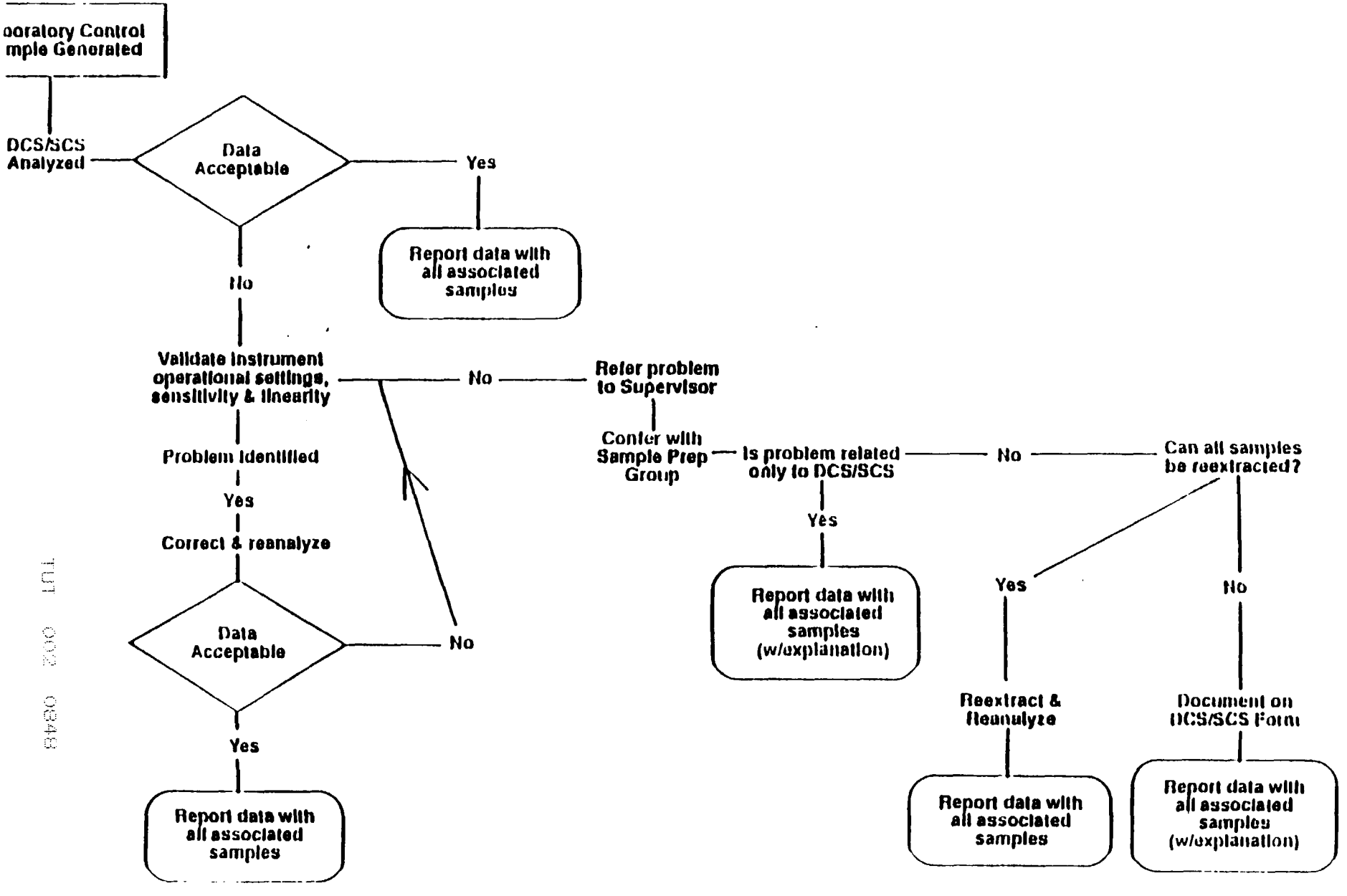
Accuracy data (average recovery of each analyte in the DCS pair) and precision data (Relative Percent Difference [RPD] between each analyte in the DCS pair) are compared to control limits that have been established for each of the analytes contained in the DCS. Initially, control limits for analytes spiked into the DCS are taken directly from the CLP program. If CLP limits are not available, Enseco historical data are used to set the control limits. The control limits are recalculated periodically, as sufficient laboratory data become available. Control limits for accuracy for each analyte are based on the historical average recovery (mean of the average recoveries of the DCS pairs) plus or minus three standard deviation units. Control limits for precision for each analyte are based on the historical RPD. Acceptable RPDs range from zero (no difference between DCS results) to the average RPD plus three standard deviation units. Analytical data that are generated with a DCS pair which falls within the established control limits are judged to be in control. Data generated with a DCS pair which falls outside of the control limits are considered suspect and corrective action must be performed. The procedure used to evaluate data from control samples is given in Figure 11-1. The procedures include examination of instrument performance and preparation and analysis information, consultation with the supervisor, and finally a decision path for determining whether reanalysis is warranted.

DCS have been established for each routine analytical method. Reagent water is used as the control matrix for the analysis of aqueous samples. The DCS compounds are spiked into reagent water and carried through the appropriate steps of the analysis. The control matrix for solids samples for organic analyses is standard Ottawa sand, an ASTM approved material for use in highway construction, due to its homogeneity. The DCS compounds are spiked into the Ottawa sand and carried through the appropriate steps of the analysis. For metal analyses, a spiked solid matrix from a commercial source is used.

As stated previously, DCS are analyzed at a frequency of no less than one DCS pair per 20 samples. The DCS program is supplemented with the SCS program to ensure that Laboratory Performance QC is available with each batch of samples processed (see following subsection).

Figure 11-1

Laboratory Performance QC Control Sample Evaluation



DCS precision and accuracy data are archived in the LIMS. In addition, the associated DCS data are reported with each set of sample results to enable the client to make a quality assessment of the data.

Single Control Samples (SCS)

As stated above, a DCS pair is analyzed with every 20 samples to measure the precision and accuracy of an analysis on an ongoing basis. However, samples are often analyzed in lots of less than 20, due to holding time or turn-around time requirements. Since it is necessary to have a measure of laboratory performance with each batch of samples processed, Enseco has instituted the SCS program.

An SCS consists of a control matrix that is spiked with surrogate compounds appropriate to the method being used. In cases where no surrogate is available, (e.g., metals or wet chemistry) a single DCS serves as the control sample. An SCS is prepared for each sample lot for which the DCS pair are not analyzed. Recovery data generated from the SCS are compared to control limits that have been established for each of the compounds being monitored. Initially, CLP control limits or Enseco historical data are used to set the control limits. Control limits are recalculated periodically as sufficient SCS data are available. Control limits for SCS components are based on the historical average recovery in the SCS plus or minus three standard deviation units.

Analytical data that are generated with an SCS which falls within the control limits are judged to be in control. Data that are generated with an SCS which falls outside of acceptance criteria are considered suspect and corrective action must be performed. The protocols for evaluating SCS are identical to those established for DCS (see Figure 11-1). SCS recovery (accuracy) data are archived in the LIMS. In addition, the associated SCS data are reported with each set of sample results to enable the client to make a quality assessment of the data.

Method Blank

Method blanks, also known as reagent, analytical, or preparation blanks, are analyzed to assess the level of background interference or contamination which exists in the analytical system and which might lead to the reporting of elevated concentration levels or false positive data.

As part of the standard Enseco QC program, a method blank is analyzed with every batch of samples processed. A method blank consists of reagents specific to the method which are carried through every aspect of the procedure, including preparation, clean-up, and analysis. The results of the method blank analysis are evaluated, in conjunction with other QC information, to determine the acceptability of the data generated for that batch of samples.

Ideally, the concentration of target analytes in the blank should be below the Reporting Limit for that analyte. In practice, however, some common laboratory solvents and metals are difficult to eliminate to the parts-per-billion levels commonly reported in environmental analyses. Therefore, criteria for determining blank acceptability must be based on consideration of the analytical techniques used, analytes reported, and Reporting Limits required.

For organic analyses, the concentration of target analytes in the blank must be below the Reporting Limit for that analyte in order for the blank to be considered acceptable. An exception is made for common laboratory contaminants (methylene chloride, acetone, 2-butanone, and phthalate esters) which may be present in the blank at up to 5 times the Reporting Limit and still be considered acceptable. This policy is consistent with the CLP policy and has been established in recognition of the fact that these compounds are frequently found at low levels in method blanks due to the materials used in the collection, preparation, and analysis of samples for organic parameters.

For non-routine organic analyses, other components may be established as common contaminants for that particular analysis. For example, naphthalene is frequently found in PAH-SIM analyses. If, upon thorough review of the method during validation (see Section 9) it is deemed impossible to eliminate trace amounts of analytes from the process, these analytes are likewise allowed at up to 5 times the reporting limit.

For metals and Wet Chemistry analyses, where the Reporting Limits are typically near the Instrument Detection Limit (IDL), the policy is that the concentration of the target analytes in the blank must be below two times the Reporting Limit. If the blank value for a target analyte lies below the Reporting Limit, the Reporting Limit for that analyte in the associated samples is unaffected. If the blank value lies between the Reporting Limit and two times the Reporting Limit, the Reporting Limit for that analyte in the associated samples is raised to the level found in the blank. A blank containing an analyte(s) above two times the Reporting Limit is considered unacceptable unless the lowest concentration of the analyte in the associated samples is at least ten times the blank concentration (as per CLP protocol) or the concentration of the analyte in all samples associated with the blank is below the reporting limit.

In addition, for Wet Chemistry tests, the method SOP directs how the blank is treated. Generally, a reagent blank is used both to zero the equipment and as one of the calibration standards. If a preparation step is required for the analysis, then a prep blank is also analyzed to determine the extent of contamination or background interference. The concentration found in the prep blank is subtracted from the concentration found in any associated sample prior to calculating the final result when specified by the method. Blanks have no application or significance for some Wet Chemistry parameters (e.g. pH).

If the blank does not meet acceptance criteria, the source of contamination must be investigated and appropriate corrective action must be taken and documented. Investigation includes an evaluation of the data to determine the extent and effect of the contamination on the sample results. Corrective actions may include reanalysis of the blank, and/or repreparation and reanalysis of the blank and all associated samples.

For organic and metals analyses, and selected Wet Chemistry tests, method blank results are reported with each set of sample results. Sample results are not corrected for blank contamination unless required by the analytical method or requested by the client. Occasionally, due to limited sample volume or other constraints, the laboratory reports data associated with an unacceptable blank. In these cases, the Reporting Limit for each analyte contained in the blank is raised to the level found in the blank for all sample results associated with that blank.

Matrix-Specific QC

Matrix-Specific QC is used to assess the effects of a sample matrix or field conditions on the analytical data. The main elements of Matrix-Specific QC are:

- The analysis of matrix spikes, matrix duplicates, and matrix spike duplicates;
- Monitoring the recovery of surrogate compounds from environmental samples;
- Monitoring the results of standard additions in environmental samples;
- The analysis of field blanks; and
- The determination of method detection limits in a specific matrix.

Different regulatory programs have different requirements in terms of Matrix-Specific QC. In order to ensure that the data generated meet all Data Quality Objectives, Enseco recommends that its clients include Matrix-Specific QC that fulfills the Data Quality Objectives and regulatory requirements of the project. A discussion of the different elements of Matrix-Specific QC follows.

Matrix Spikes, Matrix Duplicates, and Matrix Spike Duplicates

A Matrix Spike (MS) is an environmental sample to which known concentrations of analytes have been added. The MS is taken through the entire analytical procedure and the recovery of the analytes is calculated. Results are expressed as percent recovery. The MS is used to evaluate the effect of the sample matrix on the accuracy of the analysis.

A Matrix Duplicate (MD) is an environmental sample that is divided into two separate aliquots. The aliquots are processed separately and the results compared to determine the effects of the matrix on the precision of the analysis. Results are expressed as RPD.

A Matrix Spike Duplicate (MSD) is an environmental sample that is divided into two separate aliquots, each of which is spiked with known concentrations of analytes. The two spiked aliquots are processed separately and the results compared to determine the effects of the matrix on the precision and accuracy of the analysis. Results are expressed as RPD and percent recovery.

Surrogate Recoveries and Standard Additions

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 the analysis. Results are reported in terms of percent recovery.

Enseco routinely adds surrogates to samples requiring GC or GC/MS analysis and reports these surrogate recoveries to the client. The laboratory does not control its operations based on surrogate recoveries in environmental samples. As discussed earlier in this section, Enseco controls its operations based on the results of Laboratory Control Samples. The surrogate recoveries are primarily used by the laboratory to assess matrix effects. However, obvious problems with sample preparation and analysis (e.g. evaporation to dryness, leaking septum, etc.) which can lead to poor surrogate spike recoveries must be ruled out prior to attributing low surrogate recoveries to matrix effects.

Standard Additions (SA) is the practice of adding a series of known amounts of an analyte to an environmental sample. The fortified samples are then analyzed and the recovery of the analytes calculated. The practice of SA's is generally used with metal and wet chemistry to determine the effect of the sample matrix on the accuracy of the analyses.

Field Blanks

Field blanks are check samples that monitor contamination originating from the collection, transport or storage of environmental samples. One example of a field blank is an equipment blank. An equipment blank is blank water that is poured through the sample collection device to check the adequacy of the cleaning procedures for the sampling equipment. Another type of field blank is a trip blank. A trip blank is a laboratory control matrix (typically water) which is sent to the field in an appropriate sample container, remains unopened in the field, and then

is sent back to the laboratory. The purpose of the trip blank is to assess the impact of field and shipping conditions on the samples. The results from field blanks are reported to the client as samples in the same concentration units as the samples. No correction of the analytical data is done in the laboratory based on the analysis of field blanks.

Matrix-Specific Detection Limits

Method Detection Limits (MDL's) determined on a specific sample matrix are called Matrix-Specific Detection Limits. See Section 14 for a discussion of detection and reporting limits.

12. PERFORMANCE AND SYSTEM AUDITS

Enseco laboratories participate in a variety of federal and state programs, (including the U.S. EPA CLP), that subject each of the laboratories to stringent system and performance audits on a regular basis. A system audit is a review of laboratory operations conducted to verify that the laboratory has the necessary facilities, equipment, staff and procedures in place to generate acceptable data. A performance audit verifies the ability of the laboratory to correctly identify and quantitate compounds in blind check samples submitted by the auditing agency. The purpose of these audits is to identify those laboratories that are capable of generating scientifically sound data. Enseco is certified to perform environmental analyses under programs administered by the U.S. Department of Energy, U.S. Air Force, U.S. Navy, and over 20 states. The most current list of Enseco certifications is available upon request.

In addition to external audits conducted by certifying agencies or clients, Enseco regularly conducts the following internal audits:

- Quarterly systems audits conducted by the Divisional QA Director.
- Periodic (at least yearly) audits conducted by the Corporate QA Office.
- Special audits by the Divisional QA Director or Corporate QA Office when a problem is suspected.

Enseco laboratories also routinely analyze check samples as described below:

- Laboratory Control Samples (DCS, SCS, and method blanks) are analyzed at a frequency equal to at least 10% of the total number of samples analyzed (see Section 11).

- All Enseco laboratories participate in the analyses of EPA check samples provided under the Water Supply (WS) and Water Pollution (WP) Performance Evaluation Studies. The results of these PE samples are tabulated by the Corporate QA Office to identify performance trends within the Enseco laboratories.

- The majority of the Enseco laboratories are CLP labs and thus analyze organic and/or inorganic CLP PE samples on a quarterly basis. The results of these analyses are also tabulated and evaluated by the Corporate QA Office.

- The laboratories participate in multiple state certification programs (including New York, New Jersey and California) which require that PE samples be analyzed periodically.

- Blind check samples from an independent commercial firm are sent to the laboratories periodically by the Corporate QA Office. The frequency and type of samples sent is based on problem areas identified by evaluation of tabulated PE results.

The results of these check samples are used to identify areas where additional training is needed or clarification of procedures is required.

13. PREVENTIVE MAINTENANCE

To minimize downtime and interruption of analytical work, preventive maintenance is routinely performed on each analytical instrument. Designated laboratory personnel are trained in routine maintenance procedures for all major instrumentation. When repairs are necessary, they are performed by either trained staff or trained service engineers employed by the instrument manufacturer.

Each laboratory has detailed SOPs on file that describe preventive maintenance procedures and schedules. The laboratories also maintain detailed logbooks documenting the preventive maintenance and repairs performed on each analytical instrument.

14. SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA QUALITY AND DETERMINE REPORTING LIMITS

Data Quality Assessment

The effectiveness of a QA program is measured by the quality of data generated by the laboratory. Data quality is judged in terms of its precision, accuracy, representativeness, completeness and comparability. These terms are described as follows:

Precision is the degree to which the measurement is reproducible. Precision can be assessed by replicate measurements of DCS, reference materials, or environmental samples. Enseco routinely monitors precision by comparing the RPD between DCS measurements with control limits established at plus three standard deviations from the mean RPD of historical DCS data.

Precision is frequently determined by comparison of replicates. The standard deviation of "n" measurements of "x" is commonly used to estimate precision.

Standard deviation (s) is calculated as follows:

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2}$$

where a quantity "x" (e.g., a concentration) is measured "n" times.

The relative standard deviation, which expresses standard deviation as a percentage of the mean, is generally useful in the comparison of three or more replicates (although it may be applied in the case of n = 2).

$$RSD = 100\ (s/\bar{x})$$

where: RSD = relative standard deviation

s = standard deviation

$\bar{x}$ = mean

In the case of duplicates, the RPD between the two samples may be used to estimate precision.

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

where: RPD = relative percent difference

D_1 = first sample value

D_2 = second sample value (duplicate)

Accuracy is a determination of how close the measurement is to the true value. Accuracy can be assessed using LCS, standard reference materials, or spiked environmental samples. Unless specified otherwise in special contracts, Enseco monitors accuracy by comparing LCS results with control limits established at plus or minus three standard deviation units from the mean of historical LCS results.

The determination of the accuracy of a measurement requires a knowledge of the true or accepted value for the signal being measured. Accuracy may be calculated in terms of percent recovery as follows:

$$\text{Percent Recovery} = \frac{x}{T} \times 100$$

where: x = the observed value of measurement

T = "true" value

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Analytical data should represent the sample analyzed regardless of the heterogeneity of the original sample matrix. Enseco strives to accommodate all sample matrices. Some samples may require analysis of multiple phases to obtain representative results.

Completeness is a measure of the amount of valid data obtained from a measurement system compared with the amount that was expected to be obtained under normal conditions.

To be considered complete, the data set must contain all analytical results and data specified for the project. In addition, all data are compared to project requirements to ensure that specifications were met. Any deviations are reported in the report narrative.

The percent completeness for each set of samples can be calculated as follows:

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

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved analytical methods, consistency in the basis of analysis (wet weight, volume, etc.), consistency in reporting units (ppm, ppb, etc.), and analysis of standard reference materials.

Reporting Limits

Assuring the validity of quantitative measurements at low concentrations is an extremely difficult technical problem. With regulatory action levels being pushed lower and lower, the validity of any given measurement becomes even more important. The consequences of false positive or false negative data can be significant.

A number of terms have been used, by the EPA and other technical groups, to express the lowest concentration of an analyte which can be measured. Some of these terms, their definitions, and sources are listed in Table 14-1. A graphical representation of these terms is given in Figure 14-1.

Enseco takes very seriously its responsibility to report technically defensible data. Therefore, we have established a Reporting Limit (RL) for each analyte in each method. The RL represents the value above which we believe reliable data can be routinely obtained.

These Reporting Limits were established by collecting Method Detection Limit (MDL) data for organic and wet chemistry analyses and Instrument Detection Limit (IDL) data for metals analyses from each Enseco laboratory. The MDL data were collected using the procedures described in 40 CFR 136 Appendix B. IDL data were calculated using the procedures outlined in the EPA Contract Laboratory Program (CLP) Statement of Work dated 7/88. The MDL/IDL data were then compared to various limits published in EPA methods and in the regulations. For example for

Volatile Organics, the MDL data generated in Enseco laboratories were compared to the Practical Quantitation Limits (PQLs) published in SW-846 method 8240; the PQLs contained in the July 9, 1987, Federal Register Final Rulemaking on Appendix IX; the Contract Required Quantitation Limits (CRQLs) in the CLP Method for Volatile Organics; and the MDLs in Method 624. Then a Reporting Limit for each analyte was established which considered all of this information. The RL was set at a level above which we were confident that our laboratories could detect and quantify the analyte consistently. Using this procedure, the Reporting Limits established are generally between 2 to 5 times the laboratory MDL/IDL. This range is consistent with the American Chemical Society definition for the Limit of Quantitation (LOQ). (See Table 14-1)

Enseco routinely reports results below the reporting limit as Not Detected (ND) because, by definition, the reliability of the data at that level is questionable. As an option, Enseco can report data below the reporting limit and flag the data. Reporting limits are adjusted for sample dilution.

TABLE 14-1

DEFINITION OF DETECTION LIMIT TERMS

	DEFINITION	DETERMINATION	CALCULATION	SOURCE
ıtection Limit (DL)	The concentration which is distinctly detectable above, but close to a blank.	Analysis of replicate standards	Two times the standard deviation	Methods for Chemical Analysis of Water and Wastes
mit of Detection (LOD)	The lowest concentration that can be determined to be statistically different from a blank	Analysis of replicate samples	Three times the standard deviation	ACS Definition
ıthod Detection Limit MDL)	The minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero.	Analysis of a minimum of seven replicates spiked at 1 to 5 times the expected detection limit.	The standard deviation times the Student t-value at the desired confidence level. (For seven replicates, the value is 3.14)	40 CFR 136 Definition for EPA Water Programs
ıstrument Detection ımit (IDL)	The smallest signal above background noise that an instrument can detect reliably.	Analysis of seven replicate standards on three non-consecutive days.	Three times the standard deviation	Contract Laboratory Program
ethod Quantitation Limit MQL)	The minimum concentration of a substance that can be measured and reported	Analysis of replicate samples	Five times the standard deviation	SW-846
of Quantitation	The level above which quantitative results may be obtained with a specified degree of confidence	Analysis of replicate samples	Ten times the standard deviation	ACS Definition
cal Quantitation (PQL)	The lowest level that can be reliably determined within specified limits of precision and accuracy during routine laboratory operating conditions	Interlaboratory analysis of check samples	1) Ten times the MDL 2) Value where 80% of laboratories are within 20% of the true value	RCRA SDWA Programs
ontract Required	Reporting limit specified	Unknown	Unknown	

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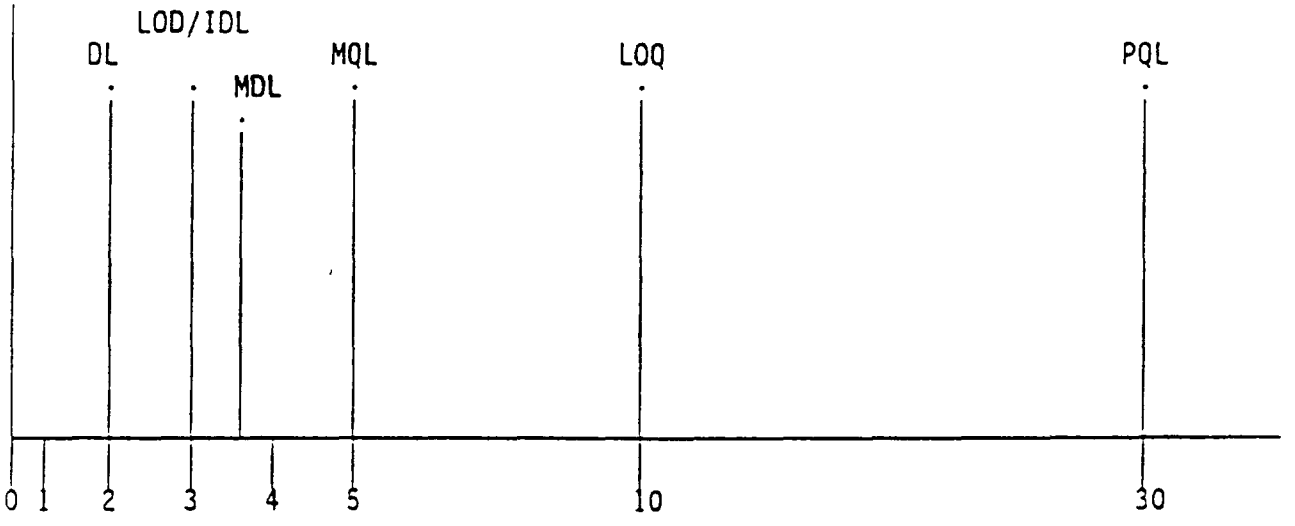
FIGURE 14-1

Graphical Representation of Detection Limit Terms
(See Table 14-1 for Definitions)



MULTIPLIER OF STANDARD DEVIATION OF REPLICATES

NOTE: The values along the horizontal "Standard Deviation (SD)" axis are approximate values and are meant to show the relative, not absolute, relationship between the terms.

15. CORRECTIVE ACTION

When errors, deficiencies, or out-of-control situations exist, the QA program provides systematic procedures, called "corrective actions," to resolve problems and restore proper functioning to the analytical system.

Laboratory personnel are alerted that corrective actions may be necessary if:

- QC data are outside the acceptable windows for precision and accuracy;
- Blanks, DCS or SCS contain contaminants above acceptable levels;
- Undesirable trends are detected in spike recoveries or RPD between duplicates;
- There are unusual changes in detection limits;
- Deficiencies are detected by the QA department during internal or external audits or from the results of performance evaluation samples; or
- Inquiries concerning data quality are received from clients.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory supervisor, manager and/or QA department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with the project records.

16. QA REPORTS TO MANAGEMENT

The 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 Corporate QA Director, the Director of Quality Assurance and Technology, the General Manager and the President. These reports include:

- The results of internal systems audits including any corrective actions taken;
- Performance evaluation scores and commentaries;
- Results of site visits and audits by regulatory agencies and clients;
- Performance on major contracts, (including CLP);
- Problems encountered and corrective actions taken;
- Holding time violations;
- Comments and recommendations; and
- A summary of the 5% QA data audits conducted.

The Corporate QA Director regularly reports on the status of the QA Program to the President and each General Manager. These reports summarize the information gathered through the laboratory reporting system and contain a thorough review and evaluation of laboratory operations throughout Enseco.

17. LABORATORY DOCUMENTATION

Complete and accurate documentation of analytical and procedural information is an important part of the QA program. The following describes different types of documentation used in the Enseco laboratories.

SOPs

Details of analytical and QC protocols are contained in SOPs. SOPs are documents that contain detailed proprietary information on how to perform a laboratory procedure. Enseco has four categories of laboratory SOPs:

- SOPs for Performance of an Analytical Method;
- SOPs for Preparation of Standards and Reagents;
- SOPs for Equipment Operation, Calibration, and Maintenance; and
- SOPs for General Laboratory Procedures.

The formats for these SOPs are given in Appendix II.

All SOPs are approved by the QA Department before being implemented. The distribution of current SOPs and archiving of outdated ones is controlled through the QA Department.

Because of the detailed nature of SOPs, Enseco considers them to be proprietary documents. SOPs are available for review at each location.

LIMS

Enseco laboratories rely on a customized Laboratory Information Management System (LIMS) as the primary database. Client information, sample results, and QC results are all stored in the LIMS. Reports are generated directly from the database to eliminate transcription errors. A tiered security system is in place to control the ability of lab personnel to change results, and the system is designed with an audit trail that identifies when information has been changed and who changed it. The most recent data are kept on-line. Data are periodically archived on magnetic tape or optical disk.

Laboratory Bench Sheets

Laboratory bench sheets are used to document information from routine laboratory operations, including sample preparation and analysis. Bench sheets are used to ensure that the information is recorded in a complete and organized manner and that the analysis can be reconstructed, if necessary. Portions of information from the bench sheet are also stored in the LIMS. Each bench sheet is initialed and dated as information is entered.

Laboratory Notebooks

Laboratory notebooks are used to document information that cannot easily be recorded on benchsheets such as methods development information. Each page in a laboratory notebook is initialed and dated as information is entered.

Control Charts

Enseco laboratories use control charts to visually track the LCS precision and accuracy data. These control charts are used to identify trends in the analyses which may indicate a problem with the analytical procedure. When an adverse trend is detected corrective action is performed.

Anomaly Forms

Any situation which is outside of the normal scope of operations, as described in the laboratory SOPs, is documented on an Anomaly Form. Examples of anomalous situations include: formation of a precipitate in an extract; formation of an emulsion during an extraction step; or missed holding times. These situations are documented to enable a thorough review of the data to occur.

Out-of-Control situations are also documented on Anomaly Forms. An Out-of-Control situation occurs when QC data fall outside of established control limits. The documentation associated with an Out-of-Control situation is reviewed by the supervisor and the QA Department. Out-of-Control situations trigger Corrective Action. Corrective Actions taken are also documented on the Anomaly Form.

Project Files

The project file consists of a project summary file and a raw data file. The project summary file includes correspondence from the client, (letters, phone logs, contracts, project plans) copies of preliminary and final reports, chain of custody, air bills, photographs of samples, level 3 review checklists, QA review checklist when applicable and the summary

file inventory. The raw data file includes sample data, QC data, benchsheets, level 1 and level 2 review checklists, instrument logbook pages pertinent to the project and the raw data file inventory. Contracts, project plans, calibration data and QC data may be stored separately from the project record. All project records contain cross-references to this information. When a project is complete, all records are passed to the Document Custodian who inventories the file, checks for completeness, and puts the file into document archive.

APPENDIX I

MAXIMUM HOLDING TIMES AND SAMPLE COLLECTION/PRESERVATION INFORMATION

Sources:

Tables A-E
Federal Register, October 26, 1984
Methods for Chemical Analyses of Water and Wastes
SW-846, 3rd Edition, Update I
State of California Leaking Underground
Fuel Tank Field Manual, May 1988

Table F:
Contract Laboratory Program Statement of
Work for Organic Analysis dated 3/90 (as amended)
Contract Laboratory Program Statement of
Work for Inorganic Analysis dated 7/88

Table G:
Federal Register, June 29, 1990

(QA Program Plan, Revision 3.4)

A. VOLATILE ORGANICS

Matrix	Container	Minimum Sample Size	Preservative	Holding Time (From Date Sampled)
Water Samples				
No Residual Chlorine Present	3 40 mL vials with Teflon lined septum caps	40 mL	HCl to pH<2, 4°C	14 days
Residual Chlorine Present	3 40 mL vials with Teflon lined septum caps	40 mL	4 drops of 10% sodium thiosulfate, HCl to pH<2, 4°C	14 days
Acrolein and Acrylonitrile	3 40 mL vials with Teflon lined septum caps	40 mL	Adjust to pH 4-5, 4°C	14 days
Soil/Sediments and Sludges	Glass jar with Teflon liner or core tube	10 g	4°C	14 days
Concentrated Waste Samples	Glass jar with Teflon liner or core tube	10 g	None	14 days

The above information applies to the following parameters and methods:

Parameter	Method
Volatile Halocarbons	601/8010 (GC)
Volatile Aromatics	602/8020 (GC)
Volatile Organics	624/8240/8260 (GC/MS), 8015 (GC)
Acrolein/Acrylonitrile	603/8030 (GC)

B. SEMIVOLATILE ORGANICS

Matrix	Container	Minimum Sample Size	Preservative	Holding Time (From Date Sampled)
Water Samples				
No Residual Chlorine Present	1 liter glass with Teflon liner	1 liter	4°C	Samples must be extracted within 7 days and analyzed within 40 days of extraction.
Residual Chlorine Present	1 liter glass with Teflon liner	1 liter	Add 3 mL 10% sodium thiosulfate per gallon, 4°C	Samples must be extracted within 7 days and analyzed within 40 days of extraction.
Soil/Sediments and Sludges	Glass jar with Teflon liner or core tube	50 g	4°C	Samples must be extracted within 14 days and analyzed within 40 days of extraction.
Concentrated Waste Samples	Glass jar with Teflon liner or core tube	50 g	None	Samples must be extracted within 14 days and analyzed within 40 days of extraction.

The above information applies to the following parameters and methods:

Parameter	Method
Phenols	604/8040 (GC)
Phthalate Esters	606/8060 (GC)
Organochlorine Pesticides/PCBs	608/8080 (GC)
Polyaromaltic Hydrocarbons	610/8310 (HPLC)
Organophosphate Pesticides	614/8140 (GC)
Phenoxy acid Herbicides	615/8150 (GC)
Semivolatile Organics	625/8270 (GC/MS)
Carbamate & Urea Pesticides	632 (HPLC)

C. OTHER ORGANICS

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Dioxins/Furans	8280	Water	30 days extn. 45 days anal.[b]	One liter glass	4°C	1000 ml
		Soil/Waste	30 days extn. 45 days anal.[b]	core tube or glass jar	4°C	50 g
Petroleum Hydrocarbons as Gasoline	TPH-Gasoline Purge & Trap (LUFT manual)	Water	14 days	3 40 mL vials with Teflon liners	4°C, HCl to pH < 2	40 ml.
		Soil/Waste	14 days	Core tube or glass jar	4°C	50 g
Petroleum Hydrocarbons as Gasoline	TPH-Gasoline Extractable (LUFT manual)	Water	14 days extn. 40 days anal.	One liter glass	4°C, HCl to pH < 2	500 ml.
		Soil/Waste	14 days extn. 40 days anal.	Core tube or glass jar	4°C	50 g
Petroleum ocarbons iesel	TPH-Diesel Extractable (LUFT manual)	Water	14 days extn. 40 days anal.	One liter glass	4°C	500 ml.
		Soil/Waste	14 days extn. 40 days anal.	Core tube or glass jar	4°C	50 g
oleum ocarbons)	TPH-IR (418.1)	Water	28 days	One liter glass	4°C, H_2SO_4 to pH < 2	1000 ml.

extn: extraction anal: analysis

from date of collection

D. METALS

Parameter	Method No.	Matrix	Holding Time (from Date Sampled to Analysis)	Container	Preservative[a]	Min. Sample Size
Metals (ICP)	200.7/6010	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
		Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Arsenic (GF-AA)	206.2/7060	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
		Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Mercury (CV-AA)	245.1/7470	Water	28 days	Poly	HNO_3 to pH < 2.0	100 ml
		Soil/Waste	28 days	core tube/glass jar	4°C	10 g
Selenium (GF-AA)	270.2/7740	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
		Soil/Waste	6 months	core tube/glass jar	4°C	10 g
Thallium (GF-AA)	279.2/7841	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
		Soil/Waste	6 months	core tube/glass jar	4°C	10 g
	239.2/7421	Water	6 months	Poly	HNO_3 to pH < 2.0	100 ml
A)		Soil/Waste	6 months	core tube/glass jar	4°C	10 g
lum (III/VI)	220.7/218.4/ 312B/7197	Water	24 hours	Poly	4°C	100 ml
		Soil/Waste	24 hours extn. [b]	core tube/glass jar	4°C	10 g

(a) sted preservative is for total metals. Dissolved or suspended metals require filtration prior to pH adjustment.

(b) extn: extraction

E. WET CHEMISTRY

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled to Analysis)	Container	Preservative	Min. Sample Size
Acidity	305.1	Water	14 days	Poly	4°C	50 ml
Alkalinity	310.1	Water	14 days	Poly	4°C	50 ml
Ammonia	350.1	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	50 ml
Biochemical Oxygen Demand	405.1	Water	48 hours	Poly	4°C	200 ml
Bromide	Dionex	Water	28 days	Poly	4°C	50 ml
Chemical Oxygen Demand	410.4	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	100 ml
oride	300.0	Water	28 days	Poly	4°C	50 ml
rine, dual	330.1	Water	ASAP	Poly	4°C	100 ml
orm, Total al	909A/ 909C	Water	6 hours	Sterile poly	4°C, $Na_2S_2O_3$	100 ml
Color	110.2	Water	48 hours	Poly	4°C	100 ml

E. WET CHEMISTRY (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Cyanide	335.1/ 335.2/335.3	Water	14 days	Poly	4°C, NaOH to pH > 12	250 ml
Fluoride	340.2	Water	28 days	Poly	4°C	50 ml
Gross Alpha, Beta and Radium	9310/ 9315	Water	6 months	Poly	HNO_3 to ph < 2	2000 ml
Hardness	200.7/ 314A/314B	Water	6 months	Poly	HNO_3 to pH < 2	50 ml
Iodide	Dionex	Water	28 days	Poly	4°C	50 ml
Nitrate	353.2/300.0	Water	48 hours	Poly	4°C	50 ml
Nitrite	354.1	Water	48 hours	Poly	4°C	50 ml
Nitrite plus Nitrate	353.2	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	50 ml
Odor	140.1	Water	ASAP	Glass	4°C	1000 ml.

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E. WET CHEMISTRY (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Oil and Grease	413.1/ 413.2	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	1000 ml
Organic Carbon (TOC)	415.1	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	100 ml
Organic Halogen (TOX)	9020	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	200 ml
Orthophosphate	365.3	Water	48 hours	Poly	4°C	100 ml
pH	150.1	Water	ASAP	Poly	4°C	50 ml
Phenolics	420.1/ 420.2	Water	28 days (b)	Glass	4°C, H_2SO_4 to ph < 2	100 ml
Specific Conductance	120.1	Water	28 days	Poly	4°C	50 ml
Sulfate	300.0	Water	28 days	Poly	4°C	50 ml
Sulfide	376.2	Water	7 days	Poly	4°C, NaOH to pH > 9 $Zn(C_2H_3O_3)_2$	100 ml

E. WET CHEMISTRY (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Sulfite	377.1	Water	ASAP	Poly	4°C	100 ml
Surfactants (MBAS)	425.1	Water	48 hours	Poly	4°C	100 ml
Total Dissolved Solids	160.1	Water	7 days	Poly	4°C	100 ml
Total Kjeldahl Nitrogen	351.2	Water	28 days	Glass	4°C, H_2SO_4 to pH < 2	100 ml
Total Phosphorus	365.3	Water	28 days	Glass	H_2SO_4 to pH < 2	100 ml
Total Solids	160.3	Water	7 days	Poly	4°C	100 ml
Total Suspended Solids	160.2	Water	7 days	Poly	4°C	100 ml
Total Volatile Solids	160.4	Water	7 days	Poly	4°C	100 ml

E. WET CHEMISTRY (Cont.)

Parameter	Method No.	Matrix	Holding Time[a] (from Date Sampled)	Container	Preservative	Min. Sample Size
Turbidity	180.1	Water	48 hours	Poly	4°C	50 ml

a) Parameters with holding times of 24 hours or less are analyzed on the day of receipt in the laboratory. Parameters with holding times between 24 and 48 hours are analyzed within one day of receipt in the laboratory.

b) The 28 day holding time comes from Table 1 of Methods for Chemical Analysis of Water and Wastes, issued March 1983. This information supercedes that contained in Method 420.1/420.2 published in 1979.

F. CLP HOLDING TIMES

Parameter	Matrix	Holding Time[a] (from Date Received)	Container	Preservative	Min. Sample Size
Volatile Organics	Water	10 days	3 40 mL vials with Teflon lined caps	4°C	40 mL
	Soil	10 days	Glass jar with Teflon liner or core tube	4°C	10 g
Extractable Organics	Water	5 days extn. 40 days anal.	1 liter glass with Teflon liner	4°C	1000 mL
	Soil	10 days extn. 40 days anal.	Glass jar with Teflon liner or core tube	4°C	50 g
Metals (other than Mercury)	Water	180 days	P,G [b]	HNO_3 to pH < 2	100 mL
	Soil	180 days	P,G	4°C	10 g
Mercury	Water	26 days	P,G	HNO_3 to pH < 2	100 mL
	Soil	26 days	P,G	4°C	10 g
Cyanide	Water	12 days	P,G	0.6 g ascorbic acid,[c] NaOH to pH >12, 4°C	100 mL
	Soil	12 days	P,G	4°C	10 g

(a) Holding times calculated from date of receipt in laboratory
(b) Polyethylene (P) or glass (G)
(c) Only used in the presence of residual chlorine

G. TCLP HOLDING TIMES

arameter	Matrix	From: Field Collection To: TCLP Extraction	From: TCLP Extraction To: Prep Extraction	From: Prep Extraction To: Determination Analy.	Container	Preservative	Min. Sample Size
olatiles	Waste	14	NA	14	Glass	4 degrees C	4 oz
emivolatiles	Waste	14	7	40	Glass	4 degrees C	32 oz (1)
ercury	Waste	28	NA	28	Glass	4 degrees C	32 oz (1)
etals (Except Mercury)	Waste	180	NA	180	Glass	4 degrees C	32 oz (1)

(1) Smaller sample size is adequate for solid samples or individual fractions. A combined volume of 32 oz is recommended for semivolatiles and metals. A separate 4 oz container should always be used for the volatile fraction. Volatile fractions should be stored with minimal headspace.

APPENDIX II

FORMATS FOR STANDARD OPERATING PROCEDURES (SOP)

(QA Program Plan, Revision 3.

FORMAT FOR SOP - LABORATORY, ANALYTICAL METHOD

Title (includes method number)

1. Scope and Application
   - 1.1 Analytes
   - 1.2 Detection limit (instrument and method)
   - 1.3 Applicable matrices
   - 1.4 Dynamic range
   - 1.5 Approximate analytical time (i.e., 5 minutes, 2 days)

2. Method Summary
   - 2.1 Generic description of method and chemistry behind it (i.e., extract with solvent, convert to methyl ester, analyze by electron-capture gas chromatography)

3. Comments
   - 3.1 Interferences
   - 3.2 Helpful hints

4. Safety Issues

5. Sample Collection, Preservation, Containers, and Holding Times

6. Apparatus

7. Reagents and Standards

8. Procedure (detailed step-by-step)
   - 8.1 Sample preparation
   - 8.2 Calibration
   - 8.3 Analysis

FORMAT FOR SOP - LABORATORY, ANALYTICAL METHOD
(cont.)

9. QA/QC Requirements

   9.1 QC samples

   9.2 Acceptance criteria (precision and accuracy, % of multi-component QC analytes which must be within windows)

   9.3 Corrective action required (reference current QC manual)

10. Calculations

11. Reporting

   11.1 Reporting units

   11.2 Reporting limits

   11.3 Significant figures and reporting values below detection limit

   11.4 LIMS data entry

12. References

   12.1 Method source

   12.2 Deviations from source method and rationale

13. Appendices (optional)

   Additional information may be placed in appendices. This may include supporting data (e.g. method validation information), tables, flow charts. etc.

FORMAT FOR SOP - LABORATORY, STANDARDS AND REAGENTS

Title

1. Reagent/Standard Name

2. Type (reagent, calibration standard, DCS, SCS, stock solution, etc.)

3. Constituents/concentration/solvent

4. Safety Issues

5. Shelf Life

6. Procedure

   6.1 Preparation
   6.2 Documentation (purchase date, open date, labeling, etc.)
   6.3 Verification

7. Responsibilities

8. Appendices (optional) Any additional information.

FORMAT FOR SOP - LABORATORY, EQUIPMENT OPERATION, CALIBRATION, AND MAINTENANCE

Title

1. Purpose

2. Safety Issues (applicable to the specific equipment)

3. Procedure

   3.1 Initial start-up
   3.2 Calibration and performance documentation
   3.3 Example output
   3.4 Shut-down sequence
   3.5 Maintenance and maintenance records

4. Responsibilities

5. Comments

6. Definitions

7. Appendices (optional) Any additional information.

FORMAT FOR SOP - LABORATORY, PROCEDURAL

Title

1. Purpose
2. Policies
3. Safety Issues
4. Procedure
5. Responsibilities
6. Comments
7. Definitions
8. Appendices (optional) Any additional information.

APPENDIX F

RESUMES OF KEY PERSONNEL

Ana Gloria Ramos
Zaragoza #2
Villa España
Bayamón, Puerto Rico 00619

Home: (809) 780-5577
Office: (809) 792-2920

Environmental/Safety/Health/Project Engineer

Twenty years of Environmental Protection Safety and Health Management, and all Phases of Project Engineering and Coordination.

EMPLOYMENT HISTORY

Esso Standard Oil Company (Puerto Rico)

Environmental Protection, Safety and Health Coordinator

1985 To Present

- Coordinate all environmental, safety and health efforts and procedures for Esso's Central Caribbean operations which includes Puerto Rico, U.S. Virgin Islands, Dominican Republic and Haití
- Direct supervision and evaluation of UST assessments and corrective actions under the EPA Underground Storage Tank Regulations for the Esso service stations in Puerto Rico and U.S. Virgin Islands
- In charge of corporate environmental compliance audits at Esso's bulk terminal facilities and service stations
- Corporate coordinator for environmental, safety and health local and federal regulatory affairs, including the following govermental agencies: U.S. Environmental Protection Agency, Puerto Rico Environmental Quality Board, Department of Planning and Natural Resources of the U.S. Virgin Islands; OSHA, OSHO, among other .
- Direct coordinator for all environmental, safety and health consultants retained by Esso for its Central Caribbean operations

- Responsible for environmental reporting and record-keeping requirements under all applicable federal and local environmental laws and regulations

Union Carbide Caribe Inc. (UCCI) - Ponce, P.R.

Safety & Health Coordinator 1980 to 1985

- Control of annual department budget of $1MM which led to the reduction of $300M annually
- Direct Supervision and evaluation of two exempt (Safety and Health Supervisor) and four technicians
- Developed and recommended annual Safety & Health Program, new Safety & Health Procedures, and Mandatory Training program
- Coordinated test, inspection and maintenance of fire and respiratory protection equipment
- Prepared report and analysis of safety statistics, i.e., on-the-job and off-the-job injury analysis, unsafe condition reports, accidents and incident reports, OSHA Form 200 report and Chemical Manufacturers Association injuries report, also classification of injuries in accordance with ANSI.
- Member of multidivision Fire Protection, Process & Personnel Safety and Occupational Health Audit Team
- Conducted in-house safety and health audits every year
- Screened, interpreted and procured line management action of OSHA and PROSHO regulations also of Corporate Safety and Health procedures

Senior Project Engineer 1978 to 1980

- Designed, cost estimated and field inspected a total of 33MM in capital projects, a partial list follows:
  - Internal Floating Roof installation
  - Unit Control Room building expansion
  - Deminralized water Neutfalization System
  - Energy conservation projects (heat exchangers)

- Environmental Protection and Fire Protection related projects

Advanced Project Engineer 1974 to 1978

- Designed, cost estimated and field inspected and controlled engineering projects for:
  - Utilities unit including sewer revisions and raw water storage and transfer facilities
  - Wastewater effluent pipe - fiberglass installation
  - Purchased and installed 10 high-speed surface aerators ($400M) at wastewater Treatment Plant
  - Designed and installed distillation column

Area Project Engineer 1971 to 1974

- Designed, cost estimated and implementation of engineering projects

Area Process Engineer 1970 to 1971

- Supervised and improved efficiency of operational units (training purposes)

Area Process Engineer 1969 to 1970

- Trainee at the Plant Engineering Department becoming familiar with cost estimate procedures, preparation of projects for drafting, reading of troop, electrical, piping and instrument drawings

EDUCATION

- B.S. in Chemical Engineering, 1969 - University of Puerto Rico
- Radiation Protection Officers West Virginia - 1983 - Obtained License
- Construction Supervisors and OSHA New Developments Safety Seminar - 1981

- Interaction Management, (1980); Time Management (1979); Professional Management (Louis A. Allen Associates, 1974)
- Fundamentals of Fire Explosion Hazards, AICHE, Charleston, W.Va., 1980
- Management and Control of Toxic and Hazardous Substances, CIA, 1979
- Advanced Water Pollution Control, University of Texas at Austin, 1974
- Process Design in Water Quality, Vanderbilt University, 1973
- Annual Environmental Update Seminar of the Puerto Rico Manufacturers Association (PRMA) - (1986, 1987, 1988, 1989)

LANGUAGES English and Spanish

ASSOCIATIONS

- Association of Engineers and Surveyours of Puerto Rico P.E. License #5891
- Sociedad Profesionales de Prevención de Accidentes de Puerto Rico - 1984
- Industrial Hygiene Association of P.R.
- Chairperson of the Safety & Health Committee of the Puerto Rico Manufacturing Association (PRMA)
- Member of the Environmental Committee of PRMA

SOIL TECH

RESUME

NAME	:	José C. Agrelot-Peña
ADDRESS	:	P.O. Box 1704 Hato Rey Station Hato Rey, P.R. 00919
SOCIAL SECURITY NO.	:	583-50-9762
DATE AND PLACE OF BIRTH	:	July 1, 1951 - Santurce, Puerto Rico
TITLE	:	Master of Science in Civil Engineering
LICENSE	:	Puerto Rico No. 7362 - Issued: July, 1975
ACADEMIC PREPARATION	:	
High School	:	San José School - Río Piedras, P.R. 1966 - 1969 - General Diploma
University	:	U.P.R. Mayaguez Campus - Mayaguez, P.R. 1969 - 1974 - Bachellor of Science in Civil Engineering
		U.P.R. Mayaguez Campus - Mayaguez, P.R. 1974 - 1977 - Master of Science in Civil Engineering, specialized in Soil Mechanics and Foundations

PROFESSIONAL EXPERIENCE :

1. Soil Tech Corporation

   Address: Corner of Amur and Duina Street
   Reparto Landrau
   Río Piedras, Puerto Rico 00927

   Telephone: 792-8900

   Responsibilities:

   1. President of Soil Tech Corporation
   2. Administrative Coordination
   3. Report writing, invoicing and personnel supervision.

RESUME

(José C. Agrelot)

2. Partner - Ortíz, Agrelot & Cardona

Address: State Road #838 - Monacillos Ward #1757
Río Piedras, Puerto Rico 00928

Telephones: 751-4994 / 763-4753 / 751-4639

Responsibilities:

1. Report writing and invoicing. Field personnel supervision.

2. Secretary/Treasurer of Corporación Geotec

3. Partner - Paniagua, Rodrígues, García, Crumley & Solum de Puerto Rico, Inc.

Address: Mayagues Street No. 70
Hato Rey, Puerto Rico 00917

Time Employed: May 1977 until November 1978

Position: Soils and Foundation Engineer

Responsibilities:

Report writing and invoicing. Performance of special laboratory tests. Field personnel supervision.

4. Employer - University of Puerto Rico - Mayaguez Campus

Address: Civil Engineering Department - R.U.M.
Mayaguez, Puerto Rico

Time Employed: August 1974 until May 1977

Position: Instructor

Director of the Soil Mechanics Laboratory
(June 30, 1976 until June 30, 1977)

RESUME

(José C. Agrelot)

Responsibilities:

Teaching Soil Mechanics I - (INCI 441)
Soil Mechanics Lab. I - (INCI 443)
Soil Mechanics Advanced Lab. - (INCI 643)
Soil Mechanics II - (INCI 542)

Director of the Soil Mechanics Laboratories

5. Employer - University of Puerto Rico - Mayaguez Campus

Address: Technical Institute
Mayaguez Campus
Mayaguez, Puerto Rico

Time Employed: August 1976 until May 1977

Position: Instructor

Responsibilities:

Teaching Advanced Mathematics

RESUME

(José C. Agrelot)

MEMBERSHIP IN PROFESSIONAL SOCIETIES:

1. Associate Member - (American Society of Civil Engineers)
   (Section President)
2. Member - "Colegio de Ingenieros y Agrimensores de Puerto Rico"
3. Member - TAU BETA PI Honorary Society
4. Member - American Concrete Institute
5. Member - Home Builders Association
6. Member - Association of General Contractors
7. Member - "Sociedad de Ingenieros Geotécnicos de Puerto Rico"
   Past President (1981 - 1983)
8. Member - National Water Works Association
9. Member - Asociación de Recursos de Agua de P.R.
   (Past President 1986-1987)

PUBLICATIONS:

1. "Análisis de la Hinca de Pilotes por la Ecuación de Propagación de Onda"

   Biblioteca de la U.P.R. - Recinto de Mayagues - 1977

2. Grouting Caverns and Soft Zones by Concrete Pumps

   American Society of Civil Engineers, Grouting in Geotechnical Engineering Specialty Conference - 1982

3. Vacuum: Defense System for Ground Water VOC Contamination
   Proceedings of Fifth National Symposium and Exposition of Aquifer Restoration and Ground Water Monitoring, May 21-24 1985.

RESUME

(José C. Agrelot)

4. Investigation, Analysis and Remedial Actions taken for the containment of groundwater contamination in a karst environment. (International Symposium on Tropical Hydrology and Second Caribbean Islands Water Resources Congress, 1985).

5. Run-Off Disposal in the Limestone Region of Northern P.R.

(International Symposium on Tropical Hydrology and Second Caribbean Islands Water Resources Congress, 1985.)

DANIEL A. NACHMAN

Vice President

CREDENTIALS/REGISTRATION

B.S. Geology, New York University, 1973
M.S. Geology, Oregon State University, 1977
Certified Professional Geologist: AIPG No. 6524
Registered Geologist, Commonwealth of Virginia No. 000425

PROFESSIONAL AFFILIATIONS

National Water Well Association
Geologic Association of New Jersey

FIELDS OF SPECIALIZATION

- Regional hydrogeologic assessments and management programs, well head and aquifer protection strategies.
- Exploration and development of ground-water resources.
- Design of test-well and production-well drilling programs.
- Development of well field maintenance and rehabilitation programs.
- Ground-water contamination investigations and design of monitoring programs.
- Evaluation of ground-water flow regimes in complex alluvial, glacial, and other sedimentary depositional environments.
- Interpretation of ground-water quality data.
- Expert testimony.

EXPERIENCE SUMMARY

Mr. Nachman has over 12 years of experience in hydrogeology. He has directed and implemented a wide variety of ground-water supply and contamination studies throughout the United States, particularly in New Jersey, New York, and Puerto Rico. He has developed regional aquifer assessment and ground-water exploration programs for industries, private water companies, and public utilities. He has extensive experience in the design and implementation of remedial investigations under Superfund, RCRA, and state regulations.

Mr. Nachman has lectured at graduate level courses in hydrogeology at Stevens College in Hoboken, New Jersey and at the New Jersey Institute of Technology in Newark, New Jersey. He has also presented several talks on ground-water contamination and aquifer protection at seminars sponsored by various agencies and associations. Mr. Nachman has served as the manager of Geraghty & Miller's Hackensack, New Jersey office and is presently manager of the firm's office in Santurce, Puerto Rico.

KEY PROJECTS

- Carried out field investigations and supervised test drilling and pumping operations for expansion of the ground-water supply system for the Puerto Rico Water Resources Authority power plant in Aguirre, Puerto Rico. Responsible for data collection and supervision of test drilling at several proposed power-plant sites in Puerto Rico.

- Coordinated and supervised an extensive investigation of existing and potential ground-water resources for the government of the U. S. Virgin Islands.

- Contributed to the preparation of a ground-water management plan and a strategy for assessment of Class V underground injection wells for the U. S. Virgin Islands.

- Coordinated and managed a Remedial Investigation/Feasibility Study (RI/FS) at an industrial facility in northwestern New Jersey, under an Administrative Consent Order issued by the New Jersey Department of Environmental Protection (NJDEP). Study involved geophysical surveys, monitoring well installation, and sampling of ground water, soils, surface water, and surrounding domestic wells, to define contaminant extent and assess the feasibility of remedial alternatives. Served as project officer/senior technical advisor for the Phase II RI.

- Conducted a ground-water contamination and remedial investigation in Morris County, New Jersey. Studies included delineation of two separate contaminant plumes, the design of recovery-well networks for the removal of contaminated water, and the design of injection-well networks for the reinjection of treated ground water. Project involved the preparation of permit applications for working in designated wetlands, injecting treated water, and long-term remediation and monitoring.

- Implemented several projects at an oil refinery in Puerto Rico, including ground-water exploration programs to augment the refinery's water supply; the modification and regular sampling of a RCRA monitoring well network; and a subsurface investigation associated with a fuel spill.

- Assisted property owners and a New Jersey township in evaluating the suitability of a site designated for a hazardous waste incinerator within the hydrogeologic parameters specified in the New Jersey Hazardous Waste Facility Siting Act. The project included field data collection, interpretation of hydrogeologic and climatological data, and the presentation of findings at public hearings. As a result of this study, the site was delisted as a possible incinerator location.

KEY PROJECTS (Continued)

- Conducted a soil and ground-water quality study at an industrial facility as part of a Superfund investigation at a site in western New York State. Project included collection of soil samples for chemical analysis, monitoring well installation, slug tests, and long-term pumping tests to define the plant production well's capture zone. Coauthored report that assessed the facility's potential as a source of contamination to a municipal well field, and participated in negotiations with the USEPA on the need for additional investigative and remedial work.

- Assisted a township in Sussex County, New Jersey in assessing the state's plan to blend and dispose radium-contaminated soils at a sand and gravel quarry. The project involved preparing an independent environmental site assessment and identifying potential impacts to ground-water quality from the proposed disposal.

- Coordinated a study to identify alternative sources of water for a water company in Burlington County, New Jersey. Project was initiated in response to the state's plan to curtail pumpage from the Potomac-Raritan-Magothy aquifer system. Tasks included identification of sources of ground water and surface water, the selection of test-drilling sites, and predictions of long-term yields from well fields.

- Coordinated an extensive well-field rehabilitation program for a private water company in Essex County, New Jersey. Project included selection of well-development techniques and design of pumping tests to evaluate effectiveness of well redevelopment.

- Responsible for preliminary assessment of ground- and surface-water resources for a resort complex on St. Croix.

- Coordinated a complex seismic investigation on an undeveloped site in Dutchess County, New York. The project included mapping of buried bedrock surface, siting of monitoring wells, and interpretation of subsurface hydrogeologic conditions.

- Assisted with a complex study of ground-water contamination at the Rocky Mountain Arsenal in Denver, Colorado. Compiled geologic and water-quality data, and prepared contaminant distribution maps, cross sections, and water-level maps. Investigated regional aquifer conditions in the area.

KEY PROJECTS (Continued)

- Supervised drilling operations and prepared reports in connection with ground-water contamination investigations in Pittsfield, Massachusetts, Fort Edward, New York, Baton Rouge, Louisiana, and Rockford, Illinois.

- Designed and managed several projects at industrial properties carried out in compliance with New Jersey's Environmental Cleanup Responsibility Act. Projects involved soil sampling, monitoring well installation and sampling, pumping tests, assessment of remedial alternatives, preparation of cleanup plans, and negotiation with the NJDEP to establish cleanup levels.

- Responsible for several litigation-related projects. Work included evaluation of reports prepared by other consultants, identification of key hydrogeologic and water-quality issues, preparation of expert reports, and presentation of testimony at depositions, public hearings, and court proceedings.

THOMAS V. DANAHY

Senior Scientist

CREDENTIALS/REGISTRATION

B.S. Chemistry and Geology, State University of New York at Cortland, 1982
M.S. Geology, East Carolina University, 1986
Health and Safety at Hazardous Waste Sites - 40-Hour, 1987 and 8-Hour Supervisor, 1990
Registered Professional Geologist: State of North Carolina No. 1039

PROFESSIONAL AFFILIATIONS

National Water Well Association
Geological Society of America
Sigma Gamma Epsilon National Geology Honor Society

FIELDS OF SPECIALIZATION

- Ground-water contamination investigations.
- Assessment of potential NPL hazardous waste sites.
- Regional hydrogeological studies.
- Soil-gas and geophysical surveys.
- Exploration and development of ground-water resources.
- Remedial design for ground-water contamination.

EXPERIENCE SUMMARY

Mr. Danahy has 7 years of experience in hydrogeology and geotechnical engineering. Since joining Geraghty & Miller in 1991, he has been the project manager for a Remedial Investigation and Feasibility Study (RI/FS) in St. Thomas, U.S. Virgin Islands. Mr. Danahy was previously a consultant hydrogeologist with Dunn Geoscience Corporation in Albany, New York. He has also been employed with Law Engineering Testing Company in Greenville, North Carolina and Soil and Material Engineering, Inc. in Raleigh, North Carolina.

Mr. Danahy's experience has been in the fields of geology, chemistry, hydrology, and geotechnical engineering. He has conducted several field investigations, including aquifer evaluations, hazardous waste site assessments, solid waste landfill siting and closure studies, RI/FS projects, and ground-water monitoring programs.

KEY PROJECTS

- Project Manager of a $1.5 million contract with the New York State Department of Environmental Conservation. Included development of project tasks and budgeting and implementation of hazardous-waste investigations at nine sites.

- Project Manager of an investigation of PCB content and geotechnical characteristics of Hudson River bottom sediment for a proposed hydroelectric facility.

KEY PROJECTS (Continued)

- Project Hydrogeologist/Principal Investigator for a hydrogeologic assessment of a manufacturing facility in Central New Jersey. The assessment demonstrated that the facility was not the source of contamination at a nearby municipal water-supply wellfield.

- Project Manager/Project Hydrogeologist for a hydrogeologic investigation and Closure Design of a solid waste landfill in northeastern New York. Hydrogeologic characterization of the site formed the basis for negotiation of an approved Closure Plan with the New York State Attorney General's Office and New York State Department of Environmental Conservation. Provided technical review of remedial alternatives, closure report preparation, and regulatory liaison/negotiations.

- Project Manager of a hydrogeologic investigation in support of a Petition to Delist a landfill from the New York State Registry of Inactive Hazardous Waste Sites.

- Project Hydrogeologist for a Superfund site in central New York. Conducted a subsurface investigation for the remedial design of groundwater control at this PCB-contaminated site.

- Project Hydrogeologist for a RI/FS of a public-water supply well field contaminated with trichloroethene and tetrachloroethene.

- Project Manager of a closure investigation for a municipal sanitary landfill. The investigation included leachate outbreak mapping, landfill gas evaluation, landfill cover evaluation, leachate and groundwater sampling.

PUBLICATIONS

Danahy, T.V., Howard, W.O. and Wolterding, D.J., 1988, Hydrogeologic and Soil Gas Evaluation of Groundwater Contamination at a Municipal Landfill in New York State, Proceedings of Focus Conference Eastern Regional Ground Water Issues, National Water Well Association pp. 613-633.

Howard, W.O., Danahy, T.V. and Ianniello, M., 1988, An Air-Lift Development System for Deep Wells, Proceedings of Focus Conference Eastern Regional Ground Water Issues, National Water Well Association pp. 559-564.

Danahy, T.V., 1986, Petrology, Depositional Environment and Diagenesis of the Hillsdale Limestone (Mississippian, Meramecian) in Washington County, Virginia, M.S. Thesis, East Carolina University. (Included trace element and stable isotope analysis).

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JUAN A. GARCIA, Jr.

Project Scientist
Regional Data Quality Assurance Manager (RDQAM), Northeast

CREDENTIALS/REGISTRATION
B.S. Chemistry, University of Tampa, 1983

PROFESSIONAL AFFILIATIONS
American Chemical Society
American Society of Quality Control

FIELDS OF SPECIALIZATION
- Analytical chemistry.
- Laboratory automation systems.
- Data validation.
- Analytical procedure evaluation.
- Data management (reduction and reporting)
- Field analyses.

EXPERIENCE SUMMARY

Mr. Garcia has 8 years of experience in applied analytical chemistry. At Geraghty & Miller, Inc. he leads a Data Management and Data Validation group. The work includes validation of analytical data in compliance with various state and federal guidelines and standard operating procedures. Mr. Garcia has prepared a number of Quality Assurance Project Plans in compliance with CERCLA, RCRA, and other state and federal regulations.

Prior to joining Geraghty & Miller, Mr. Garcia was associate scientist in the Quality and Technical Affairs Division of Ortho Pharmaceutical Corporation, a Johnson & Johnson Company. While at Ortho, he performed a variety of analyses including high performance liquid chromatography (HPLC), gas chromatography/mass spectrometry (GC/MS), GC electron capture detection (ECD), flame ionization detection (FID), and thermal conductivity detection (TCD). He was also responsible for contract laboratory compliance, gas chromatography instrumentation (maintenance and upgrades), and all data generated by the marketed product stability program. He was also the back-up manager for laboratory automation.

KEY PROJECTS
- Prepared Quality Assurance Project Plan and managed laboratory contract for an ECRA Case in Great Meadows, Warren County, New Jersey. Performed data validation and managed the database generated by this project.

KEY PROJECTS (Continued)

- Prepared Quality Assurance Project Plan and managed laboratory contract for a RCRA Facility Investigation in Puerto Rico.

- Prepared Quality Assurance Project Plan for a NPL CERCLA in Dublin, Pennsylvania.

- Prepared Quality Assurance Project Plan for a CERCLA investigation in St. Thomas, U.S. Virgin Islands.

- Performed validation of data for a RCRA investigation in Newark, New Jersey.

- Performed validation of data for a residential well project in St. Thomas, U.S. Virgin Islands in accordance with CERCLA requirements.

- Audited Ekotek, Inc. laboratory in Atlanta, Georgia and RECRA Environmental Laboratories in Buffalo, New York for their inclusion in the Geraghty & Miller Analytical Quality Assurance/Laboratory Contract Program (AQA/LCP).

ALBERTO COLBERG NEVARES

Project Scientist

CREDENTIALS/REGISTRATION

A.D. Liberal Arts, Boston University, 1979
B.S. Geology, University of Puerto Rico, 1985
License for purchase, transport, and use of explosives

SHORT COURSES/SEMINARS

Hazardous Waste Site Activities Health and Safety Training, 1987; Refresher Program 1989
Analysis of Groundwater Data, Oklahoma State University, 1988

PROFESSIONAL AFFILIATIONS

National Water Well Association
Geological Society of Puerto Rico
Puertorican Water Resource Association

FIELDS OF SPECIALIZATION

- Design and implementation of ground-water contamination investigations.
- Monitoring well installation and sampling.
- Specialized product and ground-water recovery systems.
- Field gas chromatography studies; interpretation of ground-water quality data.
- Health and safety procedures for hazardous waste sites.
- RCRA closure plans.

EXPERIENCE SUMMARY

Prior to joining Geraghty & Miller, Inc., Mr. Colberg was employed by Terra Vac, Inc. of San Juan, Puerto Rico for 5 years as a hydrogeologist, project manager, and Health and Safety Officer. He has been involved in ground-water contamination and remediation projects in a wide variety of geologic terrains in Puerto Rico and the United States. He has conducted hydrogeologic investigations at gasoline service stations, has managed a subsurface product recovery project at a petroleum refinery in Puerto Rico, and has extensive experience in the design and implementation of in-situ vacuum extraction systems. Mr. Colberg has prepared and implemented RCRA closure plans for container storage areas and wastewater lagoons for several industrial facilities in Puerto Rico.

CAMERON S. DUNNAN

Staff Scientist

CREDENTIALS/REGISTRATION

B.S. Biochemistry, Brown University, 1985
M.B.A. Rutgers University Graduate School of Management, 1991

PROFESSIONAL AFFILIATIONS

American Chemical Society
National Alumni Schools Program

FIELDS OF SPECIALIZATION

- Analytical chemistry.
- Gas and liquid chromatography.
- Statistical analysis.
- Data validation.
- Data management.
- Technical editing.

EXPERIENCE SUMMARY

Mr. Dunnan has been part of the newly created data validation group at Geraghty & Miller, Inc. since October 1990. He has been involved in the streamlining of the validation process and the standardization of validation reports.

Prior to joining Geraghty & Miller, Inc., Mr. Dunnan was employed as an analytical chemist at a major pharmaceutical corporation. While in the pharmaceutical industry, he was responsible for raw material, finished product, and stability analyses, as well as instrument maintenance and calibration. His other duties included the evaluation, purchasing and set-up of laboratory equipment to support the newly created biotechnology division.

KEY PROJECTS

- Carried out domestic well resampling project for an ECRA site in Warren County, Great Meadows, New Jersey.

- Authored organic and inorganic data validation reports in accordance with USEPA Functional Guidelines for a proposed municipal pool site in Newark, New Jersey.

- Coordinated data management and authored technical memorandum in conjunction with an outside environmental consultant for a ground-water project in Vega Alta, Puerto Rico.

KEY PROJECTS (Continued)

- Authored multiple organic and inorganic data validation reports in accordance with USEPA-Region III guidelines for water and soil samples from a landfill in South Whitehall Township, Pennsylvania.

- Authored organic and inorganic data validation report in accordance with USEPA Functional Guidelines for a non-regulated environmental site in Dos Campos, Brazil.

- Authored inorganic data validation report in accordance with NJDEP guidelines for a chemical production facility in Morristown, New Jersey.

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