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REVISED QAPP

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DOE-FSO/EPA
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LETTER

Department of Energy
FMPC Site Office
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NOV 07 1991
DOE-228-91

Ms. Catherine A. McCord, Remedial Project Manager
U. S. Environmental Protection Agency
Region V - 5HR-12
230 South Dearborn Street
Chicago, IL 60604

Mr. Graham E. Mitchell, DOE Coordinator
Ohio Environmental Protection Agency
40 South Main Street
Dayton, OH 45402

Dear Ms. McCord and Mr. Mitchell:

REVISED QAPP

Reference: Letter, Catherine A. McCord to Bobby Davis, "QAPP U.S. DOE Fernald OH6 890 008 976," dated October 7, 1990

In response to the referenced letter, enclosed is the revised QAPP and a listing of each change and the corresponding date of implementation. These changes were considered minor in nature and were transmitted as change pages to you as they were issued.

If you have any questions, please contact me at FTS 774-6161 or Oba Vincent at FTS 774-6937.

Sincerely,

Andrew P. Avel
FMPC Remedial Action
Project Director

DP-84:Vincent

Enclosure: As stated

cc w/encl.:

R. P. Whitfield, EM-40, FORS
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1.0 INTRODUCTION

Prime contractors and subcontractors have been retained by the U.S. Department of Energy (DOE) to provide a site wide Remedial Investigation and Feasibility Study (RI/FS) and Remediation Projects for the Feed Material Production Center (FMPC). This Quality Assurance Project Plan (QAPP) has been prepared to document measures that will be undertaken by all prime contractors and their subcontractors so that the work performed will be of needed quality to accomplish project objectives and will be responsive to requirements of Westinghouse Materials Company of Ohio (WMCO), the DOE, and the United States Environmental Protection Agency (U.S. EPA).

The QAPP is the governing document of quality assurance (QA) practices to be implemented for the FMPC remedial investigation. This document includes the quality objectives, the requirements for work performance to meet these objectives, and the means for verifying that the objectives have been met.

2.0 PROJECT DESCRIPTION

The tasks that comprise the site characterization for the remedial investigation are as follows: description of current situation, work plan requirements, site investigation, site investigation analysis, laboratory and bench-scale studies, reports, community relations support, and assistance with the Federal Facility Compliance Agreement (FFCA).

Laboratory analytical support levels are to comply with Section 4.3 of EPA/540/G-87/003 for the analysis of FMPC samples. The support levels are as follows:

Level I -- field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative, but results are available in real-time.

Level II -- field analyses using more sophisticated portable analytical instruments; in some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. The quality depends on the use of suitable calibration standards, reference materials, sample preparation equipment, and the training of the operator. Results are available in real-time or several hours.

Level III -- all analyses performed in an off-site analytical laboratory. Level III analyses may or may not use Contract Laboratory Program (CLP) procedures, but do not usually utilize the validation or documentation procedures required of CLP Level IV analysis. The laboratory may or may not be a CLP laboratory.

Level IV -- CLP routine analytical services. All analyses are performed in an off-site CLP analytical laboratory using CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

Level V -- analysis by non-standard methods. All analyses are performed in an off-site analytical laboratory which may or may not be a CLP laboratory. Method development or method modification may be required by specific constituents or detection limits. CLP special analytical services are Level V.

Table 2-1 is a list of laboratories currently used and their analysis support level capabilities.

Subcontractor laboratory procedures are to be submitted to the responsible DOE prime contractor for approval prior to the start of work. Copies of approved laboratory procedures will be supplied to DOE (or others, as directed by DOE) if requested.

2.1 SITE DESCRIPTION AND HISTORY

The FMPC is an industrial facility owned by the United States government and operated for the DOE under a management contract with WMCO. WMCO is administratively responsible to the Department of Energy - Oak Ridge Operations Office (DOE-ORO).

The FMPC is located in a rural area of southwestern Ohio approximately ten miles northwest of Cincinnati and eight miles southwest of Hamilton. The site occupies 1,050 acres and is bounded by Highway 126 to the north, a transmission line to the east, Willey Road to the south, and Paddy's Run Road and the Ohio and Chesapeake Railroad to the west (See Figure 1-1, Work Plan).

Approved Subcontractor Laboratories and Support Level Capabilities

Laboratory and Analysis Support Level	Type of Analysis
Radiological Sciences Laboratory (RSL) (V) Oak Ridge, Tennessee	Radiological
Mixed Waste Laboratory (MWL) (III) and (IV) Oak Ridge, Tennessee	Chemical
Middlebrook Pike Laboratory (IV) Knoxville, Tennessee	Chemical
Export Laboratory (III and IV) Pittsburgh, Pennsylvania	Chemical
Technology Development Laboratory (V) Knoxville, Tennessee	Dioxins Geotechnical
San Jose Laboratory (III) San Jose California	Chemical Organo-phosphorus pesticides
Cerritos Laboratory (II), (III), and (IV) Cerritos, California	Chemical
Austin Laboratory (III) and (IV) Austin, Texas	Chemical
Cincinnati Laboratory (III) and (IV) Cincinnati, Ohio	Chemical
Edison Laboratory (III) and (IV) Edison, New Jersey	Acute & Chronic
Westinghouse Laboratory (V) Cincinnati, Ohio	Radiological
Chem-Nuclear Laboratory (III) Greenville, South Carolina	Chemical
Net Laboratory (III) Dayton, Ohio	Chemical

Table 2-1

The facility commenced operations in 1952; prior to 1986, it was operated by National Lead of Ohio, Inc. (NLO) under contract with DOE. The primary function of the FMPC is the production of metallic uranium fuel cores and other uranium compounds for use in United States defense programs. In addition, small amounts of thorium have also been processed. As a result of these processes, the FMPC has generated both radioactive and nonradioactive wastes.

The FFCA was entered into on July 18, 1986, by the DOE-ORO and the U.S. EPA, pertaining to the FMPC. The FFCA was entered into pursuant to Executive Order 12088 (43 Federal Register [FR] 47707) to set forth compliance with existing environmental statutes and implementing regulations. The FFCA is intended to provide that the potential environmental impacts associated with past and present activities at the FMPC are thoroughly and adequately investigated and appropriate remedial response actions are taken, as required by the Resource Conservation and Recovery Act (RCRA) as amended, 42 USC 6901 et seq., and by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 USC 9601 et seq., and by the Superfund Amendments and Reauthorization Act (SARA).

In accordance with the FFCA, this site characterization is being conducted at the FMPC to determine the nature and extent of releases, or threat of releases, of hazardous or radioactive substances, or pollutants at or from the FMPC. Additionally, data necessary to support a Remedial Investigation (RI) and Feasibility Study (FS) will be gathered.

Information developed as a result of the RI will subsequently be used to support preparation of an FS. The purpose of the FS will

be to develop and evaluate remedial action alternatives and recommend remedial action alternatives to the U.S. EPA in order to protect the public health, welfare, or the environment from releases or threatened releases of hazardous or radioactive substances, or pollutants at or from the FMPC.

A complete description of the site background and history is provided in Section 2.0 of the Work Plan. Section 3.0 of the Work Plan discusses the nature and extent of problems at the FMPC.

2.2 PROJECT SCHEDULE

A project schedule will be submitted in accordance with the Work Plan.

2.3 INTENDED USE OF ACQUIRED DATA

The intended use of the acquired data is to assess the nature of the site and the degree and extent of potential problems resulting from past activities at the site, to evaluate the potential hazard to human health and the environment, and to identify and evaluate the alternative remedial actions. These objectives can be efficiently met by completing the following tasks:

- Characterizing the site in terms of wastes present and produced; lateral and vertical extent of contamination in surface waters, ground waters, sediments, and soils; rate and direction of waste migration; target receptors (population at risk, threatened resources, and sensitive ecosystems); and site geology and surface water/ground water hydrology.

- Developing and evaluating alternative production, handling, and disposal measures considering economic feasibility, technological feasibility, environmental impacts, regulatory constraints, and timeliness of the completion; and offering recommendations regarding the most cost-effective remedial alternatives.

3.0 ORGANIZATION, RESPONSIBILITIES, TRAINING, PROCUREMENT/SUBCONTRACTOR CONTROL, REPORT, REVIEW, AND STOP WORK AUTHORITY

The organizations and responsibilities of the Project Lead, Prime Contractors, and major subcontractors are discussed in the Work Plan.

3.1 TRAINING

Contract personnel who are required to comply with the Work Plan will be properly trained, and/or qualified. Field personnel will be given instruction specific to the FMPC investigation and site specific requirements, as appropriate, prior to commencing work on the project. Training will include as a minimum the following:

- Organization and lines of authority and communication
- Description of the work areas
- Overview of project work plan, the QAPP, sampling plan and health & safety plans
- Documentation requirements
- New requirements or procedures changes for the site, as appropriate
- Decontamination procedures
- Emergency Procedures
- Sampling Procedures that the specific individual(s) may be assigned to perform

Training for field personnel in field procedures or health and safety procedures will be provided by the responsible field manager or the Health and Safety Officer or manager, as appropriate, or by other assigned personnel. Documentation of

training will be maintained by the responsible manager or officer. Copies of training records will be maintained in the project central files.

3.2 PROCUREMENT/CONTROL OF SUBCONTRACTORS

The level of control identified as necessary for procurement of prime subcontractor or subcontractor field or engineered equipment, material, or services will be based on a review by procurement, quality assurance, and technical personnel, and/or by the Health and Safety Officer, as appropriate.

Prime contractors are responsible for incorporating provisions in subcontractor contract documents to assure that subcontractor review of procurement documents is performed, that pass down of QAPP requirements are provided for in subcontractor procurements, that necessary field inspections are performed and documented, and that documentation is required for the maintenance and calibration of equipment. Equipment which does not meet project requirements shall not be used.

For field operations, project personnel shall perform an inspection of each subcontractor, prior to the subcontractor commencing work. This check is to verify that the subcontractor meets the requirements to perform his specified task in accordance with the contractual documents and applicable project plans and procedures. The review shall be performed by procurement, quality assurance, technical, and/or health and safety, as appropriate.

3.3 QUALITY ASSURANCE REVIEW OF REPORTS

Prior to issuance of a final report, it shall be reviewed in accordance with approved procedures.

3.4 STOP WORK AUTHORITY

Project personnel are responsible for informing their management and supervision of work proposed or in progress that is likely to produce data that does not meet the project quality assurance objectives described in Section 4.2 of this QAPP. The DOE QA officer, or designee, is responsible for stopping work, that, if allowed to proceed, will produce data that does not meet the project quality assurance objectives.

All stop work actions and their resolution will be documented and made a part of the project records. Where appropriate, this documentation can be a part of nonconformance reports, variance request, or document change requests. An appropriately formatted report should be used in all other instances. Stop work and resume work orders may be communicated orally, provided that they are documented in writing within 10 working days.

4.0 QUALITY ASSURANCE PROGRAM

The purpose of a QA program is to establish policies for the implementation of regulatory requirements and to provide an internal means for control and review so that the work performed is of the highest professional standard.

The responsibility of the overall direction and implementation of the QA program rests with the DOE QA officer and/or designees. The DOE QA officer and/or designees are responsible for maintaining the QA program and verifying its implementation through audits and surveillances.

4.1 QUALITY ASSURANCE DOCUMENTS

The QA Program is documented in the QAPP and supporting RI/FS and remediation procedures which direct quality-related activities. The policies and procedures specified by these manuals define acceptable practices to be used by personnel. The QAPP is project specific and serves as the governing QA document for this project.

Copies of applicable documents will be supplied to DOE or others as directed by DOE for this project.

4.2 PROJECT QUALITY ASSURANCE OBJECTIVES

Data generated by the RI/FS must be of known quality. That is, the data must be traceable, technically and legally defensible, and have definable characteristics. Traceability indicates the final data can be traced to original data, data characteristics and measurement techniques. Legal defensibility refers to acceptable record keeping and the fact that data generated have enforcement potential and the quality of the analytical results and supporting documentation must be sufficient to support possible litigation. Data characteristics refer to the accuracy, precision,

completeness, comparability and representativeness. Quality levels are established for both field and laboratory activities.

Fundamental mechanisms that will be employed to achieve these quality goals can be categorized as prevention, assessment, and correction. These include:

- Prevention of errors by planning, documented instructions and procedures, and careful selection and training of skilled, qualified personnel;
- Quality assessment through a program of audits and surveillances to supplement continual informal review; and
- Correction for prevention of recurrence of conditions adverse to quality.

The QAPP has been prepared in direct response to these goals. This plan describes the QA Program to be implemented and the quality control (QC) procedures to be followed by DOE and its contractors during the course of the RI/FS and Remediation for the FMPC site.

The QAPP describes the project organization structure and specifies the procedures, documentation requirements, sample custody requirements, acceptance criteria, audit and corrective action provisions, etc. to be applied to provide confidence that all operations and activities meet the intent of RCRA requirements. The QAPP is prepared in accordance with U.S. EPA guidance as presented in Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005-80.

The procedures contained or referred to herein have been taken from:

o RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD), September, 1986.

- Code of Federal Regulations (CFR), 40 CFR 261, Appendix II, "EP Toxicity Test Procedures;"
- U.S. EPA Quality Assurance Handbook, (U.S. EPA 600/9-76-005);
- Proposed Sampling and Analytical Methodologies for Additional to Test Methods for Evaluating Solid Waste Physical/Chemical Methods, U.S. EPA, (PB85-103026);
- American Society for Testing and Materials (ASTM) Standards, Section 11, Volumes 11.01 and 11.02, "Water," and Section 4, Volume 04.08, "Soil and Rock, Building Stones;"
- American Public Health Association, Standard Methods for the Examination of Water and Waste Water, 16th Edition, 1985;
- Methods for Chemical Analysis of Water and Wastes, (U.S. EPA-600/4-79-020);
- Federal Register, Volume 49, October 26, 1984, 40 CFR 136, pages 43234-43436;
- Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, U.S. EPA (SW-846);
- Handbook for Sampling and Sample Preservation of Water and Waste Water, U.S. EPA (PB83-124503);
- Field and Laboratory Methods Applicable to Overburdens and Mine Soil, (U.S. EPA-600/2-80-054);
- Prescribed Procedures for Measurement of Radioactivity in Drinking Water, (U.S. EPA-600/4-80-032);
- Code of Federal Regulations, 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants;"
- American National Standards Institute (ANSI) NQA-1, Quality Assurance Program Requirements for Nuclear Facilities;
- USNRC Regulatory Guide 4.15, Rev. 1, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment";
- Chemical Analytical Services for Multi-Media Multi-Concentration Metals and Inorganics, U.S. EPA (WA-87-K026);

- Chemical Analytical Services for Multi-Media Multi-Concentration Organics, GC/MS Techniques, U.S. EPA (WA-87-K236); and

- Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, U.S. EPA, (QAMS 005/80).

4.3 ANALYTICAL QUALITY ASSURANCE OBJECTIVES FOR DATA

Definitions for the QA objectives of precision, accuracy, completeness, representativeness, and comparability are as follows:

- Precision - A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Comparison of replicate values is best expressed as the relative percent difference (RPD). Various measures of precision exist depending upon the "prescribed similar conditions."

- Accuracy - The degree of agreement of a measurement (or an average of replicate measurements), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system.

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

- Representativeness - Expresses 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 concern.

- Comparability - Expresses the confidence with which one data set can be compared to another.

The minimum completeness expected to be obtained for this project under correct normal conditions is 90 percent.

The QA objectives established for precision and accuracy for each major measurement parameter for the FMPC project are presented in Tables 4.1, 4.2, and 4.3 and are pertinent to laboratory procedures. Data will be reported in units consistent with the references cited in Sections 4.3.1 and 4.3.2.

4.3.1 Analytical Laboratory

4.3.1.1 HSL Compounds

The overall QA objectives for laboratory analysis of groundwater and soil/sediment for HSL parameters shall follow the guidelines listed in the CLP SOW dated 7/88 for inorganic analyses and the CLP SOW dated 2/88 for
organic analyses. See Sections 8.3.1 through 8.3.4 and 11.4.1 and 11.4.2.

4.3.1.2 Groundwater, EP Extracts, and TCLP Extracts

The overall QA objectives for groundwater monitoring and EP Extracts and TCLP analyses covered under the Resource Conservation and Recovery Act (RCRA) shall conform to the guidelines specified in SW-846, Third Edition, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. See Section 8.3.5.

4.3.1.3 Dioxins/Furans

QA Objectives for dioxins/furans shall conform to the guidelines established by modified EPA Method 8280, SW-846. See Section 8.3.6.

4.3.1.4 Miscellaneous Procedures

Where EPA procedures are not available, alternative methods, such as ASTM methods or APHA methods, may be used with the consent of the client.

4.3.2 Radiological Laboratory

The overall QA objectives for laboratory Analyses of radionuclides follow the guidelines of DOE's Environmental Measurements Laboratory (EML) Procedures Manual ("HASL 300").

4.4 EVALUATION OF ANALYTICAL PRECISION

4.4.1 Analytical Laboratory

To determine the precision of a chemical method and/or chemical laboratory analyst, a routine program of duplicate analysis will be performed. The results of the duplicate analyses will be used to calculate the relative percent difference (RPD), which is the governing quality control indicator for precision. RPDs are generated through duplicates or matrix spike duplicates.

The RPD for duplicate analyses is defined as 100 times the absolute difference of each duplicate set, divided by the average of the duplicate set. For duplicate results D_1 and D_2, the RPD is calculated from the following equation:

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

The RPD of duplicates is used to generate control charts for precision.

4.4.2 Radiological Laboratory

For radiological analyses, statistical range analysis is used to calculate the expected mean range and control limits for a replicate result and assess whether a lab replicate is "in control". A range analysis result that lies within the mean range plus 3σ is said to be "in control"; a range analysis result greater than the mean range plus 3σ is said to be "out-of-control". Range analysis is used to determine the precision, or reproducibility, of lab results.

4.5 EVALUATION OF LABORATORY ACCURACY

4.5.1 Analytical Laboratory

To determine the accuracy of a chemical method and/or a chemical laboratory analyst, where applicable, a periodic program of sample spiking will be conducted. The results of sample spiking will be used to calculate percent recovery (%R) which is the quality control indicator for accuracy.

The %R is defined as 100 times the observed spike sample concentration or result (SSR) minus the observed sample concentration or result (SR) divided by the amount of spike added (SA) to the sample. The percent recovery is calculated from the following equation:

$$\%R = \frac{SSR - SR}{SA} \times 100$$

Percent Recovery of matrix spikes is used to generate control charts for accuracy.

4.5.2 Radiological Laboratory

For radiological analyses, laboratory accuracy is determined by calculating the expected precision for a known value (either a reference standard sample or a matrix sample) and assessing the divergence of the recovered sample result from the known value in terms of statistical control. Statistical control bounds are defined as the mean ("known") value $\pm 3\sigma$. Results outside $\pm 3\sigma$ are considered "out-of-control".

4.6 FREQUENCY OF QUALITY CONTROL SAMPLES

4.6.1 Analytical Laboratory (Organics)

The frequency of analysis of quality control samples shall be one matrix spike and matrix spike duplicate for every twenty samples of a similar matrix analyzed. Relative percent difference and % Recovery will be calculated to determine precision and accuracy. Advisory limits are listed in Table 4.1.

All samples, field duplicates, blanks, matrix spikes and matrix spike duplicates shall be fortified with surrogate spiking compounds. Advisory limits are listed in Table 4.2.

The frequency of analysis for preparation blanks shall be one preparation blank for every twenty samples prepared per matrix or every time samples are prepared, whichever is more frequent.

The frequency of quality control samples may be increased but may never be less stringent than specified above.

4.6.2 Analytical Laboratory (Inorganics)

The frequency of analysis of quality control samples shall be one matrix spike and duplicate for every twenty samples of a similar

matrix analyzed. Relative percent difference and % Recovery will be calculated to determine precision and accuracy. Advisory limits are listed in Table 4.1.

The frequency of analysis of preparation blanks shall be one preparation blank for every twenty samples prepared per matrix or every time samples are prepared, whichever is more frequent.

The frequency of laboratory control samples shall be one LCS per matrix for every twenty samples analyzed or every time samples are prepared, whichever is more frequent.

The frequency of quality control samples may be increased but may never be less stringent than specified above.

4.6.3 Radiological Laboratory

The frequency of analysis of quality control samples shall be one spike, one blank, one matrix spike, and one duplicate per analytical batch, where a batch is not to exceed twenty samples. Exception shall be made when there is insufficient sample or other analytical limitations (i.e., matrix interferences). Advisory limits are listed in Table 4.3.

The frequency of quality control samples may be increased but may never be less stringent than specified above.

4.6.4 Field QC Samples

Field QC samples, such as field blanks and equipment decontamination rinsate samples will be collected and analyzed as specified by the Sampling Plan.

Table 4.1

ANALYTICAL LABORATORY ADVISORY RECOVERY LIMITS FOR MATRIX SPIKE AND MATRIX SPIKE DUPLICATE QC SAMPLES

Fraction	Matrix Spike Cmpd	% Recovery[1] Water	% Recovery[1] Soil/ Sediment	RPD[1] Water	RPD[1] Soil/ Sediment
VOA	1,1-dichloroethene	61-145	59-172	14	22
VOA	trichloroethene	71-120	62-137	14	24
VOA	chlorobenzene	76-127	66-142	11	21
VOA	toluene	76-125	59-139	13	21
VOA	benzene	75-130	60-133	13	21
BN	1,2,4-trichloro-benzene	39-98	38-107	28	23
BN	acenaphthene	46-118	31-137	31	19
BN	2,4-dinitrotoluene	24-96	28-89	38	47
BN	pyrene	26-127	35-142	31	36
BN	n-nitroso-di-n-propylamine	41-116	41-126	38	38
BN	1,4-dichlorobenzene	36-97	28-104	28	27
AE	pentachlorophenol	9-103	17-109	50	47
AE	phenol	12-89	26-90	42	35
AE	2-chlorophenol	27-123	25-102	40	50
AE	4-chloro-3-methyl-phenol	23-97	26-103	42	33
AE	4-nitrophenol	10-80	11-114	50	50
Pest.	lindane	56-123	46-127	15	50
Pest.	heptachlor	40-131	35-130	20	31
Pest.	aldrin	40-120	34-132	22	43
Pest.	dieldrin	52-126	31-134	18	38
Pest.	endrin	56-121	42-139	21	45
Pest.	4,4'-DDT	38-127	23-134	27	50
Metals, CN		75-125	75-125	20	20

1 - Recoveries and RPDs are for advisory purposes only.

Note: AE = acid extractable; BN = base neutral; Pest. = pesticides
VOA = volatiles

Table 4.2

ANALYTICAL LABORATORY ADVISORY RECOVERY LIMITS
FOR SURROGATE SPIKE QC SAMPLES

Fraction	Surrogate Compound	% Recovery[1] Water	% Recovery[1] Soil/Sediment
VOA	toluene-d_8	88-110	81-117
VOA	4-bromofluorobenzene	86-115	74-121
VOA	1,2-dichloroethane-d_4	76-114	70-121
BN	nitrobenzene-d_5	35-114	23-120
BN	2-fluorobiphenyl	43-116	30-115
BN	p-terphenyl-d_{14}	33-141	18-137
AE	phenol-d_5	10-94	24-113
AE	2-fluorophenol	21-100	25-121
AE	2,4,6-tribromophenol	10-123	19-122
Pest.	dibutylchlorendate	24-154	20-150

1 - Recoveries for pesticides are for advisory purposes only.

Table 4.3

RADIOLOGICAL LABORATORY QC SAMPLE ADVISORY LIMITS

Isotope	Standard Deviation (Single Determination)	
Gross Alpha	25%	(@ 20 pCi/L)
Gross Beta	5%	(@ 100 pCi/L)
U	15%	(@1 pCi/L)
Th	15%	(@1 pCi/L)
Ra-226	15%	(@5 pCi/L)
Ra-228	15%	(@7 pCi/L)
Ac-228	15%	(@7 pCi/L)
Pb-210	10%	(@20 pCi/L)
Po-210	15%	(@1 pCi/L)

5.0 FIELD PROCEDURES

Approved procedures will be submitted to provide information on the advancement of geotechnical borings, geotechnical sampling, piezometer/well installation and monitoring, and permeability testing. These procedures will be used to supplement this QAPP, as necessary.

Approved procedures submitted to describe the manner in which soil and rock core logging is performed and information obtained from subsurface borings is recorded, shall also be used on this project.

Information obtained from site exploration activities shall be recorded and documented. Required documentation of field investigations and testing includes a daily log of project activities; any photographic records taken; and the appropriate subsurface logs, test data forms, piezometer/well installation forms, and field collection forms.

Members of the Project Field and Sample Staff working in field operations shall keep a daily log (Figure 5-1, Field Activity Daily Log) of the project activities. Items to be included in the daily log, as appropriate, are:

- Field activity subject;
- General work activity;
- Unusual events;
- Changes to plans and specifications;
- Visitors on site;
- Samples collected (Sample No.s), time and depth
- Surveillance observations/findings

Figure 5-1

FIELD ACTIVITY DAILY LOG

DATE:	NO.	PAGE	OF
WELL/BORING/LOCATION:		PROJECT NO.	
FIELD ACTIVITY SUBJECT:			
DESCRIPTION ON DAILY ACTIVITIES AND EVENTS:	SAMPLE #	TIME	DEPTH
CALIBRATION CHECKS			
	TIME	READING	
VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS:		
WEATHER CONDITIONS: TEMP:	SURVEILLANCES OBS/FINDINGS:		
PERSONNEL ON SITE:			
SUPERVISOR:	DATE:		

- Calibration checks performed
- Subcontractor progress and specifications; and
- Communication with WMCO, regulatory agencies, or others.

Field Activity Daily Logs (Figure 5-1) will be completed daily to indicate drilling and sampling activities such as footage drilled, materials used, sampling ending, and bottom casing depth. Boring logs (Figure 5-8) will be generated to document subsurface conditions.

Copies of the daily log entries should be sent to the Field Supervisor and others as required on a weekly basis. If the logs are not submitted as required, it is the responsibility of the Field Supervisor to contact the field personnel. Original copies of the reports are to be sent to the Project Files after review by the Field Supervisor and QA.

Any photographs obtained are to be identified with the project number, date taken, and a brief description. This may be done individually on the back of the photographs or in an album in which the photographs are mounted. Album photographs must be provided with the individual descriptions and dates taken.

Appropriate test data forms shall also be prepared. They shall include, as appropriate, the test location (e.g., boring, depth, sampling station, elevation, field coordinates) and the items listed for laboratory test data forms. All requested information shall be addressed. If not applicable, requested information should be designated as such.

Originals of field records will be maintained in the project central file. During performance of the field program, a copy of the field records will be maintained by the Field Supervisor and Sample Manager. These copies can provide adequate documentation of work activities should the originals be destroyed, lost, or stolen.

Procedures are described for the following field activities in the remainder of Section 5.0:

- Radiation measurement techniques;
- Drilling procedures;
- Monitoring well/piezometer design and installation;
- Monitoring well development;
- Borehole geophysical logging; and
- Aquifer testing.

5.1 RADIATION MEASUREMENT TECHNIQUES

This section describes applicable standards and practices for the performance of field radiation measurements. The following procedures can also be found in a separate project-specific document, titled "Radiation Measurements Task Procedures."

5.1.1 FIELD RADIATION SURVEY WITH FIDLER DETECTOR

This procedure describes the methods by which a Field Instrument for the Detection of Low Energy Radiation (FIDLER) is used to monitor ground surface deposits of uranium.

Included in the procedure are instructions for:

- Initial instrument setup;
- Daily instrument standardization using a sealed "check source";
- Determination of the instrument's response to terrestrial background radiation;

- Establishment of field calibration factors;
- Radiation survey measurements of ground surface areas; and
- Use of the instrument to estimate the uranium concentration in the surface soil.

Method references for the above techniques are presented in:

- UMTRA Procedure 10.17.3, In-Situ Ra-226 Measurement Using the Shielded Delta Procedure;
- Tinney, J.F. and Koch, J.J., An X-Ray Screening Meter for Plutonium Contamination, UCRL-5000-67-3, 1967; and
- Instrument manufacturer's instructions.

The FIDLER was developed in the 1960s as a portable instrument to monitor ground surfaces contaminated with plutonium. A five-inch diameter, thin sodium iodide (NaI) crystal serves as the detector. It is optically coupled to a quartz light pipe and installed in a standard five-inch probe housing, which has an entrance window of beryllium. The principal use of this detector is for photons with energies less than about 75 KeV. Uranium is an alpha emitter; however, the radiation from its daughter products include low-energy photons, principally L x-rays from thorium. In the case of U-238, by far the predominant uranium isotope at FMPC, there are two low-energy photons from Th-234 which can be detected by the FIDLER. These are 63 KeV (3.5 percent abundant) and 93 KeV (4 percent abundant). If significant concentrations of natural thorium are present, radiation from Ac-228 will create interference in detecting the 93 KeV photon from Th-234. For this reason, the instrument will be adjusted for maximum response from the 63 KeV photon from Th-234.

5.1.1.1 Initial Instrument Setup

Before this instrument can be used to monitor low-energy radiation in the field, it is necessary to determine the maximum response for contamination by the uranium daughter, Th-234. This is done by using a source of Am-241 (60 KeV) (whose intensity is several times greater than background radiation levels), as follows:

- Inspect the FIDLER, ratemeter/scaler (RM/S), and interconnecting cable for obvious damage. If no damage is observed, connect the FIDLER and RM/S, and adjust the High Voltage to 50 volts or less.
- Depress the THRESH button. Turn the THRESH potentiometer clockwise until 0049 displays.
- With WINDOW IN/OUT switch IN, depress the WINDOW button. Turn the WINDOW potentiometer until 0020 appears on the display.
- Switch the WINDOW IN/OUT to OUT.
- Connect the probe and expose the Am 241 source.
- Increase HV (if HV potentiometer is at a minimum, it will take approximately 3 turns before any change is indicated). While increasing the HV, observe the log scale of the ratemeter. Increase HV until ratemeter indication occurs.
- Switch the WINDOW IN/OUT to IN.
- Turn the HV control until maximum reading occurs on the log scale. Increase HV until reading starts to drop off. Then decrease the HV for maximum reading.
- Turn RANGE selector switch to the X1K position.
- Press ZERO button. If meter does not read, switch to a lower range until a reading occurs.
- Carefully adjust the HV potentiometer until maximum reading is achieved on the range scale. The instrument is now peaked for daughters of uranium-238 on both the LOG and RANGE scales.

5.1.1.2 Daily Instrument Standardization

Following completion of the instrument setup procedure, establish a fixed source-detector geometry so that the source-to-detector distance is a matter of record and reproducible from one day to the next. Standardize the FIDLER as follows:

- Make five one-minute counts with the Am-241 source in its check position. Record each count on the "Instrument Checks" form (Figure 5-2).

- Determine the standard deviation of the five one-minute counts. Record this value (σ) and three times the value (3σ) in the instrument logbook.

$$\text{standard deviation } \sigma = \left[\frac{(\Sigma x^2) - (\Sigma x)^2}{n(n-1)}\right]^{0.5}$$

- A control chart will be prepared using information from the previous two steps. This chart will be prepared at the beginning of the site characterization and will be used each day to record the FIDLER's response to the Am-241 source. On a piece of linear graph paper, place consecutive calendar dates on the x-axis. Define a range along the y-axis which includes the average FIDLER source count 3 times the standard deviation. Draw three horizontal lines which intersect the y-axis at these three points.

FIGURE 5-2

TITLE: Walk-Over Surveys Using a Large Volume Scintillation Detector	NO: RSL-2003
	REVISION: 1

LARGE VOLUME SCINTILLATION DETECTOR

INSTRUMENT CHECK
PROCEDURE RSL-2003

Scaler Model _____ Serial No. _____

Detector Model _____ Serial No. _____

Date	Battery Response	Bkgd (cpm)	Cesium Check Source (cpm)	Americium Check Source (cpm)	Surveyor's Initals

- On a daily basis, repeat the five-point standardization procedure before the FIDLER is used for field measurements.

Determine the average count rate; plot this value on the control chart for that day. If the average count rate falls within the boundary as defined above, the FIDLER may be used for field measurements. However, if the average count rate is not within the boundary, corrective action must be taken according to the following procedure.

- Repeat the procedure "Initial Instrument Setup."
- Turn off ratemeter and disconnect cable to FIDLER. Clean the cable and chassis connectors with ethyl alcohol and let dry.
- Reconnect cable, turn on ratemeter; check voltage setting.
- Check the source-to-detector distance; make necessary corrections.
- Confirm proper window setting.
- Repeat the five-point standardization procedure. If FIDLER response is within the average count rate 3s, the unit may be used. If the average count rate is still outside the control boundary, turn off the ratemeter and use a substitute ratemeter. Repeat the five-point standardization procedure. If problems still exist, repeat the initial instrument setup. Repeated failures will require the attention of a manufacturer-certified service technician.

5.1.1.3 Determination of Instrument Response to Background Radiation

As part of the site characterization, several background locations will be selected in the vicinity of the FMPC. Each instrument, while having the same discriminator settings, responds differently to radiation. It is important that all

instruments be checked at the same time to document the differences in responses. The FIDLER response to radioactivity in the soil at each of these background locations will be determined as follows:

- At each background station, establish an area where measurements can be made with the FIDLER probe in contact with the surface. Mark the location so that additional (or repeat) measurements can be made at later dates.
- In a field logbook or on the Field Activity Daily Log (Figure 5-1), describe the area chosen for background measurements and list specific features (soil is sandy, rocky, damp, wet, etc.). Also record climatic conditions at the time measurements are made. Make five one-minute counts and record in the field logbook or Field Activity Daily Log.
- When all background location measurements have been completed, compare the average count rate at each station with the concentration of uranium in the soil samples collected at that point.

5.1.1.4 Establishment of Field Calibration (FIDLER)

The response of a FIDLER to radioactivity in the soil is site specific and is governed by several parameters, such as the presence of radioactivity other than uranium, a layer of clean soil between a subsurface deposit of uranium and the ground surface, nearby radioactive sources such as radon in the air or a waste storage pit, etc. Therefore, the field calibration factors determined in this instruction can only be considered estimates. Use of this calibration serves as an indicator for the need to perform soil sample analyses.

Several areas within the FMPC site where surface radioactivity is evident will be chosen as test areas. These should range from

near-background radiation levels to the highest expected level on site. Readings will be taken at the designated test areas as follows:

- Perform five one-minute measurements with the FIDLER in contact with the ground surface and record the count rate in a field logbook or the Field Activity Daily Log.
- Collect a sample of surface soil (0 to 2 inches); submit it to the analytical laboratory for a gamma-ray spectral and total uranium analysis. Soil sample collection procedure and chain-of-custody requirements are described in detail in Sections 6.0 and 7.0.
- Following completion of the analysis of soil samples, compare the data from the five one-minute measurements to the soil concentration of uranium and prepare a table of values.

Based on the information above, using a least square fit, establish a calibration factor. Record this factor in the instrument logbook.

5.1.1.5 Radiation Survey Measurements of Ground Surface Areas

Surface scanning (whether on the ground, on equipment, or on building surfaces) with portable radiation detectors is normally carried out to determine the location of anomalous areas (radiation levels in excess of guideline values) within a measurement grid block or the average radiation level within a measurement grid block. The scan of ground surfaces at FMPC will be carried out to determine the average estimated soil concentration of uranium within small areas which have been staked by a licensed surveyor. This will be accomplished by moving the FIDLER probe in a serpentine pattern over the area to be surveyed. During this scan, the detector will be held approximately two inches above the surface. Although the beryllium window is protected by

Lucite, care must be taken to protect the window during this operation. Radiation survey measurements will be performed according to the following procedure:

- Determine by checking the daily instrument standardization documentation that the FIDLER system has been checked and is ready for field measurements.

- Receive instructions from the Radiation Measurements Task Leader. These instructions should be specific as to:

  - The transit survey has been completed and 100-foot grids have been established;

  - The number of people required (one technical to monitor and one to record data);

  - Time requirements; and

  - Special instructions.

- Areas to be scanned should be subdivided into square grid blocks approximately 100 feet by 100 feet.

- Grid block squares should be further subdivided into smaller square or rectangular grids, the total area of which can be scanned in several minutes. Areas 25 feet by 25 feet can be scanned in three minutes. The grids will be measured with a tape measure.

- Drainage paths will have been staked at 100-foot intervals. Scanning these areas with a FIDLER can only be done if the area is free of standing or flowing water. If the area meets these criteria, place a grid stake at 25-foot intervals between the 100-foot stakes.

- Attach a Surface Measurements Field Logbook Form (Figure 5-3) to a clipboard or other suitable writing surface; mark the grid block coordinates in the boxes along the left and top margins of the form.

- Scan measurements will be recorded as integral counts over the area to be scanned; that is, pulses from the FIDLER will be summed for the three-minute intervals necessary to scan each 25-foot by 25-foot area.

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FIGURE 5-3

FERNALD RI/FS

Surface Measurements Field Logbook Form

Site: _____ Surveyors: _____

Area: _____ Recorded By: _____

Date: _____ Count Time: _____ Background: _____ CPM

_____ CPM

(-X)W←←←←Coordinates→→→→E(+X)

(-Y)S ←←←←Coordinates→→→→N(+Y)

Comments: _____ Scaler Model _____ Serial No. _____

_____ Probe Model _____ Serial No. _____

_____ Scaler Model _____ Serial No. _____

_____ Probe Model _____ Serial No. _____

_____ PIC Serial No. _____

- Scans will begin at one corner of a grid block and will progress in a serpentine pattern over the entire block, ending at the diagonally opposite corner of the block. Push the count button as the scan begins. With practice, the timed count will end upon reaching the opposite corner. During the scan, the technician must listen to the audible signal. This may be achieved by using headphones. Although scanning speed should not be slowed when increased audible signals are heard, the presence of apparent "hot spots" should be noted when the integrated count for the scan is recorded.

- Upon completion of the scan for an individual grid block, record the integrated count in its respective position on the Surface Measurements Field Logbook Form.

- Return to the locations that were identified as having a "hot spot" and conduct a one-minute count over the area indicated as having the highest concentration. Record the count on the Surface Measurements Field Logbook Form.

- Repeat the survey of at least two subgrids (approximately 10 percent) for each 100-foot by 100-foot grid. The subgrid yielding the highest count, as well as a subgrid selected randomly, should be recounted. A calculator generating random numbers may be used to select the specific subgrid. Record the repeated data in the appropriate box on the Surface Measurements Field Logbook Form, under the first data point.

- When all grid blocks for each assignment have been completed, return signed Surface Measurement Field Logbook Forms to the radiation measurements task leader and return the FIDLER system to its storage area.

5.1.1.6 Use of the FIDLER to Estimate Soil Uranium Concentration

The determination of uranium contamination in soil is based on the laboratory analysis of soil samples to identify isotopes of uranium. The FIDLER serves to identify areas which have "elevated" readings and provides a systematic approach to a biased soil sampling program by collecting samples in areas where

the instrument response is consistently higher. It is possible to develop a correlation between the FIDLER response and degrees of soil contamination by comparing instrument response and the laboratory results of soil samples.

The correlation is determined by first collecting soil samples from grids which exhibited elevated readings. A survey with the FIDLER is repeated for the 25-foot by 25-foot subgrid as described in Section 5.1.1.5, as well as for the specific location where the sample is to be collected. The FIDLER is placed directly on the soil over the sample location and the integral count recorded. The soil sample is then collected at several depths to determine the concentration on the surface versus the subsurface. The instrument response is plotted with the concentrations of uranium, and a correlation is calculated using a linear regression method.

The soil sampling program collects samples from areas previously surveyed during the radiation measurements task, especially those identified to have elevated readings. The FIDLER is used to survey each sample location to provide additional data concerning instrument response to soil contamination.

5.1.2 IN-SITU GAMMA RAY MEASUREMENTS USING THE DELTA-GAMMA TECHNIQUE

The purpose of this procedure is to provide guidance for the in-situ measurement of gamma rays emitted from surface soil and to provide a technique for screening potentially contaminated soils in the presence of adjacent sources of air-scattered gamma radiation.

These procedures were developed for the Uranium Mill Tailings Remedial Action (UMTRA) Program for measuring in-situ Ra-226 concentrations in soil where adjacent sources of radiation influence probe measurements. This procedure will be used to screen for anomalous gamma radiation levels in areas where adjacent sources of radiation influence the use of an unshielded probe.

This procedure is referenced to UMTRA PROCEDURE 10.17.3, IN-SITU RA-226 MEASUREMENT USING THE SHIELDED DELTA PROCEDURE.

Screening of soils in areas of elevated gamma-ray intensity will be based on the results of the delta-gamma technique described below. This survey technique will provide a basis for detecting anomalous conditions in the subsurface soil below the measurement location.

Twenty background delta count measurements will be taken to provide a statistical basis for evaluating gamma-ray measurements of potentially contaminated locations as a function of site background levels. The average background delta count and its standard deviation will be determined. Measurements subsequently taken during the field work that have a delta count greater than the average background plus three standard deviations of the background will be marked, and the area will be further characterized by taking additional delta-gamma measurements and sampling the surface soil according to the procedures in Section 6.0.

Figure 5-4 presents a field data sheet to be used in the laboratory for documenting background delta-gamma results, and to calculate the average and standard deviation of the background

data. Figure 5-5 provides a field data sheet to be used for documenting field delta-gamma measurements.

The delta-gamma calibration will be performed at a subcontractor laboratory. The calibration factor will account for Th-232 and K-40 concentrations. It will be initially developed for estimating the in-situ Ra-226 concentration. Site-specific calibration constants can be developed by performing delta counts at various locations having a uniform increase in surface radiation levels. At each location, a surface soil sample will be obtained and analyzed for gamma-emitting radionuclides. From this data, a correlation of delta count rate to gamma-ray contributing radionuclide concentrations can be established. In-situ gamma-ray measurements using the delta-gamma technique will be performed according to the following procedure:

- Daily before each sampling exercise, check the high voltage (as stated on detector probe), threshold setting (100), window setting (gross mode), and battery conditions (BAT indicator off) on the ratemeter/scaler.

- The measurement of in-situ gamma radiation is performed by making "up" (shield out) and "down" (shield in) counts over the area to be characterized.

- With the shield out, make and record three "up" counts with the rate meter/scaler set to integrate 1,000 counts ("c" scale). When 1,000 counts have been registered, the ratemeter/scaler will calculate the count rate (CPM) and display the value. Record each value on the field data sheet. With the shield in, make and record three "down" counts in the same fashion. Record each value on the field data sheet.

FIGURE 5-4

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Shielded Delta-Gamma In-Situ Measurement

Background Assessment

Project Name:_____ Recorded By:_____

Date:_____ Time:_____

Delta Housing No.:_____ Daily Check Results:_____

Probe No.:_____ HV_____(1000V) Threshold_____(100)

Ratemeter/Scaler No.:_____ BAT_____(OK) Window_____(OUT)

Check Source No.:_____ Check Location:_____

Unchielded C_1*_____ C_2_____ C_3_____ Avg. Unshielded_____

Shielded C_1*_____ C_2_____ C_3_____ Avg. Shielded _____

Delta 1_____ 2_____ 3_____ Avg. Delta _____

Bkg. Meas.	Location	Unshielded C_1*	Unshielded C_2	Unshielded C_3	Shielded C_1*	Shielded C_2	Shielded C_3	Delta
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Average _____

Std. Dev._____

Ave. ± 3 Std. Dev._____

*Each count represents the counts per minute based on integration of 1000 cts. on the "C" scale of a ratemeter/scaler.

FIGURE 5-5

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Shielded Delta-Gamma In-Situ Measurements
Field Radiation Measurements

Project Name: _____ Recorded By: _____

Shield Id. No.: _____ Calibration Factor: _____

Probe No.: _____ Comments: _____

Ratemeter/Scaler No.: _____ _____

Surveyors: _____ _____

_____ _____

Field Measurements

Measurement N-S	Location E-W	Unshielded Counts (CPM) C_1	C_2	C_3	Shielded Counts (CPM) C_1	C_2	C_3	Average Delta	Location For Further Consideration Yes	No

- Compare the sample delta to the average background delta plus three standard deviations of the background delta. If the sample delta is greater, the location will be staked and the areal extent of material further characterized by making additional delta-gamma measurements and by obtaining surface soil samples according to the sampling procedures in Section 6.0.

5.1.3 EXPOSURE RATE MEASUREMENTS USING A PRESSURIZED ION CHAMBER (PIC)

The purpose of this instruction is to provide uniform measurement techniques when using a secondary standard instrument, the pressurized ion chamber, for determining external gamma exposure rate at a height of one meter above the soil or facility surfaces.

One of the most accurate methods for measuring the gamma radiation exposure rate in the field is with a secondary standard instrument such as the Reuter-Stokes PIC. The PIC will be used to "field calibrate" or standardize other exposure rate measuring instruments such as the SPA-3 or hand-held scintillation instruments.

The procedure described below is referenced to the Reuter-Stokes PIC Operational Manual. However, other manufacturers' instructions for operation of the PIC may be used.

5.1.3.1 PIC Operational Procedure

Set up the PIC and perform the field measurement according to the following instructions:

- Check proper operation of the PIC according to the manufacturer's instructions.
- Place the PIC in the center of the survey grid block or at the survey grid point in accordance with the sampling plan.

- Attach the sensor head to the tripod and adjust the height of the chamber to one meter from the surface to be measured.

- Check that the electrometer and mode switches are both in the off position and connect the cable to the readout housing.

  - Turn the Display/Recorder switch to on.

  - Place ELECTROMETER switch to zero.

  - Place MODE switch to BATT position.

  - Depress the switch designated 300V.

  - If the digital display shows less than 85 (as a percent of charge), replace the 300 V battery.

- Check the charge on the -14V, +14V, and 12V lead-acid batteries by depressing the switch immediately below the voltmeters for each battery. If the needle is on or near the shaded area of the meter, recharge these batteries before proceeding.

- Place the ELECTROMETER switch in the ZERO position and wait 60 seconds.

- Place the ELECTROMETER switch in the READ position.

- Reset the mechanical counter and start the stopwatch simultaneously.

- After at least 60 minutes and when the counter integrates the next microR ()R), record elapsed time and exposure.

- Determine exposure rate in microR/hr ()R/hr) using the following formula:

$$\frac{60 \text{ minutes/hr}}{\text{count time minutes}} \times \text{exposure recorded by PIC}$$

- Record the exposure rate on Figure 5-6.

FIGURE 5-6

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Gamma-Ray Exposure Rate Survey

Site:_____ Location:_____

Date:_____ Survey No.:_____ Surveyor:_____

Scaler Model:_____ Serial No.:_____ Count Time:_____

Probe Model:_____ Serial No.:_____ Background:_____CPM

Comments:_____ Calibration Factor:_____ uR/hr/cpm

Location	uR/hr at 1 meter	Location	uR/hr at 1 meter	Location	uR/hr at 1 meter	Location	uR/hr at 1 meter

5.1.3.2 Calibration of the Sodium Iodide Detector Using the PIC

Correlation of scintillation detector measurements with PIC measurements on a site-specific basis permits the determination of correction factors which can be applied to the scintillation detector measurement to evaluate gamma exposure rates. This technique permits the use of less expensive portable instruments to obtain exposure rate survey data. This procedure describes the methodology for correlating counts obtained using a gamma ray scintillation probe coupled to a ratemeter/scaler, to the exposure rate measurements taken with the PIC.

The correlation is performed using 5 to 50 locations ranging in activity from normal background to approximately 500 uR/hr. The FMPC site will be subdivided into areas where, within the area, the variation in the photon spectrum will be relatively consistent. It is anticipated that several areas will be defined by the photon spectrum. Accordingly, each area will be correlated separately to develop area-specific correction factors.

Measurement locations will be chosen so that the exposure rate is relatively constant with slight differences in the positioning of the two detectors. Measurements will be taken alternately at each location with both instruments one meter from the ground or measurement surface. Results will be recorded on the Site-Specific Exposure Rate Correlation Form (Figure 5-7).

After performing measurements at a sufficient number of locations, the readings from both instruments will be correlated by determining the mathematical relationship between the responses of the two instruments, i.e., with a linear, least-squares regression analysis.

5.1.4 WALK-OVER SURVEYS USING THE LARGE-VOLUME SCINTILLATION DETECTOR

The purpose of this instruction is to provide uniform measurement techniques when using a large-volume scintillation detector and to provide uniform interpretation of the results from such measurements.

The most sensitive gamma-ray survey instrument is the large-volume, sodium iodide scintillation detector (e.g., the Eberline Model SPA-3 or equivalent). It is commonly used for locating gamma-ray sources in low background areas and for measurements of low-level exposure rates. This procedure is referenced in the manufacturer's operation manual. Various other manufacturers' instructions for operation of the large-volume scintillation detector may be used.

FIGURE 5-7

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Exposure Rate Correlation Data

Entry Form - Site-Specific

Site:_____ Location:_____

Date:_____ Survey No.:_____ Surveyor:_____

Location N-S	Location E-W	Location Section	PIC # ____ uR/hr at 1 meter	Inst # ____ CPM at 1 meter	Inst # ____ CPM at 1 meter

Large-Volume Scintillation Detector Operational and Field Measurement Procedure

Set up the detector and perform the field measurement according to the following instructions:

- Check proper operation of the detector and its associated ratemeter/scaler according to the manufacturer's instructions.
- Perform weekly correlation of the detector according to Section 5.1.3.2 and record the results on the Gamma-Ray Exposure Rate Survey form (Figure 5-6).
- Perform daily source checks using a 0.1)Ci Cesium-137 check source and record the response on the Instrument Checks form (Figure 5-2).
- Perform daily background checks at the field office and record the response on the Instrument Checks form (Figure 5-2).
- For walkover surveys, proceed to the assigned grid area and reset the scaler on the ratemeter/scaler.
- Subdivide the 100-foot by 100-foot grid into 16 squares, each 25 feet by 25 feet.
- At one corner of the grid, start the scaler and timer and walk at a steady rate (approximately two feet per second) over the subgrid, beginning along one side and covering the entire grid in a rectilinear fashion until all areas have been surveyed.
- The scintillation detector should be suspended by a rope or strap and swung from side-to-side in a serpentine fashion. Each 25-foot by 25-foot subgrid should be surveyed in approximately two minutes.
- During the walkover, survey meter count rate may be monitored with earphones, if necessary. Any location with an elevated count rate (indicated by a higher pitch in the earphones) in localized areas will be marked by dropping a weighted flag, and the survey will continue at the same pace.
- After the walkover of the grid is completed, the scaler and timer are stopped and the following items are

recorded on the Surface Measurements Field Logbook Form (Figure 5-3): (1) grid ID number, (2) the total count, and (3) the elapsed time.

- Return to each location which has been "flagged" within the grid and perform a systematic survey beginning at the flag and working outward to determine the areal extent of the elevated reading.

- Record the highest count rate and the approximate location and areal extent; insert a marker at the location of highest reading.

5.2 DRILLING PROCEDURES

Soil borings are made to determine the nature, arrangement, thickness and extent of the soil strata. The depth of borings, frequency, and the type of testing and sampling required are dependent upon the purpose of the subsurface investigation.

Borehole advancement for monitoring wells will be performed using cable tool drilling techniques. The use of mud rotary or continuous flight hollow stem augers is prohibited for monitoring wells. A soil auger drilling rig will be used to collect undisturbed soil samples in clay layers that may be found in the till in accordance with ASTM 1587. Cable tool borehole drilling will be performed in accordance with approved procedures supporting the RI/FS and Remediation Work Plan documents.

Comments pertinent to the cable tool drilling technique follow:

- When advancing the boring using cable tool drilling techniques, a temporary steel casing will be drilled, driven, or pushed as the borehole is advanced. The temporary casing will be threaded, nominal ten-inch diameter for constructing 1000 series monitor wells. The temporary casing will be threaded, nominal eight-inch or nominal ten-inch diameter to allow for the construction of the monitoring well in the 2000, 3000, and 4000 series borings.

- Additionally, the temporary casing in the 4000 series boring may be nominal ten-inch diameter to approximately 150 foot depth, then telescope to nominal eight-inch diameter to allow for the construction of the monitoring well. Cuttings will be removed from the borehole using a sand pump or dart valve bailer.

- During the process of drilling monitoring wells, disturbed soil samples will be collected. Disturbed samples will be collected with a split-barrel or split-spoon sampler in accordance with ASTM D1586.

- Relatively undisturbed soil samples will be collected with thin-walled tubes or Shelby tubes in accordance with ASTM D1587. These samples will be collected with a soil auger drill rig. The soil auger drill rig will only be used for borings to collect samples for geochemical and geotechnical purposes. Undisturbed samples are not being collected from borings for monitoring wells because the heavy blows from cable tool (percussion) drilling will result in significant densification of cohesionless soils and remolding of cohesive soils, which will adversely affect sampling and testing operations.

- Drilling operations shall be performed in such a manner to minimize the introduction of contaminants into the subsurface soil and ground water. Accordingly, only clear, potable water will be used as a drilling fluid and only as a last resort. Water samples will be collected from the on-site source and each water tank hose and analyzed for the full list of organic, inorganic, and radiological parameters. If possible, all drilling operations will be performed dry without the use of water.

- The source(s) of any water to be used in drilling, grouting, and well and/or piezometer installation must be approved prior to field operations. Water used in aid of drilling will be analyzed and results reviewed prior to introduction into the borehole.

- The abandonment of borings and wells will be approved in writing by the responsible manager prior to any casing removal or sealing/backfilling. Once approved, these borings and/or wells shall be sealed by grouting from the bottom of the boring or well to ground surface. This shall be done by placing a grout pipe to

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FIGURE 5-8

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER:	PROJECT NAME:	
BORING NUMBER:	COORDINATES:	DATE:
ELEVATION:	GWL: Depth Date/Time	DATE STARTED:
ENGINEER/GEOLOGIST:	Depth Date/Time	DATE COMPLETED:
DRILLING METHODS:		PAGE OF

DEPTH	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER	RECOVERY	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS

NOTES:

the bottom of the boring or well and pumping grout through this until undiluted grout flows from the boring or well at ground surface. The grout shall consist of Volclay grout mixed properly with the recommended activator. After the grout has set (about 72 hours), the contractor shall check the abandoned site for grout settlement.

Any depression in the grout shall then be filled with additional grout. Methods other than those set forth herein may be implemented as dictated by appropriate state and/or local agencies.

- The use of dug sumps is not allowed. The use of drums or a plastic-lined, above-ground holding structure is required for cuttings and water removed from the borehole.

- No dyes, tracers, or other substances shall be used or otherwise introduced into borings, wells, piezometers, grout, backfill, ground water, or surface water unless specifically required by the contract.

- Drilling equipment that enters a boring will be cleaned using a high-pressure, hot-water sprayer between borings to prevent cross-contamination.

- Each operating drill rig shall have a geologist assigned to it who will be responsible for logging the samples, preparing the boring logs (Figure 5-8) and well sketches, and installing the well. No geologist will be responsible for more than one operating rig per project site or installation involving soil sampling, rock coring, or monitoring well installation functions.

- Soils will be sampled continuously to the base of the till, then at five-foot intervals or at every lithologic change thereafter. These samples are to be obtained with a driven split-spoon or pushed thin-wall Shelby tube sampler or both in each boring. A sufficient number of continuous cores will be completed to adequately characterize the geology of the site.

The contractor shall be responsible for securing any and all boring or well drilling permits required by state or local authorities and for complying with any and all state or local

regulations with regard to the submission of well logs, samples, etc.

The contractor shall also be responsible for complying with any and all regulations (to include placement) for drilling safety and underground utility detection.

5.3 MONITORING WELL/PIEZOMETER DESIGN AND INSTALLATION

To provide proper quality control of monitoring well design and installation, the following standard operating procedures have been set forth, along with the applicable forms, to successfully complete a field drilling investigation that obtains hydrogeological and future water quality information.

All field measurements and comments will be recorded on the appropriate forms (Figures 5-9 through 5-13). Per data reporting format and protocols, all lines on the forms will be completed. The letter designation "NA" for not applicable or "NK" for not known will be used in all blank spaces. Also acceptable is a neat and precisely drawn arrow through applicable spaces from an "NA" or "NK." If some steps or procedures were not performed as described, the reason must be stated as completely as possible on the appropriate form or submitted as an attachment thereto.

All monitoring wells/piezometers will use the following design and materials:

- Well casing will be four-inch inside diameter, 316 stainless steel with flush-thread joints for monitoring wells.
- Five, ten, and fifteen foot sections of commercial 0.01-inch-slot stainless steel screens will be used (minimum three square inches open area per foot of screen).

- Screen gravel pack material will be a well-sorted medium or coarse quartz sand. A representative sample will be retained for documentation.

- Sodium bentonite pellets and Volclay grout will be used in the backfill for 100- and 200-series wells. Only Volclay grout will be used in 300- and 400-series wells. Samples of all grouts will be retained for documentation.

- Wells (100 and 200 series) will be backfilled with a sand pack to a height of two to five feet above the screen, then a five foot bentonite pellet plug will be placed on top of the sand pack and, finally, grout to the surface. The 300- and 400-series wells will be backfilled with a sandpack to a height of five feet above the screen and then grouted to the surface. The grout will consist of a slurry of American Colloid Company Volclay grout. A sample of the backfill material will be collected for analysis to identify the presence of contaminants of interest.

- Annular space grout seals will be composed of a Volclay grout mixed with potable water and activator as per manufacturer's instructions.

- All grout material will be placed using pumps and tremie line methods.

- A five-foot length (minimum thickness 1/4 inch) of ten-inch inside diameter black iron pipe will be used as a protective casing. Each protective casing will be fitted with a hinged cap, hasp, and lock. A drain hole will be drilled in the oversleeve one foot above the land surface.

- A mixture of approximately 1:2 cement:sand and approved water will be placed between the well riser and the outer protective casing to a height just below the drain hole mentioned above. This design will allow water which enters the annulus to drain.

- The top of the inside casing will be finished with a vented stainless steel cap or an airtight cap and a vent hole not more than six inches from the top of the casing.

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FIGURE 5-9

PIEZOMETER INSTALLATION SHEET

PROJECT NAME _____ FIELD ENG./GEO. _____ DATE _____
PROJECT NO. _____ CHECKED BY _____ DATE _____
BORING NO. _____
PIEZOMETER NO. _____ DATE OF INSTALLATION _____

BOREHOLE DRILLING

DRILLING METHOD _____	TYPE OF BIT _____
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID _____ FROM _____ TO _____	SIZE _____ FROM _____ TO _____
FLUID _____ FROM _____ TO _____	SIZE _____ FROM _____ TO _____

PIEZOMETER DESCRIPTION

TYPE _____	RISER PIPE MATERIAL _____
DIAMETER OF PERFORATED SECTION _____	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. _____ I.D. _____
SLOTS ☐ HOLES ☐ SCREEN ☐	LENGTH OF PIPE SECTIONS _____
AVERAGE SIZE OF PERFORATIONS _____	JOINING METHOD _____
TOTAL PERFORATED AREA _____	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH _____	OTHER PROTECTION _____
PROTECTIVE PIPE O.D. _____	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE				
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE				
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP	BOTTOM	TOP	BOTTOM
BENTONITE	TOP	BOTTOM	TOP	BOTTOM
SAND	TOP	BOTTOM	TOP	BOTTOM
GRAVEL	TOP	BOTTOM	TOP	BOTTOM
PERFORATED SECTION	TOP	BOTTOM	TOP	BOTTOM
PIEZOMETER TIP				
BOTTOM OF BOREHOLE				
GWL AFTER INSTALLATION				

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☐
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☐

REMARKS _____

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DATE	
TIME	
PAGE ___ OF ___	
PAGE	

FIGURE 5-10

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PIEZOMETER SENSITIVITY TEST

PROJET NAME_____ TESTED BY_____ DATE_____

PROJECT NO._____

BORING NO._____

PIEZOMETER NO._____

TEST TRIAL NO._____

GWL BELOW TOP OF PIPE PRIOR TO TEST _____ (M-scope, 0.01 foot accuracy)

TIME READING TAKEN _____

THE PIEZOMETER WAS FILLED WITH WATER. THE FOLLOWING DATA SHOW THE DROP OF WATER FROM THE TOP OF THE PIPE AS TIME ELAPSED.

ELAPSED TIME (MINUTES)	DROP OF WATER (FEET)

BASED ON THE ABOVE DATA, IT IS CONCLUDED THAT THE PIEZOMETER IS:

_____ FUNCTIONING PROPERLY

_____ NOT FUNCTIONING PROPERLY

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PAGE ____ OF ____					
PAGE					

PIEZOMETER DATA SHEET

PROJECT NAME _____ PROJECT NO. _____

(1) DEPTH TO THE WATER LEVEL FROM THE TOP OF PIPE
(2) ELEVATIONS SHOWN ARE TOP OF PIEZOMETER PIPE

DATE & RECORDER	PIEZOMETER READINGS - FEET (1) / ELEVATION OF WATER LEVEL - FEET										
	# EL (2)	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.	# EL.

400-11-86

FIGURE 5-11

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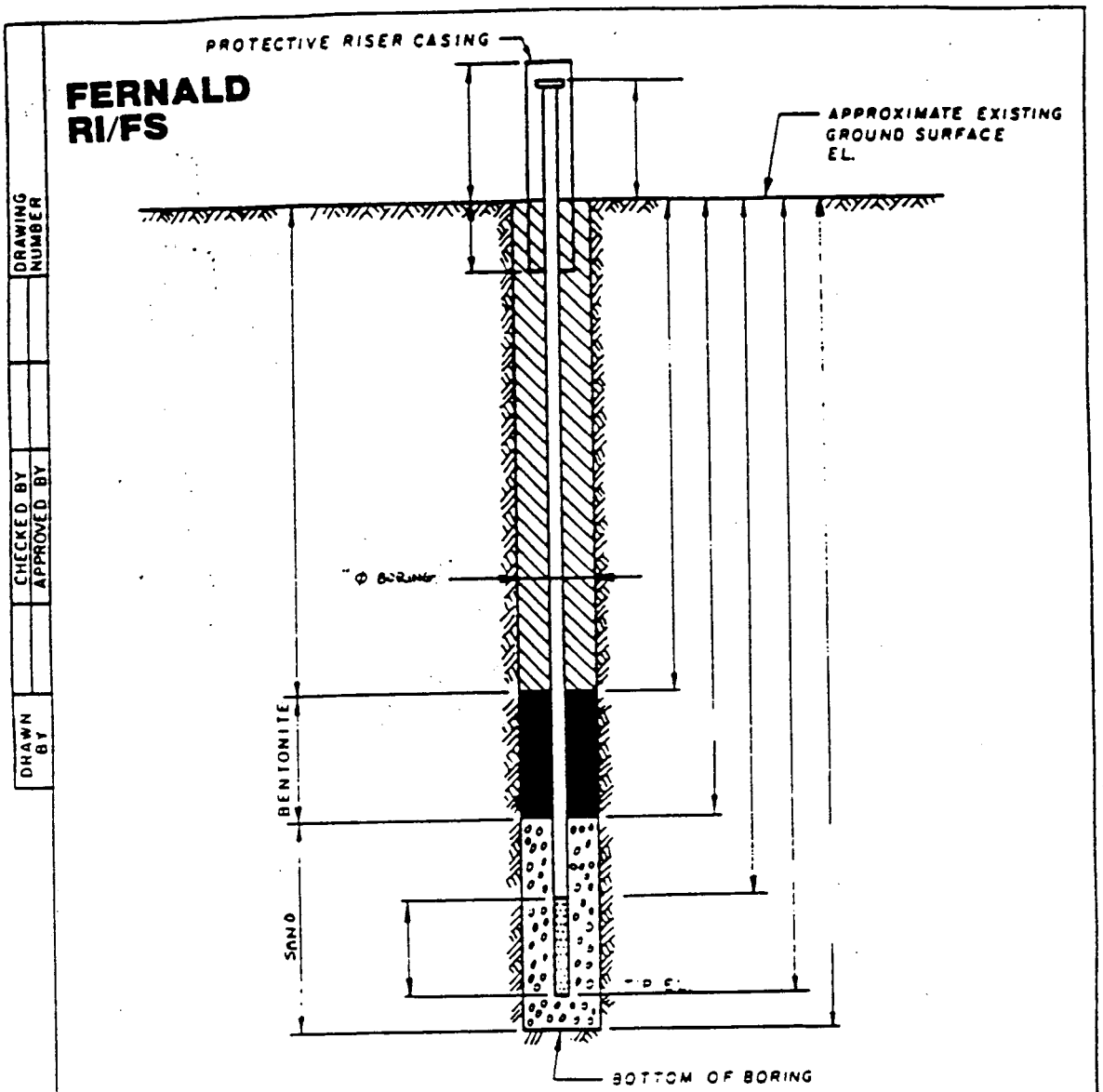
FIGURE 5-12



NOTES

1. RISER PIPE IS IN 10 SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS IN 10 PIPE CONTINUOUS SLOT SCREEN (0.0 0 IN SLOT SIZE)
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

MONITORING WELL INSTALLATION DETAILS

FIGURE 5-13

FMPC RI/FS
MONITORING WELL COMPLETION CHECKLIST
PROJECT 682

PAGE ____ OF ____
PAGE

WELL NUMBER

ITEM											COMMENTS.
1. A steel protective casing with steel lid and hasp welded to casing has been installed with a lock.											
2. The protective casing has been painted satisfactorily.											
3. The well identification no. has been welded into the top of the protective casing.											
4. The well I.D. number has been painted with enamel type paint on the inside of the lid of the protective casing.											
5. The grout seal has been installed in the annulus between the well riser and the outer protective casing to a height of about 6" above ground surface.											
6. A weep hole has been drilled through the protective casing at the proper location.											
7. A 3 foot by 3 foot by 4 inch concrete pad has been installed around the protective casing.											
8. The disturbed area around the well has been regraded as per project specifications.											
9. The well riser is finished with a vented stainless steel cap.											
10. A measuring point notch is filed on the top of the well riser for vertical control.											
11. 3" diameter steel posts, located 4' radially around the well, placed 2' below the ground and having 4' minimally above the ground are concreted in place.											

Y = YES
N = NO
NA = NOT APPLICABLE

DATE: _____

SIGNED: _____

- All wells and piezometers will be identified with a number welded into the lid of the protective casing. All protective casings will be painted high-visibility orange.
- All disturbed drilling areas will be regraded and restored to near original conditions upon completion.

A one-quart or one-liter representative sample of each type of proposed granular backfill shall be submitted by the contractor for approval prior to use. Each sample shall be described in terms of lithology, grain size distribution, and source (both company from whom purchased and pit or quarry of origin). This material shall be clean, inert, and siliceous. Typically, graded sand meeting the requirements of ASTM C-33 for fine aggregate (concrete sand) is sufficient.

A sketch of any well installation (see Figures 5-14 and 5-15) including piezometers, shall be recorded and shall show (by depth from surface grade) the bottom of the boring, screen location, granular backfill, seals, grout, cave-in, centralizers, if used, and height of riser above ground surface. The actual composition of the grout, seals, and granular backfill shall also be recorded. Also indicated shall be the screen, slot size (in inches), and slot configuration. Any use of polyvinylchloride (PVC) solvents, glues, or cleaners is prohibited.

Well sketches shall also include details of the protective casing.

Protective casing shall be installed around all monitoring wells. Exceptions will be on a case-by-case basis, as determined. Minimum elements in the protection design include:

- A five-foot minimum length of black 10-inch-diameter iron pipe or galvanized pipe extending approximately

2.5 feet above the ground surface and set in Volclay grout and concrete apron.

- A locking cover and lock shall be provided and secured to the top of each protective casing.
- The location identification shall be labeled on the well protector in two places using two methods: (1) painted on the inside of the cover with enamel type paint; and (2) welded into the top of the locking cover. Location identification shall conform with format and shall be designated by the site manager.
- The cover must keep precipitation out of the protective casing and shall be secured to that casing with a padlock.
- All padlocks at a given site shall be able to be opened by the same key.
- Protective casings are to be painted high-visibility orange.
- Three-inch diameter steel posts, each radially located four feet around each well, placed two feet below ground surface and having four feet minimally above ground surface will be concreted in place (optional).

Once the boring has been advanced to the desired depth, the well/piezometer will be constructed by the following procedure:

- Place the desired length of screen and casing inside the temporary casing.
- Place the sand pack in the annular space between the screen/casing and temporary casing.
- Withdraw the temporary casing slowly while placing sand pack material.
- After placing the sand pack to a level of at least two feet to five feet above the screen, a five-foot-thick bentonite pellet layer (only for 100- and 200-series wells) is placed on top of the sand pack as the temporary casing continues to be withdrawn slowly.

FIGURE 5-14

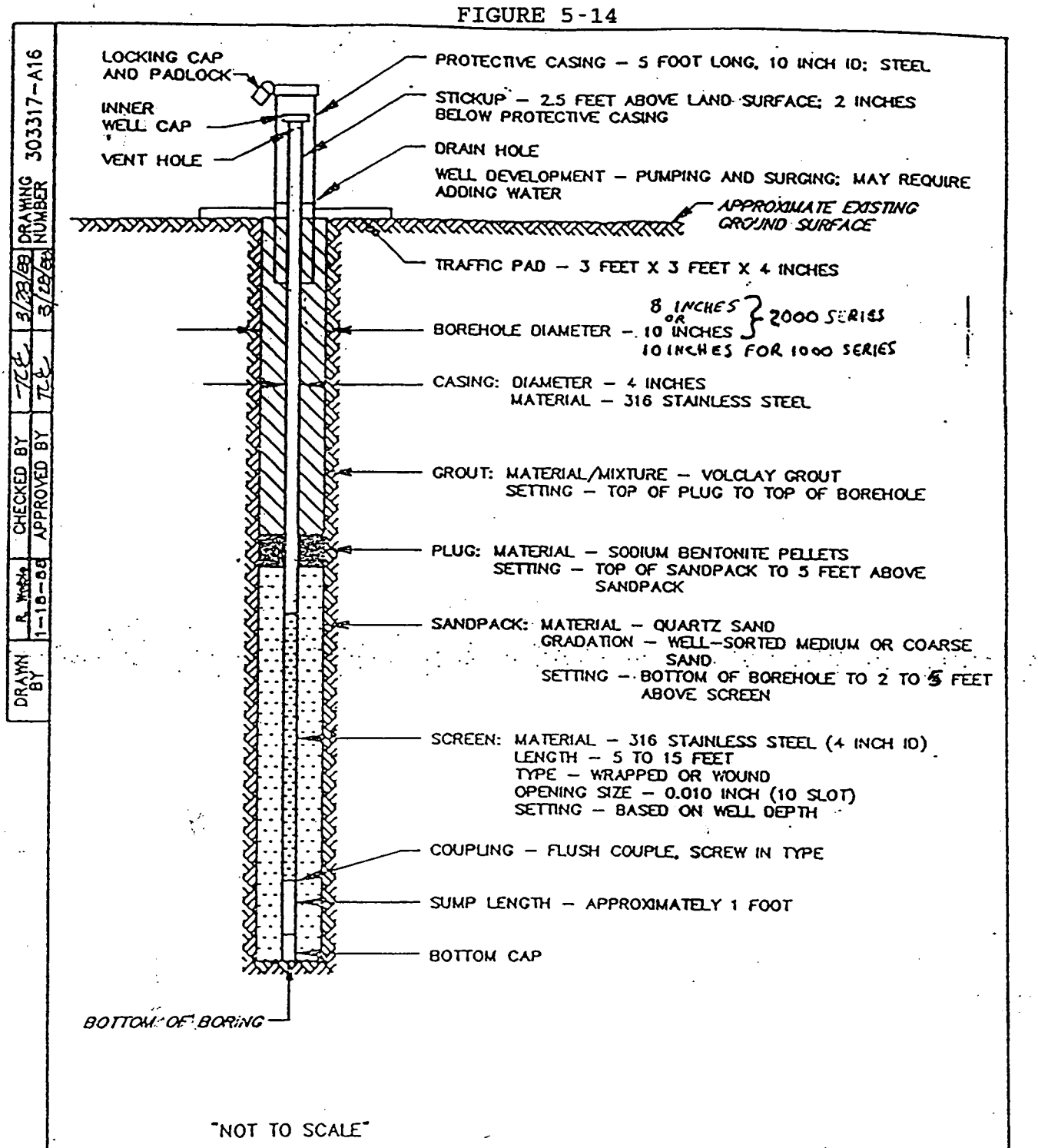


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FIGURE 5-14

SUMMARY OF SPECIFICATIONS FOR WELL COMPLETION
1000- AND 2000- SERIES WELLS

-5195

Figure 5-15

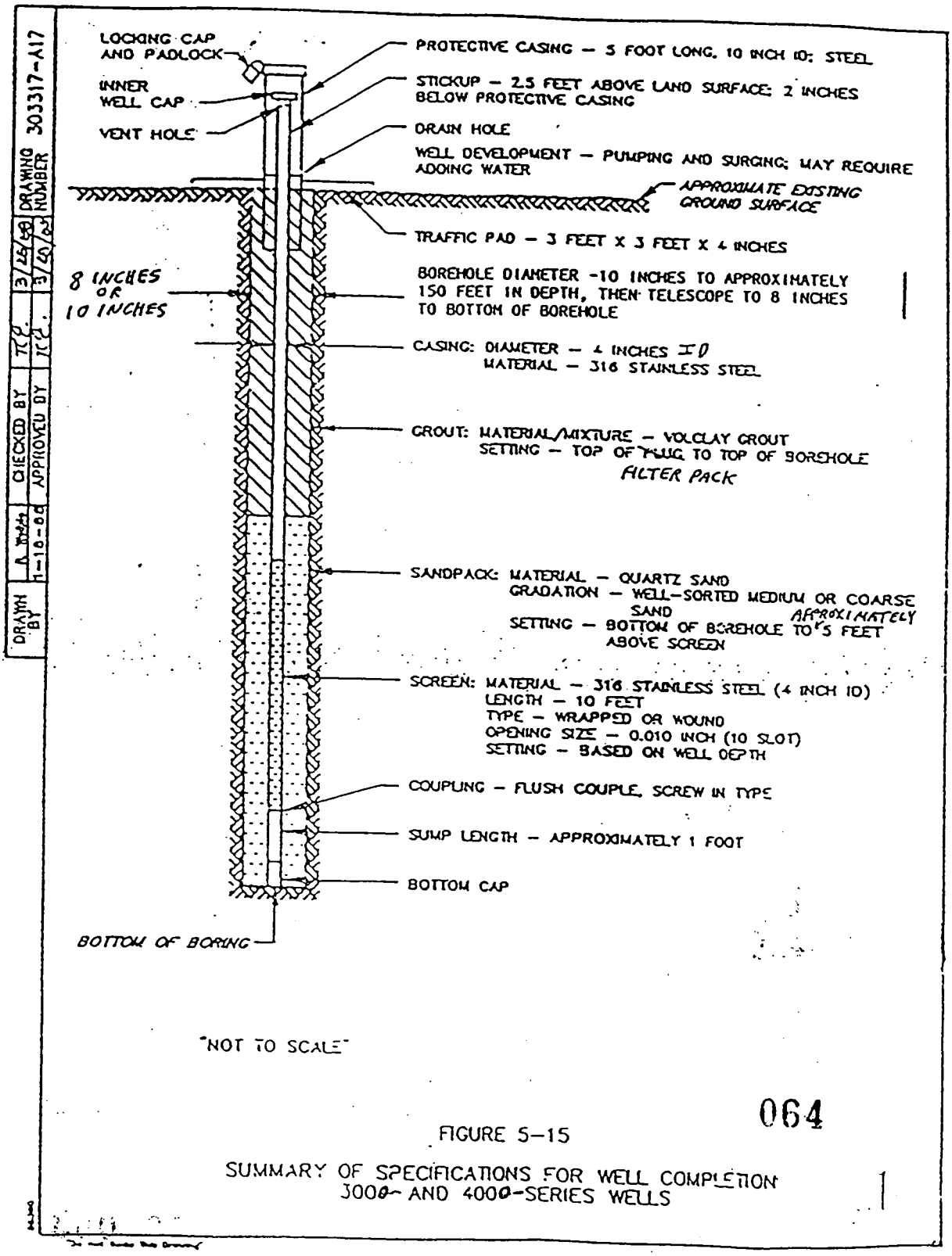

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FIGURE 5-15

SUMMARY OF SPECIFICATIONS FOR WELL COMPLETION 3000- AND 4000-SERIES WELLS

Periodic measurements will be made to check the uniform placement of the sand pack.

- The remaining annular space will be filled to the surface using Volclay grout.
- The temporary casing will be removed gradually as the backfill materials are placed in such a manner that the bottom of the temporary casing is kept below the top of the backfill material.
- The protective casing will be installed and concreted in place.
- A three-foot by three-foot by four-inch concrete apron will be installed around the protective casing.

5.4 MONITORING WELL DEVELOPMENT

The following procedure is presented for the proper development of monitoring wells and piezometers for ground water sampling purposes. All field measurements and comments will be recorded on the appropriate data reporting form (Figure 5-16). All lines on the form will be completed. The letter designation "NA" for not applicable or "NK" for not known will be used in all blank spaces. Also acceptable is a neat and precisely drawn arrow through applicable spaces from an "NA" or "NK." If some steps or procedures are not performed as described, the reason must be stated as completely as possible on the appropriate form or submitted as an attachment. Monitoring well development will be performed as soon as possible after well installation, but no sooner than 48 hours after grouting is completed.

Well development equipment may include, but is not limited to, bailers, surge blocks, pumps, and hoses. Equipment and materials used for well development will be properly decontaminated the same way as drilling equipment, before and between each use.

FERNALD RI/FS
PROJECT NO. 602
TASK 3.2

MONITORING WELL DEVELOPMENT

PAGE ___ OF ___

WELL NUMBER _____

DATE(S) OF WELL INSTALLATION _____

WELL DEVELOPMENT START DATE/TIME _____ COMPLETION DATE/TIME _____

		BEFORE DEVELOPMENT	AFTER DEVELOPMENT
STATIC WATER LEVEL			
DEPTH OF OPEN HOLE			
CHANGES IN PHYSICAL CHARACTER OF WATER REMOVED	TURBIDITY		
	COLOR		
	PARTICULATES		
	ODOR		

TOTAL CALCULATED VOLUME OF WATER TO BE REMOVED (IN GALLONS) _____

TOTAL VOLUME OF WATER ACTUALLY REMOVED DURING DEVELOPMENT (GALLONS) _____

TYPE AND SIZE OF PUMP _____ TYPE AND SIZE OF BAILER _____

PHYSICAL CHARACTER OF REMOVED SEDIMENTS (LITHOLOGY AND GRAIN SIZE)

DESCRIPTION OF SURGE TECHNIQUES (IF USED)

METER CALIBRATION

pH TEMP	pH STD.	pH STD.	SPECIFIC CONDUCT.	uMHOS/CM	uMHOS/CM	TURBIDITY	
						NTU	NTU

METER MODEL/ SERIAL NO.	pH METER	SPECIFIC CONDUCTANCE METER	TURBIDITY METER	DISSOLVED OXYGEN METER

FIELD ENGINEER/GEOLOGIST _____ DATE _____

DRILLER/HELPER _____

CHECKED/VERIFIED BY _____ DATE _____

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FIGURE 5-16
(CONTINUED)

DATE AND TIME SAMPLE COLLECTED	GALLONS OF WATER PURGED FROM WELL	TEMP.	SPECIFIC CONDUCTANCE	pH	DO	TURBIDITY	REMARKS

REMARKS/OBSERVATIONS

Decontamination will normally be high-pressure hot-water washing (steam cleaning) of equipment used to develop the well. However, if, during well development, the equipment becomes visibly contaminated, decontamination will be a high-pressure/hot-water wash, methanol wash followed by two separate deionized water rinses. In the case of visible inorganic contaminants (visibly contaminated with soil/sediment) decontamination will be high-pressure/ hot-water wash, dilute-hydrochloric-acid wash followed by two separate deionized water rinses. The internal mechanisms of pumps will be flushed using either dilute solutions of methanol and deionized water or dilute hydrochloric acid and deionized water when contaminants are visible. Development shall be continued with a sump and/or bottom discharge bailer, possibly supplemented with a surge block, until the well water is clear and sediment within the well is removed to the fullest extent practical. The natural hydraulic conductivity of the formation should have been restored and foreign sediment removed to provide turbid-free ground water samples. If the well continues to yield turbid ground water samples, the "Decision Chart for Turbid Ground-Water Samples" procedure described in the TEGD will be followed in an attempt to achieve turbidity-free water. The recommended acceptance/ rejection value of five nephelometric turbidity units (NTU) is based on the need to minimize biochemical activity and possible interferences with ground water sample quality. As a minimum:

- For those wells where the boring was made without the use of drilling fluid water, remove five times the standing water volume in the well (well screen and casing plus saturated annulus). Should recharge be so slow that five volumes could not be removed in one day or the water remains discolored or contains greater than one percent particulates after this five volume removal, the hydrogeology task leader will direct an alternate procedure based on the judgment of the field geologist.

- For those wells where the boring was made or enlarged with the use of drilling fluid (water), remove five times the measured amount of total fluids lost while drilling plus five times the standing water volume as above. The same procedure also applies here as above for cases of slow recharge, discolored, or particulate-laden water.

- No water will be added to the well to assist development without prior approval. No dispersing agents, acids, or disinfectants will be used.

- During development, an effort will be made to remove the standing water from points near the bottom of the well screen as well as from the top of the water column.

- If problems are encountered during development, the task leader will be promptly notified.

- The volume of water collected for analysis will depend on the analytical needs of the project.

The following data will be recorded on the Monitoring Well Development form (Figure 5-16) as part of development:

- Well designation (location ID);

- Date(s) of well installation;

- Date(s) and time of well development;

- Static water level before and after development;

- Quantity of water removed and time of removal;

- Depth of open hole inside the well before and after development;

- Physical character of the removed water, to include changes during development of turbidity, color, and odor;

- Physical character of removed sediments, to include lithology and grain size;

- Type and size/capacity of pump and/or bailer used;
- Description of surge techniques, if used; and
- Field characteristics of water removed including pH, specific conductance, temperature, and dissolved oxygen.

5.5 BOREHOLE GEOPHYSICAL LOGGING

This section provides a procedure for consistently performing and documenting geophysical logging activities, if required. The following procedure shall be followed by the hydrogeologist or designated field team leader (FTL).

Prior to any geophysical logging operation, the hydrogeologist or designated FTL will review the logging program and supply the information necessary to: (1) transport all applicable equipment to the drill site when required and (2) provide an acceptable logging operation. All electrodes and cables will be properly cleaned and decontaminated prior to the downhole logging operation and between each well.

The geophysical team will calibrate all logging equipment and provide documentation of all before and after survey calibrations. The FTL will forward copies of all calibrations and log runs to the hydrogeologist. The hydrogeologist will be responsible to see that all logs are appropriately filed at the field office.

When the geophysical team arrives at the drill site, the FTL will review the logging program and provide information necessary to complete the log heading of the Field Log Quality Control Check List (FLQCCL) (Figure 5-17). Field prints of all logging activities will be provided to the FTL, including calibration

steps. The FTL will monitor and record the progress of logging activities.

Prior to completing the geophysical logging, the FTL will check the electrodes and cables to see that they have been properly cleaned and decontaminated and will check the FLQCCL for completeness. Unchecked items will be discussed and recorded in the remarks section. When the FTL is satisfied with the performance of the logging operation, he/she and a member of the geophysical team will sign and date the FLQCCL.

At the conclusion of the logging operations, copies of data generated will be transferred to the hydrogeologist for distribution, analysis, and archiving. The geophysical team will secure original log data. Magnetic recordings, if generated during the course of downhole logging, will be transmitted to the field office. This will be done at the convenience of and in a recording format specified by the responsible manager.

5.6 AQUIFER/PERMEABILITY TESTING

The purpose of this section is to define the procedures to be followed by hydrologists when conducting hydraulic tests to characterize hydrogeologic units in the project area. The testing will be performed to estimate the hydrologic characteristics of a given hydrogeologic interval. The equipment used in the test will depend on the rate of flow of fluid encountered during drilling and testing. Several different test tool arrangements are planned to be able to perform various tests.

FIGURE 5-17

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FIELD BOREHOLE GEOPHYSICAL LOG
QUALITY CONTROL CHECKLIST

PAGE 1 of 4

SITE I.D. _____ LOGGING COMPANY _____

LOCATION I.D. _____ LOG DATE _____

BOREHOLE DEPTH, AS MEASURED FROM LAND SURFACE
DRILLER _____ FEET
LOGGER _____ FEET

LOG RUNS

__ NATURAL GAMMA	__ GAMMA-GAMMA DENSITY
__ NEUTRON POROSITY	__ SPECTRAL GAMMA-RAY
__ SPONTANEOUS POTENTIAL	__ INDUCED POLARIZATION
__ SHORT-NORMAL RESISTIVITY	__ INDUCTION
__ CALIPER	__ THERMAL NEUTRON
__ TEMPERATURE	__ LONG-NORMAL RESISTIVITY

LOGGING ENGINEER SHALL CHECK ALL ITEMS 1 THROUGH 43 APPLICABLE TO THE LOGGING OPERATION. ITEMS UNCHECKED SHALL BE DISCUSSED AND RECORDED IN THE "REMARKS" SECTION. ITEMS NOT APPLICABLE SHALL BE DESIGNATED "N/A." LOGGING ENGINEER AND FTR SHALL SIGN AND DATE THE CHECKLIST UPON COMPLETION OF THE LOGGING OPERATION AND THIS CHECKLIST.

NO.		GENERAL
1		LOGGING ENGINEER HAS COPIES OF NEARBY DRILL HOLES FOR COMPARISON
2		LOGGING ENGINEER HAS COPIES OF PREVIOUS LOG RUNS OF THIS DRILL HOLE
3		LOG HEADINGS COMPLETELY FILLED OUT
4		APPROPRIATE LOGGING SCALES CHOSEN AND RECORDED FOR ALL LOGS
5		DEPTHS AT WHICH ANY MAJOR CHANGES IN MUD PROPERTIES OCCURRED ARE INCLUDED IN REMARKS SECTION OF LOG HEADING
6		DEPTHS AT WHICH ANY HOLE OR CASING SITE CHANGES OCCUR ARE INCLUDED IN REMARKS SECTION OF LOG HEADING
7		DEPTHS AT WHICH ANY UNUSUAL HOLE CONDITIONS WERE ENCOUNTERED ARE INCLUDED IN REMARKS SECTION OF LOG HEADING
8		MUD SAMPLES TAKEN FROM FLOW LINE IMMEDIATELY AFTER CALCULATING BOTTOMS UP AND BEFORE COMING OUT OF THE HOLE
9		Rm, Rmf, Rmc AND CORRESPONDING TEMPERATURES MEASURED AND RECORDED
10		CASING I.D. SIZE, BIT SIZE AND HOLE SIZE RECORDED
11		LOGGING SPEEDS RECORDED AND CONFORM TO CLIENTS REQUEST OR SERVICE COMPANY SPECIFICATIONS
12		ALL SCALE CHANGES NOTED ON LOG AT CORRESPONDING DEPTHS
13		DEPTHS TO RECOGNIZABLE MARKER BEDS AGREE ON ALL LOGS
14		TOOL DESCRIPTION AND DESIGNATION INCLUDED IN LOG HEADING
15		DATE OF LAST SHOP CALIBRATION RECORDED
16		BASE OF CASING DETECTED AND LABELED ON ALL LOGS
17		CALIBRATION BEFORE AND AFTER EACH SURVEY
18		ALL CURVES LABELED

NO.		GAMMA-RAY LOG
19		BACKGROUND GAMMA RAY RECORDED
20		CALIBRATION SENSITIVITY RECORDED
21		LOGGING SPEED LESS THAN 20 FEET/MINUTE

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FIGURE 5-17
(Continued)

FERNALD RI/FS

FIELD BOREHOLE GEOPHYSICAL LOG
QUALITY CONTROL CHECKLIST

PAGE 2 OF 4

SITE CODE _____ LOCATION I.D. _____ DRILLER _____

DEPTH LOGGING COMPANY _____

DATE _____ LOGGER _____

NO.		NEUTRON LOG
22		CALIPER RECORDED
23		BACKGROUND GAMMA RAY RECORDED
24		LOGGING SPEED LESS THAN 20 FEET/MINUTE
25		POROSITY (%) AND RATIO CURVES RECORDED
26		NEUTRON MATRIX LABELED

NO.		SPONTANEOUS POTENTIAL
27		GROUND ELECTRODE IN A STABLE POSITION
28		ADEQUATE SCALE FOR SP SENSITIVITY APPROXIMATELY 5 DIVISIONS DEFLECTIONS FROM SHALE ZONE TO CLEAN SAND ZONE
29		SP BASELINE SHIFTS GREATER THAN ONE DIVISION CORRECTED ABRUPTLY AND LABELED
30		IF SP ABNORMAL, RERUN WITH SURVEY CURRENT OFF AND GROUND ELECTRODE CHECKED
31		WHILE ON BOTTOM PRIOR TO LOGGING SP RECORDED AND LABELED WITH CURRENT ON AND OFF
32		WHILE ON BOTTOM PRIOR TO LOGGING SP CALIBRATION SIGNAL RECORDED AND LABELED
33		WHILE STOPPED IN HOLE PRIOR TO LOGGING SP GALVANOMETER CHECKED FOR DRAFT OR CALIBRATION
34		LOGGING SPEED LESS THAN 20 FEET/MINUTE

NO.		RESISTIVITY LOGS
35		RESISTIVITY CURVES DO NOT READ LESS THAN ZERO
36		LOGGING SPEED LESS THAN 20 FEET/MINUTE
37		LATEROLOG HAS SYMMETRICAL CURVE SHAPE
38		BACKGROUND GAMMA RAY RECORDED

NO.		CALIPER LOG
39		CHANGES OF 1/8 INCH CAPABLE OF BEING DISTINGUISHED ON SELECTED SCALE
40		RECORDING MADE IN CASING AS A CHECK OF CALIBRATION
41		LOGGING SPEED LESS THAN 20 FEET/MINUTE

NO.		TEMPERATURE LOG
42		LOG RECORDED WHILE GOING IN HOLE AT LESS THAN 20 FEET/MINUTE
43		FLOW LINE MUD PIT AND AIR TEMPERATURE MEASURED AND RECORDED

NO.		GAMMA-GAMMA DENSITY LOG
44		CALIPER RECORDED
45		BACKGROUND GAMMA RAY RECORDED
46		LOGGING SPEED LESS THAN 20 FEET/MINUTE
47		BULK DENSITY (G/cc) AND POROSITY (%) CURVES RECORDED
48		MATRIX DENSITY AND FLUID DENSITY LABELED
49		CORRECTION CURVES (G/cc) RECORDED

FIGURE 5-17
(Continued)

FERNALD RI/FS

FIELD BOREHOLE GEOPHYSICAL LOG
QUALITY CONTROL CHECKLIST

PAGE 3 OF 4

SITE CODE _____ LOCATION I.D. _____ DRILLER _____

DEPTH LOGGING COMPANY _____

DATE _____ LOGGER _____

NO.		SPECTRAL GAMMA RAY LOG
50		LOGGING SPEED LESS THAN 20 FEET/MINUTE
51		FLOW AND T CURVES LABELED
52		BACKGROUND GAMMA RAY RECORDED

NO.		INDUCED POLARIZATION
53		LOGGING SPEED LESS THAN 20 FEET/MINUTE

NO.		INDUCTION LOG
54		RESISTIVITY CURVES DO NOT READ LESS THAN ZERO
55		LOGGING SPEED LESS THAN 20 FEET/MINUTE
56		INDUCTION LOG AND SHORT NORMAL HAVE SYMMETRICAL SHAPE
57		INDUCTION RESISTIVITY CURVE CHECKS CONDUCTIVITY CURVE
58		AMPLIFIED SHORT NORMAL RECORDED
59		SHORT NORMAL DOES NOT READ LESS THAN ZERO
60		CONDUCTIVITY DOES NOT READ LESS THAN ZERO

NO.		THERMAL NEUTRON
61		LOGGING SPEED LESS THAN 20 FEET/MINUTE
62		BACKGROUND GAMMA RAY RECORDED

NO.		GENERAL	HOUR	DATE
63		WHEN SERVICE COMPANY NOTIFIED		
64		WHEN SERVICE COMPANY REQUESTED		
65		WHEN SERVICE COMPANY ARRIVED		
66		WHEN HOLE READY		
67		WHEN LOGGING STARTED		
68		WHEN LOGGING COMPLETED		
69		WHEN SERVICE COMPANY RELEASED		

OPERATIONAL EFFICIENCY CHECK: ITEMS 63 THRU 69 SHALL BE FILLED OUT BY THE FTR

FIGURE 5-17
(Continued)

FERNALD RI/FS

FIELD BOREHOLE GEOPHYSICAL LOG
QUALITY CONTROL CHECKLIST

SITE CODE _____ LOCATION I.D. _____ DRILLER _____

DEPTH LOGGING COMPANY _____

DATE _____ LOGGER _____

LOG TYPE	DEPTH (FT.)		TIME (HOUR)	
	FROM	TO	ELAPSED	LOST

NOTE: ELAPSED TIME DOES NOT INCLUDE LOST TIME

REMARKS

NO.		

_____ DATE

_____ (SIGNATURE OF FTR)

_____ DATE

_____ SIGNATURE OF SERVICE COMPANY REPRESENTATIVE AND COMPANY

The data obtained during field aquifer or permeability tests will include:

- Static water level;
- Pumping well water discharge rate;
- Drawdown or pressure versus time data for pumping and/or monitoring wells;
- Water temperature and specific conductance; and
- Test interval.

An aquifer or permeability test data form (Figures 5-18 or 5-19) will be completed for each test to document test results. This form will be the lead page of the data records of the test. The complete original test data records will be kept at the field office. Additionally, a copy of these records will be made for the hydrogeologist and one retained by the field representative in charge of the test.

A diagram of the equipment actually used in each aquifer or permeability test will be prepared by the hydrogeologist or received from the subcontractor responsible for the testing. The diagram will show the tubing dimensions, the depth of water intake, and the location of gauges and packers. The diagram will become part of the data records of each test.

All gauges and flowmeters used in the pump-out procedures will be calibrated before arrival on site. Copies of the documentation of instrument calibration will be obtained from the instrument or testing service company by the hydrogeologist. The calibration records will consist of laboratory measurements and, if performed, any on-site zero adjustment and/or calibration.

FERNALD RI/FS

FIGURE 5-18

FIELD PERMEABILITY TESTS

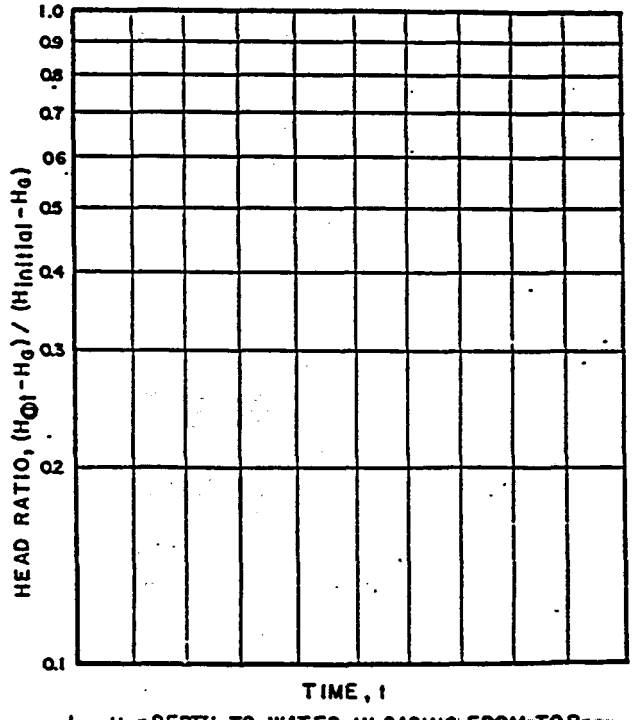
FALLING HEAD *

PROJECT _____ TESTED BY _____ DATE _____
PROJECT NO. _____ CALCULATED BY _____ DATE _____
BORING NO. _____ CHECKED BY _____ DATE _____

RADIUS OF TEST BORING, R _____ PERMEABILITY, K _____
HEIGHT OF CASING (REF. LEVEL) ABOVE GROUND SURFACE, H_C _____
DEPTH TO BOTTOM OF TEST POCKET, L_1 _____
DEPTH TO TOP OF TEST POCKET, L_2 _____
DEPTH TO GROUNDWATER TABLE FROM TOP OF CASING, H_G _____

*CASED HOLE, UNCASED OR PERFORATED EXTENSION OF LENGTH, $L_1 - L_2$.

ELAPSED TIME t SEC.	DEPTH TO WATER IN CASING H Meters



$$K = \frac{R^2}{2(L_1 - L_2)(t_2 - t_1)} \ln\left[\frac{L_1 - L_2}{R}\right] \ln\left[\frac{H_1 - H_G}{H_2 - H_G}\right]$$

NOTE: THE EQUATION ASSUMES THE HORIZONTAL AND VERTICAL PERMEABILITIES ARE EQUAL.

H_1 = DEPTH TO WATER IN CASING FROM TOP OF CASING AT TIME, t_1
H_2 = DEPTH TO WATER IN CASING FROM TOP OF CASING AT TIME, t_2

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FIGURE 5-19

FIELD PERMEABILITY TESTS CONSTANT HEAD*

PROJECT _____ TESTED BY _____ DATE _____
PROJECT NO. _____ CALCULATED BY _____ DATE _____
BORING NO. _____ CHECKED BY _____ DATE _____

HEIGHT OF CASING ABOVE GROUND SURFACE _____
INSIDE RADIUS OF CASING, R _____
DEPTH TO GROUNDWATER TABLE FROM GROUND SURFACE, H_G _____
HEIGHT TO TOP OF WATER IN CASING FROM GROUND SURFACE, H_W _____
DEPTH OF CASING BELOW GROUND SURFACE, H_D _____
LENGTH OF TEST POCKET, L _____

*CASED HOLE, UNCASED EXTENSION OF LENGTH, L

TIME 24 hr. SYSTEM	ELAPSED TIME, t SEC.	VOLUMETER READING, V	FLOW RATE $Q = V/(t_2 - t_1)$	PERMEABILITY K CM / SEC

NOTES:
ANY CONSISTENT SET OF UNITS CAN BE USED IN THE EQUATIONS BELOW.
THE EQUATIONS ASSUME THE HORIZONTAL AND VERTICAL PERMEABILITIES ARE EQUAL.

FOR TESTS BELOW GROUNDWATER TABLE:

$$K = \frac{Q}{2\pi L (H_G + H_W)} \ln \left[\frac{L}{2R} + \sqrt{1 + \left(\frac{L}{2R}\right)^2} \right]$$

FOR TESTS ABOVE GROUNDWATER TABLE:

$$K = \frac{Q}{2\pi L (H_D + H_W)} \ln \left[\frac{L}{2R} + \sqrt{1 + \left(\frac{L}{2R}\right)^2} \right]$$

Water pumped from the well during the aquifer or permeability test will be disposed of in the General Sump and treated in the WMCO wastewater system. In cases where a weir or an orifice are used to measure flow volumes or rates, these devices will be checked on site using a vessel of known volume and a stopwatch. Their accuracy will be documented before testing proceeds.

Equipment will be installed and demonstrated to the technical representative's satisfaction that the system is in proper working order and performing to specifications before the proposed start of the pumping test.

5.6.1 BOREHOLE HYDRAULIC TESTING FOR AQUIFER CHARACTERISTICS

This section provides guidelines and procedures for determining the hydraulic parameters of aquifers using slug tests and pumping tests. The hydraulic conductivity (K) of an aquifer is a measure of the aquifer's ability to conduct water. The greater the value of hydraulic conductivity, the more rapidly the aquifer conducts water. The transmissivity (T) of an aquifer is defined as the ability of the aquifer to transmit water through its entire thickness and is equal to the hydraulic conductivity (K) times the saturated thickness of the aquifer (b); this can be stated as $T = Kb$, for cases in which K is constant with depth. Otherwise, transmissivity is equal to the integration of hydraulic conductivity over depth, $T = \int K(Z)dz$.

Specific yield of an aquifer is the ratio of the volume of water drained by gravity per unit volume of aquifer material. The storage coefficient of an aquifer is the volume of water in storage released from an aquifer column of unit cross section under a unit decline of head.

5.6.1.1 Slug Test

The purpose of this section is to outline procedures for the conduct and evaluation of slug tests, which are a quick and inexpensive method of estimating the hydraulic conductivity or transmissivity of many aquifer systems. A slug test will generally work in hydrogeologic units where K is less than or equal to 10^{-2} cm/sec. In hydrogeologic units of greater hydraulic conductivity, the water level may return to static level before a sufficient number of water level readings can be made. In hydrogeologic units of low K (10^{-4} to 10^{-7} cm/sec), slug tests are generally a reliable field method of determining hydraulic conductivity or transmissivity near the screened zone of the well.

The advantages of using slug tests to estimate hydraulic conductivities are:

- Estimates can be made in situ and errors incurred in laboratory testing of disturbed samples are avoided.
- Tests can be performed quickly at relatively low cost because a pumping well and observation wells are not required.
- Hydraulic conductivity measurements of small discrete portions of an aquifer can be made (i.e., sand layers in a clay).

The disadvantages to using slug tests must be evaluated before the test is conducted. These include:

- Only the hydraulic conductivity of the area immediately surrounding the well is estimated. These results may not be representative of the average hydraulic conductivity of the area.
- Often only a range of hydraulic conductivity values rather than an average value can be deduced from test results.

- Certain assumptions are made in the analysis process. If the assumptions made are inappropriate for the geologic conditions at the site, the results may be erroneous.
- The storage coefficient (S) usually cannot be determined.
- Data sufficient for analysis may not be collected if the hydraulic conductivity is relatively high.

Design, Drilling, and Construction of a Slug Test Well

Several factors enter into the design of a well for the performance of slug testing. These include depth and diameter of the test well, length of screened interval, and size of screen openings. Some of these factors can be chosen as drilling proceeds or be predetermined from previous borings. Well design is generally determined from a combination of drill cuttings, borings, and geophysical logging.

The depth and screened interval of the hole are determined by the location of the zone of interest. The diameter of the hole and casing to be inserted in the hole should be large enough so that the volume of the slug does not cause water to overflow the top of the casing. This may be a problem when the water level in the borehole is relatively close to the ground surface. The screened interval should consist of screen with a percentage of open intervals large enough so as not to restrict water flowing from the borehole to the subsurface materials tested.

The construction of the test well involves the assembly of the appropriate diameter casing for insertion into the borehole. A preslotted screened section is prepared and attached to the casing string, with a cap on the bottom (to prevent material from entering the bottom of the screen), and the whole assembly is

lowered into the hole. If a gravel pack is necessary as a filter because the aquifer contains very fine unconsolidated sand, then it should be placed opposite the screened interval. A bentonite seal is placed between the gravel pack and the grout. The annulus is then grouted from the top of the bentonite seal to the ground surface in order to allow hydraulic connection only between the test well and the zone to be tested. The hole should be flushed or bailed before grouting if drilling fluid remains in the hole. If the ground water in the hole is highly contaminated, special safety precautions should be taken to control the discharge water before test well development. Equipment necessary to conduct a slug test includes:

- Borehole;
- Water level measuring device;
- Known volume of the slug that will fit into the well or borehole or container to add or remove a known volume of water;
- Watch with second hand;
- Semi-log graph paper; and
- Indelible pen or pencil and paper.

A number of water-level measuring devices can be used for measuring the depth to water in a well. An excellent device for measuring the depth to water during a slug test is the pressure transducer. Accurate readings may also be obtained with electric water-level indicators or weighted tapes. Water-level measurement by the weighted-tape method should be avoided as it may be difficult to obtain a sufficient number of readings for analysis of the test if the water level recovers quickly in a short period of time.

Slug Test Procedure

Before beginning the slug test, the following information should be recorded:

- Site identification and well or borehole location;
- Location and elevation of the reference point from which water depth measurements are made;
- Elevation of ground water with respect to the reference point;
- Date and time of test;
- Well depth, screen length, riser pipe radius, well screen radius, radius of the gravel pack plus the well screen or borehole depth and radius;
- Aquifer or ground water zone being tested;
- Volume of water added or withdrawn or volume of the solid cylinder (slug);
- Type of measuring device used; and
- Names of the personnel conducting the test.

The following procedures will apply to most slug tests. The field procedure required for a particular slug test may be slightly different, however, and the procedures may be modified as necessary.

- Determine the static water level in the well by periodically measuring the depth to water for several minutes and taking the average of the readings.
- Instantaneously introduce or remove a known volume of water to/from the well. Another method is to introduce a solid cylinder of known volume to displace and raise the water level, allow the water level to restabilize and remove the cylinder. It is important to remove or add the volumes as quickly as possible because the analysis assumes as instantaneous change in volume is created in the well.

- With the moment of volume addition/subtraction assigned time zero, measure and record the depth to water and the time of each reading. Depths should be measured to the nearest 0.01 foot. The number of depth-time measurements necessary to complete the test are variable. It is critical to make as many measurements as possible in the early part of the test.

- Continue measuring and recording depth-time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a semi-log plot of time versus depth.

The time required for slug test completion is a function of the volume of the "slug," the hydraulic conductivity of the formation, and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours. If the well is to be used as a monitoring well, precautions should be taken that the well is not contaminated by the material introduced into the well. If water is added to the monitoring well, it should be from an uncontaminated tested and/or approved source and transported in a clean, approved container. Bailers or measuring devices should be cleaned prior to the test. If tests are performed on more than one monitoring well, care must be taken to avoid cross contamination of the wells.

Slug Test Data Analysis

The analysis of slug test data is based on a modification of well-known ground water flow equations (the Theim equation, the Theis equation, or subsequent modifications). Several authors have presented analytical solutions for the analysis of slug test data. Most solutions require a semi-logarithmic plot of the data

collected: dimensionless head (logarithmic scale) or residual head (logarithmic scale) versus time (arithmetic scale).

Hvorslev (1951) was one of the first researchers to publish techniques of analysis of either constant or slug (falling head) tests in near-surface saturated soils. His analysis for slug tests involves a semi-logarithmic plot of the falling head (water level) divided by the initial head against time. Basic algebraic equations are presented for different configurations of the soil relative to the test hole. In general, the permeability is proportional to a "shape factor" and inversely proportional to the "time lag." The "shape factor" is determined from the test well characteristics or dimensions. "Time lag" is determined from the semi-logarithmic plot.

Cooper et al. (1967) and Papadopoulos et al. (1973) developed a set of type curves for analyzing slug test data, particularly for tests run in materials which are confined (under artesian pressure). Field data are plotted as dimensionless head (arithmetic scale) versus time (logarithmic scale) and matched to a set of type curves. The match point values are substituted into simple algebraic equations formulated to obtain a value for K.

Bower and Rice (1976) and Bower (1978) developed a technique for analyzing slug test data collected from completely or partially penetrating wells in unconfined aquifers. Their analysis involves a plot of residual head (logarithmic scale) versus time (arithmetic scale). A straight line is applied to the early-time data and used to calculate a value for K.

Pressurized slug test methods have been developed for testing extremely low conductivity (10^{-8} cm/sec or lower) materials

(Bredehoeft and Papadopoulos, 1980). Basically, the pressurized slug technique is a modification of the conventional slug test discussed previously. The advantage of the pressurized slug technique is the reduction of time required to perform a test in tight formations. This method involves creating an instantaneous pressure surcharge on drawdown in the test zone, then closing a valve in the well. Based on the rate of decay of the pressure slug and the geometry of the test zone, the transmissivity, hydraulic conductivity, and storage coefficient may be calculated.

The specific equations to be used to calculate the permeability of the aquifer materials are presented in Figures 5-17 and 5-18.

5.6.1.2 Aquifer Pumping Test

The purpose of this section is to briefly describe the use of aquifer pumping tests to evaluate aquifer characteristics. Aquifer pumping tests, commonly referred to as pump tests, are used to determine the hydraulic characteristics and properties of water-bearing zones. Pumping tests provide results that are often more representative of the aquifer's characteristics than the results of slug tests.

Aquifer characteristics which may be obtained from pumping tests include the hydraulic conductivity (K), transmissivity (T)k, and specific yield (S_y) for unconfined aquifers and the storage coefficient (S) for confined aquifers.

Advantages of pumping tests include:

- A greater portion of the aquifer is tested and the results obtained may be more reliable and representative of the aquifer characteristics.

- The coefficient of storage and specific yield values can be determined.

Disadvantages of pumping tests include:

- In low permeability aquifers, long-term pumping may be required to complete the test and obtain reliable aquifer characteristics.
- Disposal of discharged water may require special provisions if the ground water is contaminated.
- Pumping tests may be very expensive when compared to slug tests.

Equipment, personnel, and time commitments needed to conduct pumping tests are greater than those required for slug tests. Briefly, a pumping test consists of pumping one well and recording the drawdown in the pumping well and in other nearby observation wells.

There are several types of pumping tests. The most common type is the constant rate discharge test (Todd, 1980). Variable rate tests are also employed under some conditions. Although the analysis is more complicated, any sort of temporal variations in flow rate can be accounted for by assuming the law of superimposition holds. Usually this is a valid assumption. The most widely used variable rate tests are the step-drawdown test, the constant head test, and the air lift pump test (Kruseman and DeRidder, 1976). Another useful technique is injection testing. Injection tests, both constant rate and variable rate, are analytically identical to pumping tests except for consideration of the flow rate rather than a withdrawal as a surcharge to the aquifer. The data quality is also similar. Injection tests are commonly used in the petroleum industry (Earlougher, 1977) and numerous applications exist in hazardous waste management

practice. Obviously, water sampling for geochemical characterization of the aquifer must be conducted prior to application of this technique. The injection fluid should be free of suspended solids and should be of equal or higher quality than the ground water at the test site.

One major advantage of this type of test is that contaminated ground water is not removed from the formation and, thus, is not a disposal problem. A potential disadvantage of the injection test is that in certain cases the injection well would have to be able to withstand some induced hydraulic pressure. Cases where the injection rate is large enough to elevate the water level above the well casing would require a sealed well head configuration and the proper well construction to prevent leakage of injected fluid on the ground surface. These requirements may be relatively expensive and difficult to operate in the field without the necessary precautions. Once an injection system is working at a constant rate of flow, the data collected are analyzed in much the same way as data from an aquifer pumping test, except that water level buildup instead of drawdown is used in the analysis.

This procedure briefly describes equipment and other factors which must be considered for constant-rate pumping tests. Sources which provide additional information are presented in the list of references. Ground Water Wells (Johnson, 1966) is a field guide with many suggestions on how to perform the test. Ground Water Hydrology (Todd, 1980) and other references, such as Kruseman and DeRidder (1976), provide analytical techniques and example problems of pumping tests conducted under different geologic conditions.

Aquifer Pumping Test Equipment

The amount of equipment necessary to perform a constant-rate pumping test is greater than that used in a slug test. Equipment and wells needed for a pumping test include:

- Pumping well and pump; Pumps are commonly of the submersible or turbine type. The pumping well should be properly developed prior to testing.
- One or more observation wells hydraulically connected to the pumped aquifer and completed to the proper specifications for the particular test;
- An orifice, weir, flow meter, container or other type of water measuring device to accurately measure and monitor the discharge from the pumping well;
- Sufficient pipe to transport the discharge from the pumping well away from the area to prevent infiltration in the area of influence of the pump zone;
- Gate valve on the discharge pipe to control the pumping rate;
- Outlet near the well head for water quality determinations and sampling;
- Depth-to-water measuring devices for each observation well and the pumping well (this may include steel tapes, electric sounding probes, Stevens recorders, or pressure transducers);
- A thermometer and other necessary water quality equipment;
- Watches capable of reading to the nearest second for all observers, or a stopwatch;
- 3-cycle by 5-cycle log and 5-cycle semi-log graph paper;
- Indelible pens or pencils and form for recording times and drawdown measurements at each well;
- Appropriate references and calculator for determinations in the field; and

- A barometer or recording barograph (for tests conducted in confined aquifers).

Aquifer Pumping Test Pump Well Design

Design of the pump well is an important consideration in aquifer testing. In some cases, an existing well will be used for pumping. When sufficient funds and conditions permit, a pumping well can be designed and constructed specifically for the test. The pumping well should be screened throughout the thickness of the aquifer to be tested with a standard well screen. The well should be gravel packed, if necessary, to minimize sand production in unconsolidated fine-grained aquifers. Standard well construction techniques are discussed in Johnson (1966). The well should be correctly sealed from overlying and underlying units that are not to be directly pumped and so that leakage down the well annulus cannot occur; such leakage could interfere with the interpretation of the test. The completed pumping well should be developed by the appropriate methods to remove drilling fluid from the surrounding aquifer materials. Proper development of the well may prevent an unexpected variation in the pumping rate during the constant discharge test which, if the variation occurred, could lead to inconsistent drawdown data from the pumping well.

Aquifer Pumping Test Observation Well Siting

The location and number of the observation wells depends on several factors:

- Whether the aquifer tested is confined or unconfined;
- The thickness of the aquifer;
- The anisotropy of the aquifer;

- The location of the screened interval of the pumping well relative to the total aquifer thickness;
- The location of aquifer boundaries, whether positive (lake or stream) or negative (impermeable boundaries); and
- Practical and economic considerations.

Any number of observation wells may be considered. Often, four wells are desirable, three on a line passing through the center of the pumped well and one on a line normal to that line and also passing through the pumping well. A number of guidelines for location of observation wells are presented in the Ground water Manual prepared by the U.S. Department of Interior and Kruseman and DeRidder (1976).

As a general rule for tests performed in both confined and unconfined aquifers, the observation wells should be screened or completed in a substantial portion of the aquifer thickness in approximately the median depth of the test zone. In some cases, special tests require that observation wells be selectively completed in several depth zones in order to accurately determine aquifer characteristics such as anisotropy and vertical hydraulic conductivity.

The location of the observation well from the pumping well is partially controlled by the aquifer conditions, whether confined or unconfined. The location of observation wells generally depends on four aquifer conditions:

- For most aquifers with fully penetrating pumping wells, observation wells should be located at a distance estimated by using the Theis formulation (Theis, 1935). Use of this formulation is described by Walton (1970). Assumed aquifer parameters are used to determine a location which will give the amount of drawdown required for proper analysis.

- Thin aquifers with fully penetrating wells: for confined aquifers, the nearest observation well should be located at least 25 feet from the pumping well; for unconfined aquifers, observation wells should generally be located 15 to 100 feet from the pumping well.

- For thick isotropic aquifers with a partially penetrating pumping well, observation wells should be located one and one-half to two times the aquifer thickness from the pumping well.

- For thick anisotropic aquifers with a partially penetrating well, observation wells should be located at a minimum distance from the pumping well equal to twice the thickness of the aquifer times the square root of the ratio of the horizontal to the vertical hydraulic conductivity.

Aquifer Pumping Test Procedures

The water level must be monitored over time in the pumping well and in each observation well as the pumping well is discharged at a constant rate.

The following data must be recorded accurately at the time the test is performed:

- Well identification number or location of pumping well and each observation well;

- Location and elevation of each well;

- Location and elevation of reference point from which water depth measurements are made and elevation of ground surface with respect to the reference point;

- Date and time of test; and

- Well depth, pump depth, screen length, well radius and radius of gravel pack plus well screen for each well.

All gauges, transducers, flow meters, etc., used in conducting pumping tests, shall be calibrated before use at the site.

Copies of the documentation of instrumentation calibration should be obtained by the hydrogeologist and later filed with the test data records. The calibration records will consist of laboratory measurements and any on-site zero adjustment and/or calibration, if performed. In cases where a weir or an orifice is used to measure flow rates, the device will be checked on site using a container of measured volume and stopwatch. Accuracy of the meters must be verified before testing proceeds.

Changes in barometric pressure are recorded during the test (preferably with an on-site barograph) to correct water levels for any possible fluctuations which may occur due to changing atmospheric conditions.

During an aquifer test, water levels should be measured to give at least 10 observations of drawdown within each log cycle of time. During the early part of the test, sufficient personnel should be available to have at least one person at each observation well. After the first two hours, two people are usually sufficient to continue the test. It is not necessary to take readings at the wells simultaneously. It is very important that depth-to-water readings be measured accurately and readings recorded at the exact time measured.

The duration of the test is determined by the needs of the project and the aquifer properties. One simple test for determining adequacy of data is when the log-time versus drawdown for the most distant observation well begins to plot as a straight line on the semi-log graph paper. There are several exceptions to this simple rule of thumb; therefore, it should be considered a minimum criteria. Different hydrogeologic conditions can produce straight-line trends on log-time versus drawdown

plots. In general, longer tests produce more definitive results. Unconfined aquifers and partially penetrating wells may have shorter test durations. A knowledge of the local hydrology, combined with a clear understanding of the overall objectives of the project, is necessary in interpreting just how long the test should be conducted. There is no need to continue the test if the water level becomes constant with time. This normally indicates that a hydrogeologic source has been intercepted and that additional useful information will not be collected by continuing the pumping portion of the test.

Measurement of recovering water levels after pumping stops is often performed to verify results obtained from the pumping portion of the test. The recovering water levels in the pumping well and the observation wells are measured for a period immediately following cessation of pumping. Monitoring of the recovery period should, by rule of thumb, be at least one-half the length of the pumping portion of the aquifer test. This length of time usually allows the collection of useful data for additional analysis.

Aquifer Pumping Test Data Analysis

Numerous techniques of analysis have been developed by researchers to evaluate water level data collected from constant discharge aquifer pumping tests. Many of the analyses use the graphical curve matching technique which involves the matching of theoretical type curves to plot of log-drawdown versus log-time from the observation wells. Other analyses rely on other graphical techniques such as application of a straight line to plots of drawdown versus log-time.

Theis (1935) developed a theoretical formula which related the lowering of the potentiometric level in an aquifer due to the constant withdrawal of water from the aquifer. This classic formulation has been widely used to predict water level response in aquifers due to specified pumping stresses. Several authors have described the use of this formula in estimating transmissivity and storativity from aquifer test data: Lohman (1972), Walton (1970), Todd (1980) and Freeze and Cherry (1979). In brief, the method involves superimposing the Theis solution (or "type" curve) on a log-log plot of drawdown versus time data from a test well. The coordinate axis of the type curve must be kept parallel to the field data plot axes. Data from the "match point" are used to solve two algebraic equations which give the value of transmissivity (T) and storativity (S) (or storage coefficient). Hydraulic conductivity (K) may be computed by dividing T by the aquifer thickness (b). The same aquifer parameters can also be determined from a semi-log plot of drawdown versus time for either the pump well or observation wells. Cooper and Jacob (1946) analytical data when plotted as described above, compares with Theis's T, S and K values.

Hydrogeolgic judgment should be used when applying straight line (Cooper-Jacob method) fits to these plots because different hydrogeologic conditions can produce similar trends in the data plot. For example, bounded aquifers produce straight line trends that may yield apparent transmissivity values that are too low. Knowledge of the hydrogeology of the area and the type of aquifer conditions is essential for correct analysis of test data.

Since the development of the Theis equation, several other formulas have been published which attempt to describe the response of certain aquifers to a constant pumping stress.

Hantush (1955, 1956) developed a formula and a corresponding set of type curves for an aquifer which is overlain and/or underlain by a confining bed which has significant storage and experiences vertical flow when the adjacent aquifer is pumped. The same curve matching procedure is used here as with the Theis type curve, except that several type curves are available for matching to the data, depending on the degree of leakage into the pumped aquifer. Hydraulic characteristics of the confining unit can be calculated using the set of Hantush type curves.

Another commonly used set of type curves was developed by Boulton (1954, 1963) and is used when the aquifer tested is unconfined and may exhibit a phenomenon known as delayed yield. Delayed yield is a result of retardation of drainage due to capillary tension. Boulton's type curves include a set of early-time type curves and late-time type curves. The early-time data and late-time data are respectively matched to the early-time and late-time type curves to give values for transmissivity, storage coefficient, and specific yield. The particular curve used in the set of "type" curves yields additional information concerning how the unconfined aquifer responds to pumping. Nueman (1972, 1974, 1975) also developed a set of type curves for the response of unconfined aquifers to pumping, but used different assumptions concerning the physical processes in effect. In practice, Nueman and Boulton curves have been shown to give similar results.

The specific equations to be used to calculate the permeability of the aquifer materials from the pumping test data are presented in Figures 5-18 and 5-19.

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6.0 SAMPLE COLLECTION PROCEDURES

Detailed project sampling plans have been prepared to document the scope and methodology of exploration, radiation measurement, and sampling activities for the FMPC.

The following considerations form the basis for the site-specific sampling program:

- Frequency of sampling;
- Location and number of monitoring stations to be sampled;
- Methods of sampling to be employed;
- Media to be sampled;
- Number of samples to be collected;
- Volume of samples to be collected;
- Type and kind of analyses to be performed in the field;
- Type and kind of analyses to be performed at the laboratories;
- Procedures and precautions to be followed during sampling; and
- Methods of preservation and shipment.

Sampling will be frequent enough to identify materials and to describe important material changes. Methods of sampling employed shall preserve the integrity of material parameters.

The following guidelines are applicable to the implementation of a field sampling program:

- Prepare and study the site map showing the location of sample monitoring stations.

- Review the sample collection program to become familiar with the overall scope of the study and also sampling procedures and equipment, sample handling procedures, and shipping requirements.

- Determine the characteristics of the material to be sampled, become familiar with the safety precautions and practices, and obtain the necessary safety equipment.

- Obtain equipment and materials necessary to perform field sampling and analyses.

- Review manufacturer's instructions on equipment calibration and sensitivity.

- Calibrate all field equipment prior to field work according to manufacturer's instructions and calibration procedures. Note: Certain equipment may require calibration in the field before each measurement.

- Fill out the appropriate sample field collection reports (Sample Collection Log, Figure 7-3; Water Quality Field Collection Report, Figure 6-1; or Ecological Field Survey Sample Collection Log, Figure 6-2) completely prior to leaving the field location.

- Label all sample containers with appropriate information. This includes project number and name, sample number, location, sampling date and time, preservatives added, and sampler's initials.

- Complete chain-of-custody records and laboratory request for analysis forms which will accompany all samples during shipment.

- The final deionized water rinse following equipment decontamination will be sampled and analyzed at a frequency of one per every set of twenty locations or fraction thereof to check for potential cross-contamination between sample locations.

The following guidelines are applicable for sample packaging to avoid breakage or cross contamination:

FIGURE 6-1

FERNALD
RI/FS

Date: _____
Time: _____
Page: ____ of ____
Page: _____

WATER QUALITY FIELD COLLECTION REPORT

PROJECT NAME _____
PROJECT NUMBER _____
DATE COLLECTED _____
TIME COLLECTED _____
COLLECTED BY _____

SAMPLE LOCATION _____
SAMPLE NUMBER _____
SAMPLE TYPE _____

SAMPLING INFORMATION

AIR TEMPERATURE _____
DO SATURATION IN AIR _____
WATER TEMPERATURE _____
DEPTH OF SAMPLE _____
WATER LEVEL _____

FIELD READINGS

	READ 1	READ 2	READ 3
pH			
Spec. Cond. uMHOS/cm			
D.O. MG/L			

METER CALIBRATION

pH Temp.	pH Std.	pH Std.	D.O. Temp.	D.O. Zero	D.O. Full Sc	D.O. Calib. O2	Spec. Cond Temp.	Spec. Cond. Low	Spec. Cond. High
OK ✓			OK ✓				OK ✓		

WEATHER CONDITIONS _____
ADDITIONAL REMARKS _____

TEST EQUIPMENT LIST

EQUIPMENT NUMBER	EQUIPMENT NAME

NOTE: ONLY EQUIPMENT SUBJECT TO CALIBRATION NEED BE LISTED.

DATE	
TIME	
PAGE ___ OF ___	
PAGE	

FIGURE 6-2

FERNALD RI/FS

ECOLOGICAL FIELD SURVEY
SAMPLE COLLECTION LOG

PROJECT NAME _____ PROJECT NO. _____
COLLECTED BY _____ DATE _____ TIME _____
STATION NAME _____ STATION NO. _____
LOCATION _____
WEATHER _____ AIR TEMPERATURE _____

SAMPLE NO.	SAMPLE TYPE	COLLECTION METHOD/ SAMPLER	DEPTH	COLLECTION DIMENSIONS	SAMPLE PRESERVATIVE

LOCATION SKETCH

HABITAT:

TYPE _____
AVG. WIDTH _____ PERCENT SHADING _____
AVG. DEPTH _____ FLOW VELOCITY _____
TURBIDITY _____ POOL/RIFFLE RATIO _____
COVER _____
SUBSTRATE _____
GRADIENT _____
BANKS _____

GENERAL DESCRIPTION OF:

LAND USE/TOPOGRAPHY _____
POLLUTION SOURCES _____
FLOODPLAIN _____
MACROPHYTES _____
CONDITIONS/COMMENTS _____

DEPTH	DISSOLVED OXYGEN	WATER TEMP.
SURF.		

- Sample container lids are never to be mixed. Sample lids will stay on the original container until time of sampling. The original sample containers will arrive in the field in boxes or coolers with custody tape affixed on the packaging. When sample container packages are received in the field, the chain-of-custody form for shipping the empty containers to the field will be appropriately marked to state if the custody seal was affixed when the box or cooler arrived.

- After a sample is placed in a plastic/glass container, the sample container will be secured with a custody seal and placed in a plastic bag to minimize the potential for contamination from vermiculite or other packing material. Sample containers may be placed between cardboard inserts and will not need to be placed in plastic bags (e.g., subsurface soil sample jars are placed back in their original shipping container, a cardboard box with cardboard inserts).

- Upon arrival at the laboratory, sample management personnel will examine the contents of the shipping container and document on the chain-of-custody record if any sample containers do not have the custody tape affixed.

- Shipping coolers with plastic/glass containers will be filled initially with approximately three inches of vermiculite or suitable substitute (non-combustible, absorbent packing material). Under no circumstances will locally obtained material (sawdust, sand, etc.) be used. Do not use earth or ice as packing materials.

- The secured sample containers will be placed in the cooler in such a way so they do not touch one another. Use additional container protection (e.g., new, unused paint cans), if necessary. (Keep cooler closed except when placing sample in cooler).

- Commercially available artificial icing material will be used. If unavoidable, ice may be used, provided that it is placed in a plastic bag. Ice is not to be used as a substitute for packing material.

- Remaining space in the cooler will be filled with inert packing material.

- The original chain-of-custody and request-for-analysis records will be placed in a plastic bag and taped to the bottom of the cooler lid, unless the samples are transported to the laboratory by project or laboratory personnel. (Chain-of-custody and request-for-analysis procedures are in Section 7.0.)

Samples will be properly packaged and labeled for shipment and dispatched to the appropriate laboratory for analysis. Separate chain-of-custody and request-for-analysis records will be prepared for each laboratory. The following requirements for shipping containers will be followed:

- United States Department of Transportation (DOT) regulations covering the transport of hazardous materials are contained in the Code of Federal Regulations (CFR) Title 49, Parts 170-179.

- Shipping containers are to be padlocked or custody-sealed for shipment, as appropriate. The packing custody seal should consist of filament tape wrapped around the container, with a custody seal affixed at appropriate access points. In this way, access to the container can be gained only by cutting the filament tape and breaking the seal.

- Shipping cooler containers will be secured by field personnel with a proper custody seal, marked with indelible pen or ink, and addressed to the appropriate laboratory.

- Field personnel will make arrangements for transportation of samples. When custody is relinquished to a shipper, field personnel will telephone the receiving laboratory custodian to report the expected time of arrival of the sample shipment and the existing time constraints (holding times) for sample analysis.

The FMPC sampling program is based on the project objectives coupled with a review of existing data for the site vicinity. The sampling program includes the following:

- Ground water sampling;
- Surface water sampling;
- Surface soil sampling;
- Sediment sampling;
- Subsurface soil sampling; and
- Radon sampling.

6.1 GROUND WATER SAMPLING TECHNIQUES

The primary consideration in ground water sampling is to obtain a representative sample of the ground water body. To safeguard against collecting nonrepresentative stagnant water from a well or piezometer, the following guidelines and techniques should be observed during sample withdrawal:

- As a general rule, all monitoring wells will be pumped or bailed prior to collecting a sample. Evacuation of at least three well volumes of water is recommended for a representative sample.

- For wells that can be pumped or bailed dry, the well will be evacuated and allowed to recover prior to sample withdrawal. If the recovery rate is fairly rapid and if time allows, evacuation of more than one volume of water is recommended.

- As soon as the well recovers, samples will be collected in accordance with the stability and volatility of the parameters to be tested, and the Water Quality Field Collection Report (Figure 6-1) will be completed. For instance, samples for HSL volatile organic compounds, pH, specific conductance, and temperature will be collected first. Parameters which are not sensitive to pH or volatilization should be drawn last.

- For wells that cannot be pumped or bailed dry, at least three well volumes of water will be removed before collecting samples.

- Care will be taken to avoid excessive pumping of a monitoring well. Excessive pumping can lead to an increase or decrease in the concentrations of a contaminant at the sampling point of interest.

- A stainless steel submersible pump will be used to purge the monitoring wells prior to sample collection. A water-level measurement will be initially taken to determine the depth to ground water in the casing. The submersible pump will be lowered to a depth of five to ten feet below the water level; always above the well screen. The well will be initially purged from this depth so that fresh water from the screened interval will move upward through the casing and completely flush the well. The pumping rate will be less than 20 gallons per minute (gpm) and will continue until field pH, temperature, and specific conductance readings have stabilized.

- If drawdown is significant, the submersible pump will be lowered during purging to keep the pump five to ten feet below the water level in the casing and the pumping rate will be reduced.

- Once the well has been purged and allowed to recharge and stabilize, samples will be collected using a positive gas displacement stainless steel and/or Teflon bladder pump or Teflon bailer.

- During sampling, the pump will be operated continuously and the flow rate reduced to one liter/minute for the collection of volatile organic compound samples.

- The purge pump and lines will be decontaminated between wells using procedures as subsequently described.

- When the pump and lines are removed from a well, they will be placed on plastic sheeting to avoid contact with the ground.

- Prior to reuse, the pump and lines will be drained and the outside surfaces will be decontaminated with a water wash and deionized water rinse. The internal surfaces will be decontaminated by pumping deionized water through the pump system. Purging of the next monitoring well will further reduce the possibility of cross contamination. Should the equipment become visibly contaminated, it will be disassembled and cleaned by the following procedures:

  - In the case of inorganic contaminants, the equipment will first be washed with a nonphosphate detergent and

then rinsed with dilute (0.1 N) hydrochloric acid followed by two separate deionized water rinses.

- In the case of organic contaminants, the equipment will first be washed with a nonphosphate detergent and then rinsed with tap water, methanol, and two separate deionized water rinses.

- As described above, the equipment shall be thoroughly rinsed with two deionized water rinses to remove traces of hydrochloric acid, detergent, and methanol (acetone may be substituted for methanol if volatile organic compounds are not being determined).

- Sampling equipment will not be placed directly on the ground or on other contaminated surfaces prior to insertion into the well, but will be placed on a clean plastic sheet adjacent to or around the well.

- Rinsate samples to be collected as required by QAPP Section 6.0 page 2 of 59.

- Decontamination of the submersible sampling pump(s) and other sampling equipment will be performed at a designated central staging area at the FMPC. If this is not possible due to extenuating circumstances, the sampling equipment may be decontaminated in the field.

- Existing wells with limited access will be sampled from the pump discharge.

- Field measurements will be performed on unpreserved samples immediately after sample collection. Samples collected for field measurements will be kept separate from samples preserved for shipment to the laboratory.

- A sufficient amount of sample will be collected to perform all the required analyses. The sample bottles containing the appropriate preservatives will be filled to the bottle neck with the sample, without overflowing. Sample container lids will be tight and secure.

- Samples collected will be stored in the field in a cooler and maintained at approximately 4 degrees Celsius using blue ice or other approved, sealed cooling materials.

- Samples will be properly labeled and chain-of-custody records, water quality field collection report (Figure 6-1), sample collection log, and laboratory request for analysis forms will be properly filled out.

6.1.1 PARAMETER-SPECIFIC SAMPLING PROCEDURES

Water sample collection for volatile organic compounds, acid and base-neutral extractable compounds, dissolved metals, and general chemistry parameters should be performed in accordance with the following procedures:

- Volatile Organic Compounds

  - Two screw-cap vials with Teflon-lined silicone rubber septa (U.S. EPA-approved vials) will be filled to overflowing and sealed without any entrapped air bubbles. These vials will be 40 milliliters or larger.

  - Each vial will be visually checked for air bubbles and placed in a cooler.

  - A field/trip blank per each sample set will accompany the samples back to the laboratory. The field/trip blank will consist of organic-free deionized water used in the field to decontaminate the sampling equipment. The field/trip blank will monitor for ambient contamination levels in the cooler during transport. Field/trip blanks will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.

  - A sample collection log, a chain-of-custody record, a laboratory request for analysis form, and a sample label will be completed in the field. All these forms, except for the sample collection log, will accompany the samples to the laboratory.

  - The cooler will be packed with artificial icing material to maintain the samples at 4 degrees Celsius during shipment, sealed, and transported to the laboratory.

- Acid and Base-Neutral Extractable Compounds and Pesticides/PCBs

  - Appropriate glass sample bottles complete with teflon-lined caps will be filled to capacity and sealed.

  - The sample bottles will be placed in a cooler with sufficient packing to prevent breakage during shipment.

  - A field/trip blank per each sample set will accompany the samples back to the laboratory. The field/trip blank will consist of organic-free deionized water used in the field to decontaminate the sampling equipment. Field/trip blanks will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.

  - Rinsate samples will be collected as required by the QAPP Section 6.0 page 2 of 59.

  - A sample collection log, a chain-of-custody record, a laboratory request for analysis form, and a sample label will be filled out in the field. All of these forms, except for the sample collection log will accompany the samples to the laboratory.

  - The cooler will be packed with artificial icing material to maintain the samples at 4 degrees Celsius during shipment, sealed, and transported to the laboratory.

- Dissolved Metals

  - When it is desired to determine concentrations of dissolved metals in a water system, the sample should be filtered in the field, as soon as possible after collection, through a 0.45-micron filter using a Millipore filtration apparatus or equivalent equipped with a hand or electrical vacuum pump.

  - The filtering apparatus or equivalent should be cleaned or rinsed thoroughly with deionized water before filtering each sample.

-5195

- It is recommended that the first 100 to 150 milliliters of filtrate from each sample be discarded to rinse the filter and filtration apparatus of any contaminating substances.

- The filtered sample is immediately transferred to a 500-milliliter plastic bottle containing one milliliter of concentrated nitric acid preservative per 100 milliliters of sample.

- The sample pH will be checked with pH paper or a pH meter to check that the pH is less than two. The bottle will be sealed with a plastic cap fitted with a polyethylene liner.

- A sample collection log, a chain-of-custody record, a laboratory request for analysis form, and a sample label will be completed in the field. All of these forms, except for the sample collection log, will accompany the sample to the laboratory.

• General Chemistry Parameters

- Sample bottles will be either polyethylene or glass and will contain the appropriate chemical preservatives. Sample bottle closures will be plastic with polyethylene liners.

- Sample bottles will be filled to capacity and sealed.

- A field/trip blank per each sample set will accompany the samples back to the laboratory. The field/trip blank will consist of organic-free deionized water used in the field to decontaminate the sampling equipment. Field/trip blanks will be analyzed at a frequency of one per every set of twenty samples or fraction thereof.

- The sample bottles will be placed in a cooler with sufficient packing to prevent breakage during shipment.

- Collected samples will be stored in the field in an ice chest filled with blue ice and maintained at approximately 4 degrees Celsius.

- Samples will be properly labeled and sample collection logs, chain-of-custody records, and laboratory request for analysis form will be properly completed.

• Radionuclide Parameters

- In general, samples for radionuclide analyses can be collected in the same manner as samples for other chemical analyses.

- Flush sample lines and sampling equipment with sample medium to minimize radionuclide adsorption effects.

- Sample containers made of Teflon, polyethylene, or polyvinyl chloride (PVC) will be used to minimize radionuclide losses by adsorption. (Glass and metal containers tend to adsorb radionuclides.)

- Floating debris and bottom sediments will be avoided when sampling surface waters. Avoid suspended sediments when sampling ground water.

- The pump or Teflon bailer will be decontaminated in accordance with the procedures in Section 6.1, Ground Water Sampling Techniques, to minimize contamination of subsequent samples.

- Water samples will be filtered in the field through an 0.45-micron membrane filter as soon as possible after sample collection when dissolved radionuclides are to be determined. Containers without preservative will be used to initially collect samples prior to filtration. Transfer samples to containers with preservative after filtration has been performed. When samples are collected for analysis of total radionuclide concentrations, containers with preservative will be used to collect the sample and filtration will not be required.

- Sample container lids will be tightly secured.

- Samples will be properly labeled and chain-of-custody records, sample collection logs, and laboratory request for analysis forms will be properly completed.

6.1.2 WATER LEVEL MEASUREMENTS

The following procedures should be followed for collecting water level data from wells:

- Obtain permission from owner to measure water level in well if required off site.
- In the case of domestic wells, ask the owner not to use water for short time so pump does not activate and affect water level. Make sure water level is stable.
- Remove well cap if an access hole is not available. (Be sure not to take water-level measurements in the riser pipe from the pump discharge line.)
- Lower M-scope probe until water is reached (this will be indicated by a buzzer, meter needle deflection, or light); raise probe above the water level and slightly shake; then lower again and recheck. Be careful not to get tangled with electrical wiring from pump, if present.
- Note depth to water to 0.01 foot from the measuring point, i.e., top of casing, top of sanitary seal.
- Enter water level and measuring point in log with date and time or on Figure 5-11, Piezometer Data Sheet.
- Replace cover on well.

6.2 FIELD ANALYTICAL PROCEDURES FOR GROUND WATER SAMPLES

Immediately following sample collection, temperature, pH, specific conductance, and dissolved oxygen will be measured in the field and documented on the Water Quality Field Collection Report (Figure 6-1). The following field procedures pertain to these tests. All determinations will be performed on unpreserved samples. In adverse weather conditions, field determinations may be performed indoors in an area maintained at 20 to 25 degrees

Celsius. Ground water field measurements may also be taken in situ (downhole) to avoid changes which might occur if the sample is removed from the well.

6.2.1 TEMPERATURE

Scope and Application

The temperature of surface and ground water is important for numerous applications. It is required to normalize data from other analytical determinations such as pH, specific conductance, alkalinity, dissolved oxygen etc.

Summary of Method

Temperature readings are obtained by partially immersing the thermometer in a sample and allowing it to equilibrate for about two minutes. A minimum of two consecutive readings are obtained on each sample.

Apparatus

A metal-cased, direct-reading thermocouple with a normal range of zero to 50 degrees Celsius measured in two-degree intervals is used.

Measurement Practices

- Temperature readings should be taken immediately after sample collection on unpreserved samples.
- Readings should be taken until two identical values are obtained.
- The average readings for each sample will be documented immediately on field measurement or collection forms.

Reference

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 212, pp. 126-127.

6.2.2 pH

Scope and Application

pH is defined as the negative logarithm of hydrogen-ion activity in a sample and is a measure of effective hydrogen-ion concentration. The pH values are very useful for assessing the acidic or basic nature of a body of water and also for elucidating complex chemical reactions occurring in water.

Summary of Method

The pH of water is normally determined by immersing a combination electrode (glass and reference electrode) in the solution and measuring the potential difference with a pH meter.

Apparatus

- Standard pH meter (battery operated) with an expanded scale capable of measuring pH to the nearest 0.01 unit.
- Combination electrode.
  - Three standard buffer solutions
  - pH 4.0;
  - pH 7.0; and
  - pH 10.0.
- A metal-cased direct-reading thermocouple with a normal range of zero to 50 degrees Celsius measured in two-degree intervals.

Calibration

- Expose filling hole by lowering rubber sleeve.
- Make sure that the electrode is filled with potassium chloride (KCl) solution.
- Rinse electrodes with distilled water.
- Set pH meter to proper ambient water temperature. Temperature correction of readings is automatic.
- Calibrate pH meter with at least two appropriate buffers before starting pH measurement and also after every fifth sample. Follow manufacturer's instructions for calibration.

Sample Measurement

- Rinse electrodes with distilled water.
- Transfer sample into a 100-milliliter beaker.
- Insert electrode into the sample solution and let it equilibrate for a few minutes. Stir the sample during measurement.
- Read the pH values on the pH meter to the nearest 0.1 unit.

Measurement Practices

- Measure temperature and set meter to the correct temperature setting.
- Rinse electrodes with distilled water between each measurement.
- Make sure that the line cord is properly attached to the instrument.
- Expose filling hole on the electrode by lowering rubber sleeve.
- Electrode tip needs to be immersed only one inch to obtain accurate readings.
- Never move or touch connecting cables during pH measurement.

References

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 423, pp. 429-437.

2. American Society for Testing and Materials (ASTM), 1985, Water, Standard D1293-84, pp. 253-264.

3. Instruction Manual for Orion's 407A Specific Ion Meter.

6.2.3 SPECIFIC CONDUCTANCE

Scope of Application

The ability of a solution to carry an electric current under specific conditions is reflected by specific conductance values. These values also indicate the concentration of dissolved solids in the natural water. Since specific conductance of a sample can change with time, this determination will be carried out in the field. The field measurement can also aid in assessing whether the sample is representative of the site.

Summary of Method

A conductivity cell is immersed in a sample of water and the conductance in micromhos per centimeter (µmhos/cm) is measured directly from the meter. The readings are corrected for temperature and are recalculated for 25 degrees Celsius.

Apparatus

- Conductivity cell or probe;
- Conductivity meter; and
- Thermometer.

Calibration

- Switch on the instrument and let it warm up for a few minutes.
- Calibrate according to the manufacturer's instructions.

Sample Measurement

- Insert the probe completely into the sample.

- Switch the meter to the appropriate scale and record the readings in µmhos/cm.
- Measure the temperature of the sample with a thermometer.
- Record all readings on the field measurement form.
- Correct the specific conductances values for temperature using appropriate temperature correction factors.

Measurement Practice

- Replace battery when the read line adjustment cannot be accomplished.
- Rinse probe with distilled water between each measurement.

References

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 205, pp. 76-80.

2. Instruction Manual for YSI Model 33 S-C-T Meter, Yellow Springs Instrument Company.

6.2.4 DISSOLVED OXYGEN

Scope and Application

Adequate dissolved oxygen is necessary to maintain the life of aquatic organisms. The dissolved oxygen concentration may also have an effect on the redox potential of surface and ground water and the chemical behavior of aqueous constituents. Physical, chemical, and biochemical activities in water may affect the dissolved oxygen levels.

Summary of Method

Dissolved oxygen is normally measured in the field by immersing a membrane electrode into the water. Oxygen gas molecules diffuse through a membrane into a measuring cell at a rate proportional to the concentration of molecular oxygen in the water. Inside the sensor, the oxygen reacts with an electrolyte and is reduced spontaneously or by an applied voltage, depending on the instrument. The current that is generated is directly proportional to the concentration of molecular oxygen in the water outside the sensor. The instrument reading is converted to the concentration of molecular oxygen present by calculation or proper calibration of the instrument.

Apparatus

- Oxygen-sensitive membrane electrode (polarographic or galvanic); this includes two solid metal electrodes separated from the test solution by a selective membrane (commonly polyethylene or fluorocarbon).
- Samples with known dissolved oxygen concentration for calibration or reading against water-saturated air;
- Distilled water for calibration and instrument cleaning; and
- A metal-cased, direct-reading thermocouple with a normal range of zero to 50 degrees Celsius measured in two-degree intervals.

Calibration

Follow the manufacturer's calibration instructions. Generally, calibration is performed against water-saturated air or water with a known dissolved oxygen concentration when measuring fresh water containing possible interfering substances.

Measurement Practices

- Temperature measurements should be taken at the time of dissolved oxygen reading.
- Insert probe into the sample.
- Allow sufficient sample flow across membrane surface to overcome any erratic responses of instrument.
- Read current from meter (correct for temperature if the equipment is so equipped).
- Record all readings on field measurement form (Water Quality Field Collection Report, Figure 6-1).
- Convert current generated to concentration and correct for temperature (if the equipment does not compensate for temperature).
- Frequently change and calibrate membrane electrode to eliminate interference from gases other than oxygen.
- Rinse probe with distilled water between each measurement.
- Store the probe in a water-saturated air environment.

References

1. American Public Health Association, et al., 1985, Standard Methods for the Examination of Water and Wastewater, 16th Edition, Method 421F, pp. 422-426.

6.2.5 Alkalinity

Scope and Application

Alkalinity is a measure of the acid buffering capacity of a sample and is formally defined as the equivalent sum of bases that are titratable with a strong acid. The carbonate species, bicarbonate, HCO_3 and carbonate, CO_3^{-2}, are the dominant bases which contribute to alkalinity in most

natural waters. Since alkalinity concentration is affected by changes in temperature, pH, and degassing, the alkalinity analysis should be performed in the field as soon as possible after collection. Uranium and other radionuclides form carbonate complexes; therefore, an accurate determination of carbonate concentration is necessary to quantify radionuclide mobility in ground water.

Summary of Method

Bicarbonate and carbonate concentrations are determined by electrometric titration. A strong acid of known concentration is added to a water sample while the pH of the sample is monitored. Using the acid volume needed to reach the end point, the concentration of bicarbonate and carbonate is calculated.

Apparatus

- pH meter that can be read to 0.01 units
- pH probe
- pH buffer solutions
  - pH 4.0
  - pH 7.0
- 50 millimeter (ml) buret
- Volumetric pipet (Class A)
- Magnetic stirrer and small teflon stir bar
- Buret stand and clamp
- 250 ml beaker or flask
- Standardized sulfuric or hydrochloric acid, approximately 0.02 normal

Calibration

Follow the manufacturer's instructions for calibration of the pH meter. Calibrate the meter daily before starting titrations.

Sample Measurement

- Fill buret with acid; open stopcock and drain out some acid to remove all air bubbles.
- Place a clean dry teflon stir bar into a clean dry 250 ml beaker.
- Pipet 50.0 ml of sample into the beaker
- Place beaker onto center of stirring plate and gently place the clean, dry, pH probe into the beaker. Position buret over the beaker.
- Record the initial pH of the sample to the nearest 0.01 pH unit. Record to the nearest 0.01 ml the initial acid volume in the buret.
- Turn on stirring mechanism to a gentle or slow setting.
- Titrate acid into the sample. If the sample pH is not near an endpoint, i.e., pH greater than 9 or pH between 5 and 8, acid can be titrated in volumes sufficient enough to lower the pH by 0.2 to 0.5 units. However, when the pH of the sample is near an endpoint, i.e., between ph 8 and 9, or between pH 4 and 5, titrate dropwise, as very small additions of acid will cause large changes in sample pH.
- Turn off the stirring mechanism after allowing sufficient time for the sample to mix thoroughly.
- Record the acid volume and pH.
- Repeat titration of acid into the sample until the pH of the sample is in the range of 3.0 to 3.5.

Measure Practices

- Keep buret full between titrations. This will prevent a film form developing n the inside of the buret.
- Clean glassware and stir bar in a soap bath and rinse three times with deionized water. Rinse the pH probe with deionized water only.

References

1. American Public Health Association, American Water Works Association and Water Pollution Control Federation, 1985, "Standard Methods for the Examination of Water and Wastewater," (16th ed.); Washington, D.C., American Public Health Association, 1268 pp.

2. Skougstad, M.W., M.J. Fishman, L.C. Friedman, D.E. Erdmann, and S.S. Duncan, (eds.), 1979, "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments: Techniques of Water - Resources Investigations of the U.S. Geological Survey," Book 5, Chapter A1, 626 pp.

3. U.S. Environmental Protection Agency, 1983, "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, Cincinnati, Ohio, U.S. EPA, Environmental Monitoring and Support Laboratory, Office of Research Development, 460 pp.

6.2.6 Eh (redox Potential)

Scope and Application

Eh (redox potential) is a measure of the aqueous electron concentration. Eh is controlled by reactions involving elements which are present in more than one oxidation state. The chemical behavior and mobility of many aqueous constituents are strongly influenced by the redox potential of surface or ground water. Physical, chemical, and biochemical processes in water will affect Eh.

Summary of Method

Eh is measured in the field by immersing a combination electrode into water. The electrode consists of a platinum redox and a silver/silver chloride reference electrode combined in one body. Eh measurement is based on potential difference between the constant voltage reference electrode and variable voltage of the platinum electrode. The voltage of the platinum electrode is dependent on the concentration of electrons in solution. For ground water, Eh must be measure using a flow box or similar device which prevents atmospheric contamination of the water sample.

Apparatus and Reagants

- pH/mV meter; Orion Research Model 407 A/F or equivalent
- Combination redox electrode; Orion Research Model 96-78 or equivalent
- Electrode filling solution; Orion Research Model 900001 or equivalent
- Deionized water for cleaning and decontamination
- Kimwipes or equivalent
- Zobell calibration solutions

  - Solution A:
    a. 4.22 grams potassium ferrocyanide
    b. 1.65 grams potassium ferricyanide
    c. Combine and dilute to 100 millimeters (ml) with deionized water

  - Solution B:
    a. 0.42 gram potassium ferrocyanide
    b. 1.65 grams potassium ferricyanide
    c. 2.09 grams potassium fluoride
    d. Combine and dilute to 100 ml with deionized water

Calibration

Turn selector dial on pH/mV meter to "battery check." The meter should read in the "battery OK" range, if not, charge or replace batteries before using. If battery is charged, turn selector dial to "mV," remove protective cap from redox electrode, and place electrode in Zobell A solution. The meter should read 200-300 mv. Record the reading, remove the electrode from the Zobell A solution, rinse the electrode with deionized water and dry with a Kimwipe. Place the electrode in Zobell B solution; the meter is given for each Zobell solution since the Eh of the solution is a function of temperature.

Sample Measurement

- Water temperature measurements must accompany the Eh measurement. Record the water temperature to the nearest tenth of a degree centigrade.
- Turn the selector dial on pH/mV meter to "mV" and remove the protective cap. from the redox electrode.
- Place electrode into the rubber stopper or gasket on the top of the flow box. Approximately half of the electrode should remain out of the flow box, since the level of the filling solution must be higher than the water level. Also, the small hole in the electrode body must breathe.d
- Turn on water flow, allow the box to fill, and make certain no air remains trapped at the top of the flow box.
- Reduce flow in the box to as low as possible while maintaining positive pressure in the flow box.
- Allow sufficient time for thermal equilibration and Eh stabilization before taking the reading. Gently move the probe, as if stirring the water, to speed up the stabilization of the Eh reading.

- Read the "mV" or millivolt scale of the pH/mV meter (blue scale on the Orion 407 A/F). After Eh has stabilized, record the value to the nearest millivolt. Make certain to include the sign of the reading, since positive or negative potentials are possible.

- remove the redox electrode from the flow box and rinse with deionized water. Place the protective cap on the electrode tip, and turn the selector dial of the meter to "off."

- In measuring Eh of surface water, follow the same procedure. However, the flow box is not necessary. Approximately one half of the electrode must remain above the water surface; do not fully immerse the electrode.

Measure Practice

- Remove salts or precipitates from the exterior of the redox electrode by rinsing with deionized water.

- Filling hole of the electrode can be sealed with scotch tape. Do not cover the smaller breathing hole; it must stay open for proper operation.

- If the platinum tip of the electrode becomes coated with any substance, cleaning is necessary. Cleaning with deionized water and Kimwipes. If this does not remove the coating or film, use a nonabrasive cleaner, deionized water and Kimwipes. If the coating or film is still present, contact the manufacturer. Do not use cleaners which contain petroleum products on the electrode.

- To change the filling solution, turn the electrode upside down briefly to moisten the O-ring, and push the sleeve into the cap to drain the electrode. Fill the electrode with new solution, slowly push the sleeve into the cap until some solution drains from the electrode. Add more filling solution, if necessary, and retape the filling hole.

- Store the redox electrode dry. Drain filling solution and rinse interior and exterior with deionized water before storing.

References

1. American Society for Testing and Materials, 1986, "Annual Book of ASTM Standards," Volume 11.01, Philadelphia, American Society for Testing and Materials, pp. 261-267.

2. Langmuir, D., 1971, "Eh-pH determination," In "Procedures in Sedimentary Petrology," ed. R. E. Carver; New York, John Wiley, pp 597-634.

3. Orion Research Incorporated, 1983, "Instruction Manual Platinum Redox Electrodes," Form IM9778/7801; Boston, Orion Research Incorporated, 13 pp.

6.3 SURFACE WATER SAMPLING

The procedures and practices described herein are applicable to the collection of water samples from streams, ponds, lakes, rivers, springs, and seeps. Basically, there are two different techniques for collecting surface water samples. They are:

- Grab sampling; and
- Composite sampling.

Whether the technique of sampling is grab or composite sampling, the following practices will be observed:

- The sample container will be clean and uncontaminated. Appropriately cleaned sample containers with or without preservatives are prepared by the laboratory prior to shipment to the field. Sample containers with preadded preservatives will be filled to the top without overflowing to prevent loss of the preservatives. Do not rinse sample containers.

- The point of sampling will be chosen with care so that a representative sample of the water to be tested is

obtained. Choose the location of the sampling point with respect to the information desired and in conformity to local conditions.

- Avoid sampling when there is visible surface debris or when artificial turbulence is present in the stream.

- Do not use containers with preservatives to collect water samples directly from a body of water. Use a separate container (grab bottle) for sample collection and transfer the water sample into containers with preservatives.

- Stand downstream from the collection point to prevent any possible contamination during sample collection.

- Grasp the grab bottle securely at the base with one hand and plunge it mouth down into the water, avoiding surface scum. Position the bottle opening towards the current flow and away from the hand of the collector, the shore, the side of sampling platform, or boat. The sampling depth will be 15 centimeters (6 inches) below the water surface. If the water body is static, an artificial current can be created by moving the bottle horizontally in the direction it is pointed and away from the sampler. Tip the bottle slightly upwards to allow air to exit and the bottle to fill. After removal of the bottle from the stream, transfer the sample to the appropriate container with preservative.

- Collect a sufficient amount of sample to perform all the required analyses. Fill the sample bottles all the way up to the neck with the sample, without overflowing. Use the grab bottle for transfer of sample from the surface water to the sample bottles.

- VOA vials will be filled by placing an inverted glass bottle without preservative about 12 inches below the surface of the water and then turning the bottle over to allow it to fill below the water surface. The glass container is removed from the water, and the VOA vials are immediately filled from the container.

- When more than one grab bottle volume of sample is required to fill all the necessary sample containers, the portions will be composited in a holding container

prior to filling the individual sample containers. This will provide for homogeneity of the collected sample. However, composited samples should be transferred to sample containers with appropriate preservatives as soon as sufficient sample is available to fill all the sample bottles.

- Perform field measurements (Section 6.2) or sample filtration on unpreserved sample immediately after sample collection.

- Make sure that the sample container lids are tight and secure.

- Store collected samples in the field in an ice chest filled with ice and maintained at approximately 4 degrees Celsius.

- Make sure samples are properly labeled and chain-of-custody records, sample collection logs, water quality field collection reports (Figure 6-1), and laboratory request for analysis forms are properly filled out.

6.4 SURFACE SOIL SAMPLING

Surface material or soil will be collected using a hand trowel, scoop, or coring device in accordance with the Work Plan and the Surface Soil Sampling Task Procedures. The following procedures will be used for soil sampling:

- Samples will be collected using a trowel, scoop, or coring device in accordance with the sampling plan.

- Decontamination of all sampling equipment will be performed at a designated central staging area at the FMPC. Decontamination in the field will only be performed if circumstances prevent equipment decontamination at the staging area. The trowel, scoop or coring device, and other sampling equipment such as pans, gloves, etc. will be decontaminated between each sample collection by cleaning with a nonphosphate detergent and a bottle brush, rinsing with tap water, methanol (acetone may be substituted if volatile organic

compounds are not being determined) and two separate deionized water rinses.

- Sufficient sample and rinsate volumes will be collected to perform all required analyses.

- Samples will be transferred directly from the hand trowel, scoop, or coring device to the appropriate sample containers.

- If soil samples are being collected for volatile organics analysis (VOA), the sample must be transferred to standard VOA vials. Vials should be completely filled to minimize any headspace in the containers.

- Soil samples collected for other organic or inorganic analyses should be transferred to glass containers with screw cap closures.

- A field/trip blank per each sample set will accompany the samples back to the laboratory. The field/trip blank will consist of organic-free deionized water used in the field to decontaminate the sampling equipment.

- Collected samples will be stored in the field in an ice chest filled with blue ice and maintained at approximately 4 degrees Celsius.

- Samples will be properly labeled and chain-of-custody records, field collection reports, and laboratory request for analysis forms will be properly completed.

6.5 SEDIMENT SAMPLING

The following practices will be observed for sediment sampling:

- Prior to sampling sediments in a stream, the sampling device, usually a vertical pipe core sampler, will be rinsed with stream water downstream from the sampling location.

- When traverse sampling of rivers and large streams is necessary, a clamshell or dredge may be used for bottom sample collection.

- Sediment samples will be collected to a depth of approximately six inches below the sediment/water interface.

- The vertical pipe core sampler and/or dredge will be decontaminated between each sample collection by cleaning with river water and a brush. Should the equipment become heavily contaminated, it will be cleaned by the following procedures:

  - In the case of inorganic contaminants, the equipment will first be washed with a nonphosphate detergent and then rinsed with dilute (0.1 N) hydrochloric acid followed by two separate deionized water rinses.

  - In the case of organic contaminants, the equipment will be washed with a nonphosphate detergent and then rinsed with tap water, methanol, and two separate deionized water rinses.

  - As described above, the equipment shall be thoroughly rinsed with two deionized water rinses to remove traces of hydrochloric acid, detergent, and methanol (acetone may be substituted if volatile organic compounds are not being determined).

  - Sampling equipment will not be placed directly on the ground or other contaminated surfaces prior to use, but will be placed on a clean plastic sheet.

  - Samples of the final deionized water rinse will be collected in sample bottles containing the appropriate preservatives and analyzed to check for cross-contamination between sampling points.

Decontamination of the sampling equipment will be performed at a designated central staging area at the FMPC. If this is not possible due to extenuating circumstances, the sampling equipment may be decontaminated in the field, but only as a last resort.

- A sufficient amount of samples will be collected to perform all required analyses.

- Samples will be transferred directly to a stainless steel pan for thorough mixing of the sample prior to transfer to the proper sample container.
- Collected samples will be stored in the field in an ice chest filled with commercially available icing material and maintained at approximately 4 degrees Celsius.
- Samples will be properly labeled and chain-of-custody records, field collection reports, and laboratory request for analysis forms will be properly completed.

6.6 SUBSURFACE SOIL SAMPLING

6.6.1 COLLECTION OF SUBSURFACE SOIL SAMPLES

Subsurface material or soil will be collected using a split-spoon sampler or thin-wall tube in accordance with the Work Plan. Once collected, sampling equipment will be decontaminated and samples will be transferred to the appropriate containers as described in Section 6.4.

Subsurface materials or soils will be collected from soil borings. The borings will be advanced using cable tool drilling for monitoring wells and a soil auger drill rig for geotechnical and geochemical borings. Other suitable means may be used for the geotechnical borings depending on the characteristics of the subsurface material. Subsurface material or soil will be collected at specified intervals in accordance with the Work Plan.

Because of its ability to penetrate greater depths and to maintain the physical integrity of the samples, a coring tool is commonly used to collect soil samples. The most common procedures use a thin-wall steel tube (Shelby tube) which is forced into the undisturbed soil at the bottom of a borehole. This is sometimes referred to as drive sampling. Shelby tubes

are generally from one to three inches in diameter and 12 to 24 inches long. When the Shelby tube is retrieved, friction will usually retain the sample inside the tube, at least in most unsaturated materials.

Split-tube or split-spoon samples can also be used for sample collection when undisturbed samples are not required. Subsurface soil samples should be collected in accordance with the following procedures:

- The appropriate sampling device, consisting of a threaded coupling to fit a standard drill rod and a replaceable, thin-walled seamless steel tube or split-spoon sampler, is lowered down the borehole and driven into the undisturbed soil at the bottom of the boring.
- The sampling device is removed from the boring and either sealed and shipped to the laboratory as in the case of Shelby tubes, or the split tube, or split-spoon sampler is opened and the sample is removed and transferred to appropriate sample containers for shipment to the laboratory.
- Care should be taken to avoid collection of caving materials at the base of the borehole. Undisturbed soils should be collected.
- Subsurface soil samples collected for volatile organics analysis will be taken from the interior of the sample and will be transferred as soon as possible to standard VOA vials. Vials should be completely filled to minimize any headspace in the containers.
- Subsurface soil samples collected for other organic or inorganic analyses should be transferred to glass containers with screw cap lids.
- Samples to be tested for physical characteristics requiring undisturbed soil should not be transferred but should be left in the Shelby tube. The ends of the Shelby tube are capped, taped, and sealed with wax.

- A sample label, chain-of-custody form, field collection report, and a laboratory request for analysis form will be filled out in the field.

- The split-spoon sampler and other sampling equipment such as trowels, pans, gloves, etc. will be decontaminated between each collected sample by cleaning with tap water and a bottle brush, rinsing with deionized water, methanol, and deionized water again. Should the sampling equipment become heavily contaminated, it will be cleaned according to the following procedures:

  - In the case of inorganic contaminants, the equipment will first be washed with a nonphosphate detergent and then with dilute (0.1 N) hydrochloric acid followed by two separate deionized water rinses.

  - In the case of organic contaminants, the equipment will first be washed with a nonphosphate detergent and then rinsed with tap water, methanol, and two separate deionized water rinses.

  - As described above, the equipment shall be thoroughly rinsed with two deionized water rinses to remove traces of hydrochloric acid, detergent, and methanol (acetone may be substituted for methanol if volatile organic compounds are not being determined).

  - Sampling equipment will not be placed directly on the ground or other contaminated surfaces prior to insertion into the boring, but will be placed on a clean plastic sheet adjacent to or around the boring.

  - Rinsate samples to be collected as required by QAPP 6.0 page 2 of 59.

Decontamination of the sampling equipment will be performed at a designated central area at the FMPC. If this is not possible due to extenuating circumstances, the sampling equipment may be decontaminated in the field, but only as a last resort.

6.6.2 FIELD SCREENING OF SUBSURFACE SOIL SAMPLES FOR RADIOACTIVE CONTAMINATION

The purpose of this section is to provide uniform measurement techniques for screening subsurface soil samples for radioactive contamination and to determine which sample will be chosen for full radiological analysis.

The following procedure describes the technique for screening subsurface soils for intermediate and high-energy gamma ray emitters. The screening level is chosen for instrument gross count rates which exceed the background count rate by three standard deviations when the sample is counted in a low-background area.

The screening will be preformed with an ESP-1, Model 141, SPA-3, Sodium Iodine Scintillation Detector survey instrument.

The operation and calibration of this instrument are found in Section 5.1.1 and Section 5.1.4.

The following assay procedure is performed with the survey instrument:

- Perform a background check with the survey instrument. Compare the count rate with the accepted background count rate for the area. If a larger than the acceptable background count rate is present, move to an area with a lower background rate. (Note: A shielded enclosure will be used by the sample coordinator at the sample coordinator's trailer.) Perform five separate 30-second background counts for the instrument. Calculate the average; record data.

- Position the sample (in sealed container) in contactwith the survey instrument and perform a thirty-second count per sample.
- Record the count rate.
- Submit results to the field task leader (geologist).
- Subsurface soil samples will be selected for radiological analysis based on the results of screening. The sample selected for laboratory analysis will be that which exhibits the highest relative reading for the given location and horizon (at least one sample per horizon, i.e., tills, upper sand and gravel, and lower sand and gravel per location will undergo radiological analysis).

6.7 RADON SAMPLING

6.7.1 RADON SAMPLING IN SOIL (FLUX MEASUREMENTS)

This procedure provides instruction for the determination of radon flux from ground surfaces using charcoal canisters as described in W. A. Goldsmith, et al., Radon Flux Measurements, RASCA Procedures Manual, Procedure No. 13.11, Revision 8, ORNL-6000, September 1982.

Radon that emanates across a soil/air interface will vary as ambient weather conditions change. Flux is a function of Ra-226 in subsurface soil, but is affected by soil porosity, soil moisture, and ambient pressure and temperature. While determinations of radon flux are not exact, a series of canisters placed at various points in an area where ambient conditions are the same, should provide information about the relative magnitude of the radon source.

Sampling will be performed at the frequency and locations specified in the Work Plan according to the following procedures:

- Charcoal canisters to be used for sample collection will be preconditioned for 24 hours at 100 degrees Celsius.
- After the canisters have cooled, they are placed individually in a plastic bag and sealed. Also prior to use in the field, a background count must be made and recorded.
- Each charcoal canister will be placed on a smooth ground surface after grass has been removed. Remove one canister from its plastic bag and twist the canister's thin wall cylinder about 0.5 cm into the ground. Soil should be packed around the canister as a seal.
- Record the location and time of emplacement on the sample collection log sheet.
- Continue the above procedure until charcoal canisters have been installed at all the sampling locations specified in the Work Plan.
- The appropriate exposure time for the canisters is a function of the local radon flux. To determine this approximate period, it will be necessary to deploy several canisters at selected sites in order to establish an exposure time. This will be done by placing canisters in an area believed to represent near background conditions and one which is believed to represent a near maximum radon flux. At each location, four canisters will be placed on the ground and sealed as described. One canister will be removed from each location following exposures of 2, 6, 24, and 32 hours. As each canister is removed, it will be sealed in a clean plastic bag and transported to the laboratory trailer. Following a period of at least four hours, the canister will be counted using gamma-ray spectrometry techniques. An evaluation of data from this exercise will be used to establish optimum exposure periods.

- Following exposure for the established optimum period, canisters will be retrieved. When the canister is removed from the ground, a clean rag or paper wipe willbe used to remove loose soil, mud, etc., from the canister rim in contact with the ground.

- Place each canister in an individual plastic bag, complete all information blanks on a sample container label and the sample collection log sheet and attach the label to the plastic bag. Record the sample identification on the chain-of-custody record.

- Transport the samples to the laboratory for analysis. Note: If a field laboratory is used to perform the radon analysis, the samples must be stored at least four hours prior to analysis to allow equilibration of the radon daughters.

6.7.2 LONG-TERM RADON SAMPLING IN AIR

This procedure provides instructions for the collection of samples for the determination of long-term radon-222 (Rn-222) concentrations in air under ambient outdoor conditions as described in H. W. Alter and R. L. Fleisher, 1981, "Passive Integrating Radon Monitor for Environmental Monitoring," Health Physics, Volume 40, p. 693 and Terradex Corporation, "Instruction for Track-Etch[R] Type F Radon Detectors," Walnut Creek, California.

As radon and radon progeny decay, the resultant alpha particles produce radiation-damage tracks in thin plastic films exposed to the air. The film detector is mounted inside the bottom of a plastic shield. A special filter installed over the mouth of the cup filters out radon daughters, as well as dust and dirt, so that only radon gas enters the cup. The detectors are chemically treated after exposure to make the tracks visible. The number of tracks in a specified area is directly proportional to the integrated alpha exposure from the decay of the radon to which the

detector was exposed. The detection range is from 0.2 to 20,000 pCi/l-months for outdoor measurements.

Sampling will be performed at the frequency and locations specified in the work plan according to the following procedures:

- Prior to the planned installation of the film detectors, submit a purchase order for the purchase and readout of the detectors. Specify a delivery date two weeks prior to installation.

- Specify the quantity of detectors desired. This should include enough detectors to install a minimum of two detectors per location and at least ten detectors for known exposures and background determinations.

- Request that the detectors in this order be produced from the same batch of film. The detectors must all be Type F configuration.

- Specify maximum readout area for outdoor monitoring. For Terradex film detectors, this is 19.3 mm^2.

- Specify that results should be reported in pCi/l and in either tracks/mm^2 or total tracks.

- Inspect the shipment of film detector cups when they arrive from Terradex.

- Check the aluminum bags for holes or tears.

- Check the contents of each bag by feeling along the entire length of the aluminum bag for crushed cups. **DO NOT** open bag.

  IMPORTANT: **DO NOT** open the sealed aluminum bags until they are to be installed at the monitoring location.

- Attach the protective canister (shield) to a post or other suitable location at a height of two to three meters. The shield should be firmly mounted with no obstructions to the free flow of air past the detector. In general, canisters should be mounted on the northern

sides of the mounting post. Building walls, highway structures, or large signs should be avoided.

- Alternatively, the detector with the protective canister surrounding the plastic cup may be placed inside a larger stand-alone shelter. Canisters should be installed so that the entire detector is at least six inches from any obstruction. Install the canister with the open mouth facing down. The stand-alone shelter should be open and allow the free flow of air through it. The detectors must be mounted firmly to avoid movement within the shelter.

- At the monitoring location, open one aluminum bag and remove sufficient film detector cups to enable installation of the appropriate number of replicates, making sure to close the bag after removing the set.

- Visually inspect the film detector to check to see that it is securely fastened to the bottom of the cup. If the film is not secured to the bottom of the cup, secure it. Extreme care should be taken not to touch the film.

- If the film is touched, use a different cup and detector. On the field data sheet, write down the serial number of the breached cup and indicate what happened in the comments section.

- Using one filter, cover the mouth of the cup. The shiny side of the filter should be facing out.

- Using one red covering and holding the filter taut, firmly push the cover ring over the two sets of ribs of the cup.

- Check that the cover is fully seated around the cup rim. Inspect the fully assembled detector to check to see that the filter covers the entire mouth of the cup, there are no large wrinkles in the filter and that the filter has not been torn or punctured by assembly.

- Install the film detector cup at the monitoring location inside the protective canister.

- Enter the serial number of the film detector cup, the date the bag was opened, the date installed, site number, and location on the field data sheet.

- Schedule the installation of the film detector cups such that when a bag is opened, all cups can be installed immediately. Do not use film detector cups that have been stored in an opened bag overnight. The aluminum bags should be saved for use when the film detector cups are retrieved.

- Remove the film detector cup from the canister and wipe off any dust or dirt from the outside of the cup. Remove the red cover ring and filter from the mouth of the cup.

- Inspect the filter by holding it up to the light. Note any damage to the filter in the comments section of the data sheet (e.g., pinholes, scratches, tears, etc.)

- Visually inspect the film on the bottom of the cup. Note any discoloration or damage to the film in the comments section of the data sheet.

- Enter the date removed next to the correct serial number on the field data sheet and place the film detector cup in the aluminum bag.

- Stack the exposed cups. Close aluminized bag and proceed to install new cups. After an aluminized bag is filled (10 cups, maximum), insert the empty cup provided into the last film detector cup with a yellow plastic separator sheet. If an end cup is not provided, place the yellow plastic separator sheet over the mouth of the last film detector cup and secure it with one of the red coverings.

- Fold the open end of the aluminum bag and seal using tape. Remember, do not exceed 10 cups per bag.

- When all exposed detectors have been retrieved, proofread the field data sheets to check to see that all applicable information is recorded in the proper column and that all comments are legible. (Detector serial number, date opened, date installed, date removed, site number, location.)

- Check that all aluminum bags containing exposed detectors are sealed and have no pinholes or tears.
- Transcribe all data from the field data sheets to the vendor's data sheets.
- Complete the vendor's preshipping checklist. Specify the readout sensitivity with any special handling instructions and include with the data sheets and detectors.
- Ship detectors to the vendor for readout.

6.7.3 Short-Term Radon Sampling in Air

The purpose of this procedure is to describe the methods used to collect samples of ambient air and soil gas.

Two basic types of sampling are used in radon measurements, gas bag samples, and soil gas samples (radon flux). Gas bags provide integrated samples of ambient radon in air while soil gas accumulators provide samples of radon in emanated soil gas. Instantaneous air samples may be collected using an evacuated SC-6 scintillation cell.

The sampling procedures described in this method are referenced to DOE Order 5480.1, 10 CFR 20, and U.S. EPA standards 40 CFR 192. Sampling will be performed at the frequency and locations specified in the Work Plan according to the following procedures:

- Gas Sampling (24, 48, or 72 hours Integrated Sample) of Ambient Air
  - Place radon gas bag at sampling location and turn on pulse pump. Record date and time of start-up on sample collection log and on the gas bag. To fill 44-liter bag, use the following pump cycles:

Sample Time (Hours)	Pump Interval (Seconds)
24	5
48	12
72	15

Secure and protect sampling equipment from inclement weather conditions and vandalism.

- After completion of sampling period, turn off pulse pump and record date and ending time on sample collection log and on the gas bag.

- Take the gas bag to the counting room for transfer of the air sample to an SC-6 scintillation cell.

- Using a small piece of tygon tubing, attach an evacuated SC-6 cell to the valve on the gas bag in series with a 0.45-micron filter and transfer the air into the cell by opening the valves. Transfer at least three cell volumes to provide a representative sample. Record the date and time of the sample transfer on the label of the SC-6 cell and on the sample collection log.

- Place the SC-6 cell in the sample holding area for counting in a SAC-R5 alpha counter. Results of the count will be used to determine the radon gas concentration expressed in pCi/l in the integrated sample. See the calibration and counting procedure instructions for the use of the SAC-R5 and SC-6 scintillation cell radon counting system.

• Soil Gas Sampling (Radon Flux Measurements)

- Position the special 55-gallon drum section over the sampling point and, with a downward twisting motion, countersink the barrel one to two inches into the soil, or otherwise seal the drum to the ground.

- Attach the 50 cc syringe to the valve assembly, open the valve, and rapidly pump the syringe 10 times.

- Close the valve, remove the syringe, and attach an evacuated SC-6 cell by means of a piece of tygon tubing with in-line 0.45-micron filter.

- Open the valve on the drum, then open the valve on the SC-6 and fill the SC-6 cell. Close the valve on the SC-6 cell and close the valve on the barrel. Record the time and the date for the sample. Also record the cross-sectional area of the drum as the sample area.

  A 55-gallon drum with a diameter of 22.5 inches has an area equivalent to 0.256 m^2.

- After 45 minutes, repeat steps 2 through 4 using a second evacuated SC-6 cell.

  NOTE: The first sample is considered to be a background sample. The second sample represents the radon buildup over the 45-minute sampling time.

- Submit the samples to the counting lab for counting. The radon concentration will be determined by counting in a SAC-R5 alpha counter. Results will be used to determine the radon flux ratio expressed in pCi/m^2-sec.

• Instantaneous Air Sampling

- Instantaneous or "spot" air samples are collected using an evacuated SC-6 scintillation cell.

- At the desired sampling location, collect a sample by opening the valve on a SC-6 cell which has an in-line 0.45-micron filter connected to the valve by means of a small piece of tygon tubing. Record the location, date, and time of collection on the SC-6 cell label.

- Transfer the filled SC-6 cell to the counting lab for counting in a SAC-R5 alpha counter. Results in pCi/l will be used to determine the concentration of radon in the sample.

6.8 FIELD STORAGE AND SHIPMENT OF SAMPLES

Samples will be stored in a cool place away from direct sunlight. As soon as samples are collected, filtered (if necessary), and preserved, they should be stored in an ice chest packed with blue

ice. Field personnel should make sure that sample container lids are tight and secure before storing them in an ice chest. Samples must be promptly shipped to the laboratory so that sample holding times are not exceeded. Transportation of samples must be accomplished not only in a manner designed to protect the integrity of the sample, but also to prevent any detrimental effects from the potentially hazardous nature of the samples. Regulations for packaging, marking, labeling, and shipping of hazardous materials, substances and wastes are promulgated by the U.S. Department of Transportation (DOT) and described in the 49 CFR 171 through 177 (in particular, 172.402h, Packages Containing Samples). In general, these regulations were not intended to cover the shipment of samples collected at hazardous waste sites. However, the U.S. EPA has deemed it prudent to package, mark, label, and ship samples observing these DOT procedures. The information contained in this section is for general guidance and, although factual, should not be misconstrued as identical to DOT regulations for transportation of hazardous materials.

Samples collected at the FMPC site shall be classified as either environmental or hazardous substance (or waste) samples. In general, environmental samples are collected off site, such as water samples from the various drainages, and are not expected to be grossly contaminated with high levels of toxic substances. Samples of soil or water from certain locations in the waste storage area will be considered hazardous substances. A distinction between the two types of samples, environmental and hazardous, must be made for two major reasons: (1) to determine the appropriate procedures for the transportation of the samples; and (2) to protect the health and safety of the laboratory personnel

receiving the samples. Special precautions, procedures, and secondary containment areas within laboratories will be used when samples other than environmental samples are received. If there is any doubt as to the classification of a sample, it will be considered a hazardous sample and shipped accordingly.

6.8.1 ENVIRONMENTAL SAMPLES

Samples judged to be environmental are not considered hazardous material; however, environmental samples will be packaged and shipped according to the following procedures.

Environmental samples will be packaged following the procedures for samples classified as "flammable liquids" or "flammable solids," excluding packages being placed inside metal cans as required for "flammable liquids." Sample containers properly identified and with a sealed lid will be placed in sealed polyethylene bags, then packed in fiberboard containers or metal picnic cooler-type containers. Sufficient incombustible, absorbent cushioning material will be used to minimize the possibility of sample container breakage.

Sample containers will have a completed sample identification tag. The outside container will be marked "Environmental Sample." No DOT marking and labeling are required.

No DOT shipping papers are required, and there are no DOT restrictions on mode of transportation.

6.8.2 HAZARDOUS SUBSTANCE SAMPLES

FMPC samples not determined to be environmental samples or samples known or expected to contain hazardous material must be

considered hazardous substance samples and transported according to the following requirements. If the material in the sample is known or can be identified, then it should be packaged, marked, labeled, and shipped according to the specific instructions for that material if listed in the DOT Hazardous Materials Table, 49 CFR 172.101. For those samples of hazardous substances where the contents are unknown, the selection of the appropriate transportation category will be based upon the DOT Hazardous Material Classification, a prioritized system of transportation categories. This system is presented in Table 6-1.

For purposes of packaging safety, liquid and solid samples will be classified no lower than "flammable" as per Table 6-1.

The selection of the correct category for an unknown sample is through the process of elimination utilizing the DOT classification system. Unless known or demonstrated otherwise (through the use of radiation survey instruments), the sample will be considered radioactive and appropriate shipping regulations for radioactive material will be followed. If radioactive material is eliminated, the sample will be considered to contain Poison "A" materials, the next material on the list. Poison "A" is defined by DOT as extremely dangerous poisonous gases or liquids of such a nature that a very small amount of gas, or vapor of the liquid, mixed with air, is dangerous to life. The class "A" poisons listed in 49 CFR 172.101 and their physical state at normal temperatures are presented in Table 6-2.

TABLE 6-1

DOT HAZARDOUS MATERIALS CLASSIFICATION

1. Radioactive Material
2. Poison "A"
3. Flammable Gas
4. Non-Flammable Gas
5. Flammable Liquid
6. Oxidizer 13. ORM-B
7. Flammable Solid
8. Corrosive Materials (liquid)
9. Poison B
10. Corrosive Material (solid)
11. Irritating Materials
12. Combustible liquid (in containers having capacity exceeding 110 gallons)
13. ORM-B
14. ORM-A
15. Combustible liquids (in containers having capacity of 100 gallons or less)
16. ORM-E

TABLE 6-2

CLASS "A" POISONS AND THEIR PHYSICAL STATE AT ROOM TEMPERATURES

Compound	Physical State
arsine	gas
bromoacetone	liquid
chloropicrin & methyl chloride mixture	gas
chloropicrin & non-flammable, non-liquified compressed gas mixture	gas
cyanogen chloride containing less than 0.9% water	gas
cyanogen gas	gas
gas identification set	gas
gelatin dynamite (H.E. Germaine)	gas
grenade (with poison "A" gas charge)	gas
hexaethyl tetraphosphate & compressed gas mixture	gas
hydrocyanic acid (prussic solution)	liquid
hydrocyanic acid, liquified	gas
insecticide liquified gas, containing poison "A" or poison "B" materials	gas
methyldichloroarsine	liquid
nitric oxide	gas
nitrogen dioxide	liquid
nitrogen peroxide	liquid
nitrogen tetroxide	liquid
organic phosphate	gas
parathion & compressed gas mixture	gas
phosgene (diphosgene)	gas
phosphine	gas
poisonous liquid or gas n.o.s.	liquid or gas
tetraethyl dithiopyrophosphate	gas
tetraethyl pyrophosphate	gas

If poison "A" is eliminated as a shipment category, the next two classifications are "flammable" and "non-flammable" gases. Since few gas samples will be collected, flammable liquids would be the next category. The elimination of the classification of radioactive, Poison "A," flammable gas, and non-flammable gas which require more stringent shipping procedures, permits the sample to be classified as a flammable liquid (or solid) and shipped accordingly. The shipping requirements for flammable liquids would also suffice for shipping any other samples classified below flammable liquids on the DOT classification schedule. For samples containing unknown materials, other categories listed below flammable liquids/solids on the table will not be considered.

6.8.3 SAMPLES CLASSIFIED AS RADIOACTIVE

Federal regulations governing the transport of radioactive sample material are extremely complex and reflect overlapping jurisdiction of many federal agencies. The important features of the DOT regulations (49 CFR 173, dated 1 November 1983) are summarized with their application to samples contaminated with uranium and associated daughter radionuclides.

In general, most samples collected at the FMPC will not be classified as radioactive for transport purposes and will, therefore, require no special attention to be considered in compliance. On the other hand, certain samples may fall into categories for which special packaging and shipping restrictions are mandated. Guidelines for determining the category to which a particular sample shipment belongs and for selecting a suitable mode of shipment and appropriate packaging are described below.

The following definitions are summarized from those presented in 49 CFR 173.403:

- Natural Thorium Thorium characterized by the naturally occurring distribution of thorium isotopes (essentially 100 weight-percent thorium-232);

- Natural Uranium Uranium characterized by the naturally occurring distribution of uranium isotopes (approximately 0.711 weight-percent uranium-235 and the remainder essentially uranium-238);

- Specific Activity In reference to a radionuclide, the activity of the nuclide per unit mass of the nuclide. The specific activity of a material in which a radionuclide is uniformly distributed is expressed as the activity per unit mass of the material;

- Radioactive Material Any material having a specific activity greater than 0.002 microcurie per gram;

- Special Form Radioactive Material Radioactive material that is either a single, solid piece or is obtained in a sealed capsule;

- Normal Form Radioactive Material Radioactive material that is not "Special Form Radioactive Material"; and

- Transport Index The dimensionless number (rounded up to the first decimal place) marked on the label of a package to designate the degree of control to be exercised by the carrier during transport. Generally, the transport index is the number expressing the maximum radiation level, in millirem per hour, occurring at distance of 1 meter (3.3 feet) from the external surface of the package. Other considerations may apply to certain fissile materials.

6.8.3.1 Quantities of Radioactivity in Packages

The regulations impose limits on the total activity (i.e., specific activity times the weight of the package) contained within a

package of radioactive material. With respect to Type A packages, the limits are expressed as two quantities, A1 and A2, which refer to the maximum permissible activity for radionuclides in Special Form and Normal Form radioactive materials, respectively. Since the samples from FMPC fall into the latter category, the A2 value sets the activity limits for packages of such samples. In those cases where contaminated material shipments are designated Low Specific Activity or Limited Quantity, some fraction of the A2 value will normally apply.

Table 6-3 lists the A1 and A2 values cited in 49 CFR 173.435 for radionuclides of the uranium decay series. Values for radionuclides not listed in the regulations (e.g., lead-214, bismuth-214, polonium-214) have been assigned in accordance with the specifications set forth in 49 CFR 173.433(a)(2).

Determination of permissible quantities for samples that are contaminated with FMPC waste is more complicated than simple reference to the A2 values, since such material contains a mixture of radionuclides. For such mixtures, two rules apply. A mixture of radionuclides from a single decay chain is considered to be a single radionuclide if the following criteria are met: (1) the parent and daughters are present in their naturally occurring proportions (for example, in secular equilibrium); (2) no daughter has a half-life longer than 10 days; and (3) no daughter has a half-life longer than the parent radionuclide. For such a mixture, the A2 quantity to be applied is that of the parent radionuclide (49 CFR 173.433(b)(2)). For those mixtures

TABLE 6-3

A_1 AND A_2 QUANTITIES FOR RADIONUCLIDES
OF THE URANIUM DECAY SERIES

Isotope	Atomic Number	Decay	Half-Life[a]	Quantity in Curies A1	A2
U-238	92	Alpha	4.5×10^9 y	Unlimited	Unlimited
Th-234	90	Beta	24 d	10	10
U-234	92	Alpha	2.5×10^5 y	100	0.1
Th-230	90	Alpha	7.5×10^4 y	3	0.003
Ra-226	88	Alpha	1622 y	10	0.05
Rn-222	86	Alpha	3.8 d	10	2.0
Pb-210	82	Beta	22 y	100	0.2
Bi-210	83	Beta	5 d	100	4.0
Po-210	84	Alpha	138 d	200	0.2

[a]Abbreviations: y = years; d = days; m = minutes; s = seconds

in which the identity and activity of radionuclides is known, the permissible quantity for each radionuclide must be such that the following equation is true:

$$F_1 + F_2 + \ldots + F_k \ldots F_n \leq 1$$

where F_k is the ratio of the total activity of the kth radionuclide to its A1 or A2 quantity [49 CFR 173.433(b)(3)].

6.8.3.2 Low Specific Activity Materials

Low Specific Activity (LSA) materials include uranium and thorium ores, physical and chemical concentrates of these ores (e.g., yellow cake), unradiated natural or depleted uranium or thorium, nonradioactive material externally contaminated with radioactivity that is not readily dispersible, and material in which the radioactivity is essentially uniformly distributed and does not exceed certain prescribed concentration limits. These limits for radionuclides of the uranium decay series, beginning with thorium-230, are listed in Table 6-4. In general, these concentrations will not be exceeded in FMPC samples.

Details for shipping LSA materials are described in 49 CFR 173.425. The chief advantage of shipping under the LSA category arises when the shipment is consigned Exclusive Use; that is, under the supervision or direction of a single consignor from point of origin to final destination [49 CFR 173.403(i)]. When packaged shipments of LSA materials are consigned as Exclusive Use, the shipment is exempt from specification packaging, labeling and marking. Requirements that must be met include the following [49 CFR 173.425(b)]:

TABLE 6-4

LOW SPECIFIC ACTIVITY (LSA) CONCENTRATION LIMITS FOR RADIONUCLIDES OF THE URANIUM DECAY SERIES
[FROM 49 CFR 173.403(N)(4)]

Nuclide	A2 Value (curies)	Estimated Average Concentration Microcuries/Gram	Curies/Kilogram
Th-230	0.003	0.1	0.0001
Ra-226	0.05	0.1	0.0001
Rn-222	2.0	300	0.3
Pb-210	0.2	5.0	0.005
Bi-210	4.0	300	0.3
Po-210	0.2	5.0	0.005

- The shipment must be consigned Exclusive Use, unloaded from the conveyance in which it was originally loaded, and accompanied by written instructions for the maintenance of Exclusive Use shipping controls. LSA materials cannot be shipped by air.

- The material must be packaged in strong, tight packages that will not leak under normal conditions of transport, and each package must be marked "Radioactive - LSA."

- The package does not exceed the limits for removable radioactive contamination and radiation level.

- The transport vehicle must be appropriately placarded, unless the shipment consists solely of unconcentrated uranium and thorium ores.

6.8.3.3 Limited Quantities of Radioactive Material

Limited quantity shipments of radioactive material must meet the requirements specified in 49 CFR 173.421 and 173.423. If the activity per package does not exceed 10^{-3} A2 quantity of the radionuclide, then it is exempt from specification packaging and from the associated shipping-paper, marking, and labeling requirements. Instead, the package need only comply with the following requirements:

- The material must be packaged in strong, tight packages that will not leak under normal conditions of transport. The outside of the inner packaging, or the outside of the packaging itself when there is no inner packaging, must be marked "Radioactive."

- The package does not exceed the limits for removable radioactive contamination and radiation level.

- The package must be certified as being acceptable for transport by having a notice enclosed in or attached to the package, stating the name of the consignor and including this statement: "This package conforms to conditions and limitations specified in 49 CFR 173.421

for excepted radioactive material, limited quantity, n.o.s., UN2910."

One advantage of limited quantity shipments is that there are no restrictions on air transport. [Guidelines specified in the International Civil Aviation Organization (ICAO) regulations should be consulted for air shipments of radioactive materials.] The major disadvantage is the low concentrations and quantity weights permissible for mixtures of different radionuclides.

6.8.4 RADIATION AND CONTAMINATION CONTROL

Measurements of radiation level (dose rate) and of nonfixed (removable) radioactive contamination are conducted on radioactive-material shipments to control exposure to radioactivity. Inspectors of such shipments can readily determine whether the packages comply with the regulations summarized below.

6.8.4.1 Radiation Limits

Radiation level is the radiation dose-equivalent rate expressed in millirem per hour (mrem/h) [49 CFR 173.403(v)]. Permissible radiation levels for various shipping categories are described below:

- Limited Quantity Packages The radiation level at any point on the external surface of the package may not exceed 0.5 mrem/h [49 CFR 173.421(b)].

- LSA Packages The radiation level of the LSA packages transported as Exclusive Use shipments shall not at any time during transport exceed any of the following limits [49 CFR 173.441(b)]:

  - 200 mrem/h on the accessible external surface of the package; or 1,000 mrem/h if the following criteria are met: the shipment is made in a closed transport vehicle, the package is secured so that its position

remains fixed during transport, and no unloading/ loading operations occur between the beginning and end of transport;

- 10 mrem/h at any point on the outer surface of the transport vehicle;
- 10 mrem/h at any point 2 meters (6.6 feet) from the outer surfaces of the transport vehicle; and
- 2 mrem/h at any normally occupied position in the transport vehicle. This provision does not apply to private motor carriers when personnel operate under a radiation protection program.

- Other Packages The radiation level must not exceed 200 mrem/h at any point on the external surface of the package, and the transport index must not exceed 10.

6.8.4.2 Contamination Control

Nonfixed (removable) radioactive contamination is defined as radioactive contamination that is easily removed from the surface by wiping with an absorbent material [49 CFR 173.403(r)]. The maximum permissible limits for removable radioactive contamination, as set forth in 49 CFR 173.443(a), are summarized below; these limits apply to any area of 300 square centimeters.

- 10^{-5} micro Ci/cm^2 or 22 disintegrations per minute (dpm)/cm^2, for beta/gamma-emitting radionuclides, all radionuclides with half-lives less than 10 days, natural uranium, natural thorium, uranium-235, uranium-238, thorium-232, and thorium-228 and thorium-230 when contained in ore and physical concentrates; and
- 10^{-6} micro Ci/cm^2 or 2.2 dpm/cm^2, for all other alpha-emitting radionuclides.

Exclusive use consignments of radioactive material may not exceed these limits at the beginning of transport, and may not exceed 10 times the limits at any time during transport (49 CFR 173.443).

6.8.5 SAMPLES CLASSIFIED AS POISON "A"

6.8.5.1 Packaging

Collect samples in a polyethylene or glass container which is of an outer diameter narrower than the valve hole in a DOT Spec. #3A1800 or #3A1800 metal cylinder. Fill sample container allowing sufficient ullage (approximately 10 percent by volume) so it will not be liquid-full at 130 F. Seal sample container.

Attach a properly completed identification tag to sample container.

With a string or flexible wire attached to the neck of the sample container, lower it into a metal cylinder which has been partially filled with incombustible, absorbent loose packaging material (vermiculite or diatomaceous earth). Allow sufficient absorbing material between the bottom and sides of the container and the metal cylinder to prevent breakage and absorb leakage. After the cylinder is filled with cushioning material, drop the ends of the string or wire into the cylinder valve hole. Only one sample may be placed in a metal cylinder.

Replace valve, torque to 250 feet/pound (for one-inch opening) and replace valve protector on metal cylinder, using teflon tape.

One or more cylinders may be placed in a DOT-approved outside container.

6.8.5.2 Marking and Labeling

Abbreviations will be used only when specified. The following information will be placed on the side of the cylinder, or on a

tag wired to the cylinder valve protector, either hand printed or in label form: "Poisonous Liquid, n.o.s." or "Poisonous Gas, n.o.s. NA9035," laboratory name and address. Place the following DOT label on the cylinder: "Poisonous Gas" (even if the sample is liquid).

If the metal cylinders are placed in an outside container, both the container and cylinders inside will have the same markings and labels as above. In addition, "Laboratory Sample" and "Inside Packages Comply With the Prescribed Specifications" will be marked on the top and/or front side of the outside container. "THIS SIDE UP" marking will be placed on the topside of the container, with upward pointing arrows on all four sides.

6.8.5.3 Shipping Papers

The bill of lading will be completed and the certification statement signed (if the carrier does not provide a certification statement, a standard industry form will be used) with the following information in the order listed. One form may be used for more than one exterior container. Abbreviations will be used

only as specified: "Poisonous Liquid, n.o.s. NA9035, "Limited Quantity" or "Ltd. Qty.", net weight or net volume. The net weight or net volume must be placed just before or just after the "Poisonous Liquid, n.o.s." marking.

A chain-of-custody record will also be properly executed and included in the container or with the cylinder, if legal use of samples is required or anticipated.

Unless samples are driven to the laboratory, an employee will accompany shipping container to the transport carrier and, if required, open the outside container for freight inspection. Alternately, samples may be shipped through the WMCO Transportation Department.

Using the word "poisonous" does not convey the certain knowledge that a sample is in fact poisonous, or to what degree it may be poisonous; however, it is intended to describe the class of packaging in order to comply with DOT regulations.

6.8.5.4 Transportation

Poison "A" categorized packages may not be transported by Federal Express Corporation (air cargo) or other common carrier aircraft, or by rental, non-government aircraft. Samples may be shipped by ground transport or government-owned aircraft.

6.8.6 SAMPLES CLASSIFIED AS FLAMMABLE LIQUIDS OR FLAMMABLE SOLIDS PROCEDURES

6.8.6.1 Packaging

Samples will be collected in a glass container with non-metallic, Teflon-lined screw cap allowing sufficient ullage (approximately 10 percent by volume) so that the container is not liquid full at 130 F. If an air space in the innermost container cannot be tolerated in order to maintain sample integrity, the sample will be placed within a second container to provide the required ullage.

A properly completed sample identification tag will be attached to the sample container.

The sample container closure will be sealed and the sample placed in a two-millimeter-thick (or thicker) polyethylene bag, one sample per bag. The sample identification tags will be positioned to enable it to be read through the bag.

The sealed bag will be placed inside an appropriate size metal can with enough incombustible, absorbent, cushioning matter (e.g., vermiculite, diatomaceous earth) to prevent breakage and absorb liquid; one bag per can. The can will be pressure closed using clips, tape, or other positive means to hold the lid securely, tightly, and effectively.

One or more metal cans will be placed (or single one-gallon bottle) surrounded with incombustible, absorbing packaging material for stability during transport into a strong outside container, such as a cooler or inside an approved fiberboard box.

6.8.6.2 Marking and Labeling

Abbreviations will be used only when specified. The following information will be placed on the metal can (or 1-gallon bottle), either hand printed or in label form: laboratory name and address, "Flammable Liquid n.o.s. UN1993" or "Flammable Solid n.o.s. UN1325." Not otherwise specified (n.o.s.) is not used if the flammable liquid or solid is identified. In that case, the name of the specific material is used and listed before the category (e.g., "Flammable Liquid").

The following DOT labels will be placed on the outside of the can (or bottle): "Flammable Liquid" or "Flammable Solid." The "Dangerous When Wet" label will be used with the "Flammable Solid" label if the material meets the definition of a water reactive

material. The "Cargo Aircraft Only" label will be used if the net quantity of the sample in each package is greater than one quart (for "Flammable Liquid," n.o.s.) or 25 pounds (for "Flammable Solid" n.o.s.). [49 CFR 172.402, 172.101].

If the cans are placed in an exterior container, both that container and inside can (or bottle) will have the same markings and labels as above.

The words, "This End Up" or "This Side Up," will be clearly printed on the top of the outer package. Upward pointing arrows will be placed on the sides of the package. The words, "Laboratory Samples," will also be printed on the top of the package.

6.8.6.3 Shipping Papers

Abbreviations will be used only when specified: "Flammable Liquid n.o.s. UN1993" or "Flammable Solid n.o.s. UN1324"; Limited Quantity (or Ltd. Qty.); net weight or net volume (abbreviations of weight or volume are acceptable). Further descriptions such as "Laboratory Samples" or "Cargo Aircraft Only" (if applicable) are allowed if they do not contradict the required information. The net weight or net volume will be placed just before or just after the "Flammable Liquid, n.o.s." or "Flammable Solid, n.o.s." description. The bill of lading will be completed and the certification statement signed (if the carrier does not provide, a standard industry form will be used) with the following information in the order listed. One form may be used for more than one exterior container.

A chain-of-custody record, properly executed, will be included in the exterior container.

6.8.6.4 Transportation

Unknown hazardous substances classified as flammable liquids may be transported by rented or common carrier truck, bus, railroad, or by Federal Express Corporation, but they should not be transported by any other common carrier air transport, even "cargo only" aircraft. (DOT regulations permit "cargo only" aircraft such as TWA, United, etc.; however, difficulties with regular airline transportation suggests avoiding these types of transportation.)

These procedures are designed to enable air cargo shipment by entities such as Federal Express; however, they should not be construed as an endorsement of a particular commercial carrier.

If samples are transported by any type of government-owned vehicle, including aircraft, DOT regulations are not applicable. However, personnel will use the packaging procedures described. The bill of lading with a certification is an exception and does not have to be executed.

6.9 SAMPLE BOTTLE PREPARATION AND SAMPLE PRESERVATION

Sample containers and appropriate preservatives are presented in Tables 6-5 and 6-6 for specific chemical and radiological parameters. Sample bottles containing premeasured amounts of the appropriate chemical preservatives are prepared in the field trailer and are shipped to the field. Sample bottles are purchased precleaned in accordance with U.S. EPA specifications Volatile organic analysis (VOA) vials are purchased precleaned.

Glass containers for other organic analyses are washed with a nonphosphate detergent, rinsed with tap water, rinsed with methanol, rinsed with deionized water, and allowed to air dry. Plastic containers for metals analyses are washed with a nonphosphate detergent, rinsed with tap water and deionized water, and then rinsed with dilute nitric acid. Plastic containers for other general chemistry and radiological procedures are washed with a nonphosphate detergent and rinsed with tap water and deionized water.

TABLE 6-5
SAMPLING AND PRESERVATIVE REQUIREMENTS
FOR WATER SAMPLES
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

PARAMETER	CONTAINER(a)	VOLUME REQUIRED (ml)	PRESERVATION	MAXIMUM HOLDING TIMES[c]
• Alkalinity	P,G	50	Cool 4°	14 days
• Ammonia	P,G	100	Cool 4°C, H_2SO_4 to pH <2	28 days
• Chloride	P,G	50	None required	14 days[e]
• Cyanide (Total)	P,G	1,000	Cool 4°C, Na OH to pH <12, 0.6g Ascorbic Acid (d)	
• Fluoride	P	300	None required	28 days
• Redox Potential (Eh)	P,G	100	None required	Analyze immediately
• Hydrogen Ion (pH)	P,G	100	None required	Analyze immediately
• Hexavalent Chromium	P,G	50	Cool 4°C	24 hours
• Mercury (f)	P,G	100	HNO_3 to pH <2	28 days
• Metals, Except Hexavalent Chromium and Mercury(f)	P,G	200	HNO_3 to pH <2	6 months
• Nitrate	P,G	100	Cool 4°C	28 days
• Organic Carbon (Total) (TOC)	G	25	Cool 4°C, HC1 or H_2SO_4 to pH <2	28 days
• Organic Halogen (Total) (TOX)	G	100	Cool 4°C, H_2SO_4 to pH <2	14 days
• Organic Nitrogen (Total)	P,G	500	Cool 4°C, H_2SO_4 to pH <2	28 days

See footnotes at end of table.

TABLE 6-5
(continued)

PARAMETER	CONTAINER(a)	VOLUME REQUIRED (ml)	PRESERVATION	MAXIMUM HOLDING TIMES[c]
• Oxygen, Dissolved	G bottle and top	300	None required	Analyze immediately
• Phenols, (Total)	G	500	Cool 4°C, 0.008% $Na_2S_2O_3$d)	28 days
• Phosphorus (Total)	P,G	50	Cool 4°C, H_2SO_4 to pH <2	28 days
• Residue, Filterable (TDS)	P,G	100	Cool 4°C	7 days
• Specific Conductance	P,G	100	Cool 4°C	28 days
• Sulfate	P,G	500	Cool 4°C, add zinc acetate plus sodium hydroxide to pH <9	28 days
• Temperature	P,G	1,000	None required	Analyze immediately
<u>HSL Organic Compounds</u>(g)				
• Volatiles	G, Teflon-lined septum	40	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days(i)
• PCBs	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days until extraction 40 days until extraction
• Pesticides	G, Teflon-lined cap	1,000	Cool 4°C, NaOH or HC1 to pH 5-9 (h), 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction
• Acid/Base Neutral Extractables	G, Teflon-lined cap	1,000 each	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction
• Polychlorinated dibenzo-P-Dioxins and Polychlorinated	G, Teflon-lined cap	1,000	Cool 4°C, 0.008% $Na_2S_2O_3$(d)	7 days until extraction, 40 days after extraction

See footnotes at end of table.

TABLE 6-5
(Continued)

PARAMETER	CONTAINER(a)	VOLUME REQUIRED (ml)	PRESERVATION	MAXIMUM HOLDING TIMES
Radiological Samples				
• Gross Alpha	P,G	1,000	HNO_3 to pH <2	6 months
• Gross Beta	P,G	1,000	HNO_3 to pH <2	6 months
• Radium-226	P,G	1,000	HNO_3 to pH <2	6 months
• Radium-228	P,G	1,000	HNO_3 to pH <2	6 months
• Strontium-90	P,G	1,000	HNO_3 to pH <2	6 months
• Technetium-99	P,G	1,000	HNO_3 to pH <2	6 months
• Cesium-137, Gamma Spec	P,G	1,000	HNO_3 to pH <2	6 months
• Ruthenium-106	P,G	1,000	HNO_3 to pH <2	6 months
• Plutonium, Isotopic	P,G	1,000	HNO_3 to pH <2	6 months
• Neptunium-237	P,G	1,000	HNO_3 to pH <2	6 months
• Thorium, Total	P,G	1,000	HNO_3 to pH <2	6 months
• Thorium, Isotopic	P,G	1,000	HNO_3 to pH <2	6 months
• Uranium, Total	P,G	1,000	HNO_3 to pH <2	6 months
• Uranium, Isotopic	P,G	1,000	HNO_3 to pH <2	6 months

See footnotes at end of table.

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TABLE 6-5
(Continued)

(a) Polyethylene (P) or glass (G).

(b) Sample preservation will be performed immediately upon sample collection.

(c) Samples will be analyzed as soon as possible after collection. The times listed are maximum times that samples should be held in the laboratory before analysis from the Validated Time of Sample Receipt (VTSR)

(d) Will only be used in the presence of residual chlorine. sodium thiosulfate is only proposed as a sample preservative for HSL organics when residual free chlorine is known to be present. Sodium thiosulfate will be omitted in all other cases.

(e) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustment to determine if sulfide is present.

(f) Samples will be filtered immediately following collection on site before adding preservatives for dissolved metals.

(g) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(h) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

(i) If acid preservation (HC1 to pH<2) is used, the maximum holding time can be extended from 7 days to 14 days.

Reference: This table include the requirements of the U.S. Environmental Protection Agency, as published in the Code of Federal Regulations, Vol. 49, No. 209, 40 CFR 136, October 26, 1984, pg, 43260. HSL organic compound requirements are promulgated in "Chemical Analytical Services for Multi-Media Multi-Concentration Organics, GC/MS Techniques," WA-87J-K236, U.S. Environmental Protection Agency, Washington, D.C., 1987.

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TABLE 6-6
SAMPLING AND PRESERVATION REQUIRMENTS
FOR SEDIMENT AND SOIL SAMPLES
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

PARAMETER	CONTAINER	SAMPLE WEIGHT REQUIRED (gm)	PRESERVATION	REFERENCE	MAXIMUM HOLDING TIMES(A)
Radionuclides	Plastic	100(b)	None	1	Indefinite
Inorganics	Plastic, Glass	500(c)	Cool, 4°C	2,3,4,5	Indefinite
Volatile Organics	Glass, Teflon-lined septum(d)	40	Cool, 4°C	6	10 days
Semivolatile Organic(e)	Glass, Teflon-lined cap	400	Cool, 4°C	6	10 days until extraction 40 days after extraction
Pesticides/PCBs	Glass, Teflon-lined cap	400	Cool, 4°C	5	5 days until extraction 40 days after extraction
Cation Exchange Capacity (Total)	Plastic, Glass	400	Cool, 4°C	4	Indefinite

(a) Samples will be analyzed as soon as possible after collection. The times listed are maximum times that samples should be held before analysis.

(b) Check with laboratory for the volume of samples required for different radionuclide analyses.

(c) The collected sample can be divided for wet chemistry, metals, etc.

(d) 40-ml VOA vial.

(e) Semivolatile organics include acid and base-neutral extractables and pesticides/polychlorinated biphenyls.

TABLE 6-6
(Continued)

REFERENCES:

(1) U.S. Environmental Protection Agency (EPA), September 1983, "Handbook for Sampling and Sample Preservation of Water and Wastewater," EPA-600/4-82-029.

(2) U.S. Environmental Protection Agency (EPA), April 1984, "Test Methods Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 2nd ed.

(3) U.S. Environmental Protection Agency (EPA), 1984, "Proposed Sampling and Analytical Methodologies for Addition to Test Methods for Evaluation Solid Waste, Physical/Chemical Methods." PB85-103026.

(4) U.S. Environmental Protection Agency (EPA), 1978, "Field and Laboratory Methods Applicable to Overburdens and Mine Soil," EPA-600/2-80-054.

(5) U.S. Environmental Proteciton Agency (EPA), 1987, "Chemical Analytical services for Multi-Media Multi-Concentration Metals and Inorganics," WA-87-KO26, U.S. EPA, Washington, D.C.

(6) U.S. Environmental Protection Agency (EPA), 1987, "Chemical Analytical Services for Multi-Media Multi-Concentration Organics, GC/MS Techniques," WA-87-K236, U.S. EPA, Washington, D.C.

7.0 CHAIN-OF-CUSTODY PROCEDURES

7.1 FIELD SAMPLING

The following will be used in the chain-of-custody process for sample tracking and field activities:

- Sample identification and labeling;
- Sample chain-of-custody record;
- Sample collection log; and
- Laboratory request for analysis form.

7.1.1 SAMPLE IDENTIFICATION AND LABELING

All samples will be adequately marked for identification from the time of collection and packaging through shipping and storage. Marking will generally be made on the sample container (jar, bottle, etc.) but may be applied directly to the sample, or on a tag or label attached to the sample or container, depending on the type of sample and its intended use. Sample identification will include, as appropriate:

- Project name and number;
- Sample number;
- Sample location (e.g., boring, test pit, depth or sampling interval, and field coordinates);
- Sampling date and time;
- The initials of the individual(s) performing the sampling; and
- Sample preservative, if used.

An example of a sample label is illustrated in Figure 7-1. A sample numbering system will be established for the purpose of identifying the samples according to location and type as described in Sampling Plan, Volume 1, Introduction.

7.1.2 CHAIN-OF-CUSTODY RECORD

Documentation of the sample chain of custody is provided by the use of a chain-of-custody record that includes the sampling location, the type and amount of samples collected, the date and time of sample collection, the name(s) of the person(s) responsible for sample collection, the date and time of all custody transfers, the signature of the person relinquishing and accepting sample custody, and other pertinent information.

Chain-of-custody procedures document sample possession from the time of collection to disposal. A sample is considered in custody if it is:

- In one's physical possession;
- In view, after being in physical possession;
- Locked so that no one can tamper with it, after having been in physical custody; and/or
- In a secured area, restricted to authorized personnel.

A chain-of-custody record will be initiated in the field and will accompany each group of samples during shipment to the laboratory. Each time custody of the sample changes, the new custodian will sign the record and indicate the date(s) of transfer. An example of a chain-of-custody record is included in Figure 7-2.

If the samples are shipped to the laboratory by commercial carrier, the original chain-of-custody record shall be sealed in a watertight container, placed in the shipping container, and the shipping container sealed prior to giving it to the carrier.

FIGURE 7-1

SAMPLE LABEL

Project Name _____ Project Number _____

Sample Location _____ Number _____

Boring/Well No. _____ Date _____

Collector's Name _____ Time _____

Sample Type Ground Water _____ Surface Water _____

Soil _____ Sludge/Waste _____

Parameters _____ Preservative _____

Bottle _____ of _____ _____ Filtered _____ Nonfiltered

If the samples are directly transported to the laboratory, the original chain-of-custody form shall be kept in possession of the person delivering the samples.

For samples shipped by commercial carrier, the waybill shall serve as an extension of the chain-of-custody record between the final field custodian and receipt in the laboratory. (The carrier and waybill number will be written on the chain-of-custody record. If the original chain-of-custody record is sealed in the shipping container before the waybill number is received, then this number will be written on the copy of the chain-of-custody record.)

Laboratory sample receipt is discussed in Section 7.2.1.

All original chain-of-custody records, analytical data, and other project laboratory documentation will be maintained by the subcontractor laboratory in a project file. Laboratory project files will be stored in a central filing system pending disposition by DOE.

A legible copy of the field chain-of-custody record will be maintained in the project central files at the site. Once samples are received in the laboratory, chain-of-custody records will be signed by a designated representative of the laboratory and copies of the signed chain-of-custody records will be submitted to the project site office.

FERNALD RI/FS

CHAIN-OF-CUSTODY RECORD

R/A Control No. _____

C/C Control No. 00150

PROJECT NAME/NUMBER _____ LAB DESTINATION _____

SAMPLE TEAM MEMBERS _____ CARRIER/WAYBILL NO. _____

Sample Number	Sample Location and Description	Date and Time Collected	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.

Special Instructions: _____

Possible Sample Hazards: _____

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: _____

   Received By: _____

2. Relinquished By: _____

   Received By: _____

3. Relinquished By: _____

   Received by: _____

4. Relinquished By: _____

   Received By: _____

WHITE - To accompany samples
YELLOW - Field copy

FIGURE 7-2

7.1.3 SAMPLE COLLECTION LOG

A sample collection log is prepared at the site for each sample to record information pertaining to the location and collection of a sample. The following information is required on the sample collection log, as appropriate:

- Unique sample number;
- Sample location;
- Collector initials;
- Date and time sample collected;
- Sample coordinates (Ohio State Planar System); and
- Sample identification (type, media, sequence, blank, spike, duplicate, split).

An example of a sample collection log is provided in Figure 7-3.

7.1.4 LABORATORY REQUEST FOR ANALYSIS FORM

The laboratory request for analysis form is prepared to indicate the testing or analyses program required for the collected samples. The following information is recorded on the laboratory request for analysis form:

- Project name and number;
- Date samples shipped;
- Required report date and turnaround times for testing or analysis;
- Contact (with telephone number) for receipt of the analytical report and billing invoices;
- Sample identification numbers; and
- Sample volume collected and preservatives used, if any.

An example of a laboratory request for analysis form is provided in Figure 7-4.

7.2 ANALYTICAL LABORATORY

7.2.1 LABORATORY SAMPLE RECEIPT

Upon sample receipt at the laboratory, sample management personnel shall perform the following:

1) The custody seals of the cooler and, if used, on the sample containers, shall be examined for breakage and/or tampering. The condition of the custody seals will be noted on the Sample Receipt and Coding Checklist. Any breakages of the seals will be documented on a deficiency/nonconformance memo and the client shall be notified.

2) The temperature of the cooler is measured and recorded on the chain-of-custody record and the Sample Receipt log. Samples for chemical analysis that are received outside the temperature range of 2-6° C will be documented on a deficiency/nonconformance memo and shall not be analyzed unless the client so directs in writing after being notified.

3) When a sample is removed from the shipping container, the sample identification on the sample container is checked against that listed on the chain-of-custody record and the request for analysis form. If discrepancies exist, appropriate notes (initialed and dated) are made on the chain of custody record form, if necessary, and documented on a deficiency/nonconformance memo. The client shall be notified for resolution of discrepancies.

4) Each sample will be assigned a unique number. A numbered label is then affixed to each sample container. The numbers are assigned sequentially as samples are coded in. Samples are then processed through the laboratory by laboratory sample numbers.

FIGURE 7-3

SAMPLE COLLECTION LOG

UNIQUE SAMPLE NUMBER	SAMPLE LOCATION	COLLECTOR INITIALS	COLLECTION DATE			COLLECTION TIME		COORDINATES		SAMPLE DEPTH INTERVAL	SAMPLE TYPE	SAMPLE MEDIA	PRESERVATIVE	SEQUENCE	BLANK	SPIKE	DUPLICATE	DUPLICATE OF SAMPLE NUMBER	SPLIT	SPLIT OF SAMPLE NUMBER	INITIAL
			MO	DY	YR	HR	MN	NORTH	EAST												

FIGURE 7-4

00591

FEF ALD
RI/FS

REQUEST FOR ANALYSIS

R/A Control No.
C/C Control No. _____

PROJECT NAME _____
PROJECT NUMBER _____
PROJECT MANAGER _____
BILL TO _____

DATE SAMPLES SHIPPED _____
LAB DESTINATION _____
LABORATORY CONTACT _____
SEND LAB REPORT TO _____

PURCHASE ORDER NO. _____

DATE REPORT REQUIRED _____
PROJECT CONTACT _____
PROJECT CONTACT PHONE NO. _____

Sample No.	Sample Type	Sample Volume	Preservative	Requested Testing Program	Special Instructions

TURNAROUND TIME REQUIRED: (Rush must be approved by the Project Manager.)

Normal _____ Rush _____ (Subject to rush surcharge)

POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances)

Nonhazard _____ Flammable _____ Skin Irritant _____ Highly Toxic _____ Other _____ (Please Specify)

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis. Lab will charge for packing, shipping, and disposal.)

Return to Client _____ Disposal by Lab _____

FOR LAB USE ONLY

Received By _____ Date/Time _____

WHITE - Original, to accompany samples
YELLOW - Field copy

7.2.2 STORAGE

Samples for chemical analysis are stored under refrigeration in secured, temperature-monitored refrigerators accompanied by an Internal-Chain-of-Custody form, which is signed and dated, relinquishing the sample to storage.

Samples are stored as prescribed by applicable regulatory requirements.

7.2.3 INITIATION OF TESTING PROGRAM

As stated in Section 7.1.4, a request for analysis form shall be submitted with the samples to the laboratory. If the analytical program is not defined with the sample shipment, sample management personnel shall immediately notify the manager responsible for the work for definition of the analysis program.

The Laboratory Manager and assigned personnel are responsible for prioritizing samples on the basis of holding time and time needed to include the samples into the laboratory sample stream.

7.2.4 SAMPLE DISPOSAL

The chain-of-custody record for the sample is completed as part of sample disposal. There are several possibilities for sample disposition:

- The sample may be completely consumed during analysis.
- Samples may be returned to the client or location of sampling for disposal.
- The samples may be stored after analysis. Proper environmental control and holding time must be observed if reanalysis is anticipated. If reanalysis is not anticipated, environmental conditions for storage will not be observed.

The Laboratory Manager shall determine disposition of samples if not specified on the request for analysis form (Figure 7-4).

In general, laboratories will not maintain samples and extracts longer than six months beyond completion of analysis, unless otherwise specified.

8.0 EQUIPMENT CALIBRATION/MAINTENANCE

Measuring and test equipment used in the field and laboratory shall be controlled by a formal calibration program. The program shall provide equipment of the proper type, range, accuracy, and precision to provide data compatible with specified requirements. Calibration of measuring and test equipment may be performed internally using in-house reference standards (e.g., primary standards, EPA standards, NIST standards, or certified standards) or some external agencies or manufacturers.

8.1 RESPONSIBILITIES

The responsibility for laboratory instrument or equipment calibration rests with the applicable Laboratory Manager. Field equipment is the responsibility of the assigned manager.

8.2 CALIBRATION PROCEDURES

Documented and approved procedures will be used for calibrating, measuring, and test equipment. Whenever possible, widely-accepted procedures, such as those published by ASTM or the U.S. EPA, or procedures provided by manufacturers in equipment manuals, will be adopted.

Calibrated equipment shall be uniquely identified by using either the manufacturer's serial number, a calibration system identification number, other identifier(s). A calibration sticker will be attached to the appropriate equipment, or an appropriate entry will be made in a calibration log, so personnel can recognize the most recent date of calibration and/or when the next calibration is due.

It is the responsibility of all personnel to check calibration status prior to using the equipment.

Measuring and test equipment shall be calibrated at prescribed intervals and/or as part of operational use. Frequency shall be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience. Equipment shall be calibrated, whenever possible, using reference standards having known relationships to nationally recognize standards (e.g., NIST) or accepted values of natural physical constants. If national standards do not exit, the basis for calibration shall be documented.

Reference standards (physical, radiological, and chemical) shall be used only for calibration. Physical standards shall be stored separately from working, measuring, and test equipment. Equipment that fails calibration or becomes inoperable during use and is not recalibrated immediately shall be removed from service and segregated to prevent inadvertent use, or shall be tagged to indicate that it is out of calibration. Such equipment shall be repaired and satisfactorily recalibrated to the satisfaction of the Laboratory Manager of or manager responsible for field equipment, as applicable. Equipment that cannot be repaired shall be replaced.

Records shall be prepared and maintained for each piece of calibrated measuring and test equipment to indicate that established calibration procedures have been followed. Records for prime contractor field equipment and subcontractor field equipment will be retained in the project files. Records for laboratory equipment will be maintained by the laboratory.

8.3 FIELD MEASURING AND TEST EQUIPMENT

The responsible manager, or designee, shall maintain a list of all field measuring and test equipment (MTE) used for the collection of project data. The list will include the description and manufacturer of each piece of MTE, the unique identifier, the required calibration frequency, and the number and/or title of the calibration procedure or method to be used. The Project Quality Assurance Officer shall review the list for adequacy and shall review and approve the calibration procedures methods before their use.

Other records as specified in Section 8.2 shall also be prepared and maintained.

8.4 ANALYTICAL LABORATORY INSTRUMENTATION AND EQUIPMENT

8.4.1 Instruments and equipment included in calibration schedules include, but are not limited to:

* Instrumentation
* Automatic pipettors
* Thermometers
* laboratory balances

8.4.2 Calibration records shall include, as appropriate:

* Type and unique identification number of equipment
* Calibration frequency and acceptable tolerances
* Identification of calibration procedures employed
* Calibration dates and results
* Identification of personnel/organizations performing calibrations
* Certification or statement of calibration provided by manufacturer or external agency
* Statement of calibration acceptance or failure

8.4.3 Laboratory instruments shall be calibrated in accordance with the following protocol:

8.4.3.1 For samples analyzed under the SOW dated July 1988 for Inorganics, the following shall apply:

8.4.3.1.1 Instruments shall be calibrated with a minimum of three standards and a blank for all analytes.

8.4.3.1.2 Calibrations (ICV/CCV) shall be verified through the sue of NIST standards, where available. If NIST standards are not available, calibrations shall be verified using a standard from a source differing from that used to calibrate the instrument. Calibration verifications shall be run for every ten samples analyzed (every 20 injections for graphite furnace). See Table 8.1 for recovery requirements. If not within specified range, terminate the analysis, correct the problem, recalibrate, and reanalyze the preceding 10 samples since the last CCV meeting recovery requirements.

8.4.3.1.3 Calibration blanks (ICB/CCB) shall be run for every 10 samples (every 20 injections for graphite furnace) and shall have concentration of less than ± CRDL. If not within specified range, terminate the analysis, correct the problem, recalibrate the instrument, verify the calibration, reanalyze the preceding 10 samples since the last CCB meeting blank requirements.

8.4.3.1.4 CRDL standards shall be run at the beginning and end of an ICP run or twice per 8 hour shift. The ICP CRDL shall be at two times the CRDL. CRDL standards for AA shall be at the CRDL and shall be run

after the Initial Calibration Verification (ICV).

8.4.3.1.5 Preparation blank requirements are covered in Section 11.4.1.5.

8.4.3.1.6 ICP Interference Check (ICS) samples shall be run at the beginning and end of analysis or twice per 8 hour period, whichever is more frequent and shall be analyzed after the ICV. Both ICS A and ICS AB are included. Results of solution AB must be ± 20%. If not within the specified range, terminate the analysis, correct the problem, and reanalyze all samples run since the last ICS AB meeting specifications.

8.4.3.1.7 Spike sample analysis is covered in Sections 4.5 and 11.4.1.8. For flame AA, ICP, and CN analysis, if the matrix spike is not within ± 25% of known value and the sample concentration does not exceed four times the spike concentration, a post digestion spike must be run for those elements that do not meet the criteria (exception: Ag).

8.4.3.1.8 Duplicate sample analysis is covered in Sections 4.4 and 11.4.1.9.

8.4.3.1.9 Laboratory Control samples (LCS) are covered in Section 11.4.1.12.

8.4.3.1.10 ICP serial dilution analysis (L) must be performed on a sample from each group of samples of a similar sample type (i.e., water, soil) or for each sample delivery group, whichever is more frequent. If the analyte is a minimum of 50 times the instrumental detection limit (IDL), the serial dilution must agree within 10% of the original

determination after correction for dilution. If not within 10%, the analyte is flagged "E" on forms I-IN and IX-IN.

8.4.3.1.11 Instrumental Detection Limits (IDL) must be performed quarterly and must be equal to or less than the CRDLs listed in Table 9.2. IDLs are determined by multiplying by three, the average of the standard deviations obtained on three nonconsecutive days from the analysis of a standard solution at a concentration three to five times the IDL with seven consecutive measurements per day. See also Section 9.1.1.1.

8.4.3.1.12 Interelement corrections for ICP shall be performed annually for Al, Ca, Fe, and Mg, at a minimum. Correction factors for other analytes must be reported if they were applied.

8.4.3.1.13 Linear range analysis for ICP must be performed quarterly. The standard used must be analyzed during routine analytical runs and must be within 5% of true value.

8.4.3.1.14 Samples analyzed by graphite furnace require duplicate injections for all samples. All analyses must fall within the calibration range of the instrument. Samples which do not fall within calibration range shall be diluted and reanalyzed.

8.4.3.1.15 All samples, except the matrix spike, shall have an analytical (post digestion) spike when analyzing by graphite furnace. The analytical spike shall be run in duplicate and shall be at two times the CRDL.

8.4.3.1.16 The preparation blank analytical spike recovery must be within 85-115% when analyzing samples by graphite furnace. If not, verify by respiking and rerunning the prep blank once. If still out, correct the problem and reanalyze all samples associated with the blank.

8.4.3.1.17 The LCs for furnace must be quantified from the calibration curve and must not be run by the Method of Standard Additions (MSA). See also Section 11.4.1.11.

8.4.3.2 For samples analyzed for volatiles under the SOW dated February 1988 for Organics, the following shall apply:

8.4.3.2.1 Each CGMS system used for the analysis of volatile TCL compounds must be tuned to meet the requirements listed in Table 8.2. Instruments shall be tuned at least once for every 12 hours of continuous operation.

8.4.3.2.2 Initial calibration of the GCMS volatile instrument is required at 20, 50, 100, 150, and 200 ug/L.

8.4.3.2.3 The average relative response factors for volatiles must be calculated for all compounds. A system performance check must be made before this calibration curve is used. The minimum average relative response factor (RRF) is .300 (.250 for bromoform). The five SPCCs are chloromethane, 1,1-dichloroethane, bromoform, 1,1,2,2-tetrachloroethane, and chlorobenzene.

8.4.3.2.4 The Calibration Check Compounds (CCC) for volatiles are 1,1-dichloroethene, chloroform, 1,2-dichloropropane, toluene,

ethylbenzene, and vinyl chloride. The percent difference of relative response factors for CCCs must be less than or equal to 30% for initial calibration and 25% for continuing calibration.

8.4.3.2.5 Continuing calibration check for volatiles is 50 ug/L and must be analyzed every 12 hours.

8.4.3.3 For samples analyzed for semivolatiles under the SOW dated February 1988 for Organics, the following shall apply:

8.4.3.3.1 Each GCMS system used for the analysis of semivolatile compounds must be tuned to meet the requirements listed in Table 8.3. Instruments shall be tuned at least once for every 12 hours of continuous operation.

8.4.3.3.2 Initial calibration of the GCMS semivolatile instrument is required at 20, 50, 80, 120, and 160 nanograms. The 20 nanogram standard is not required for benzoic acid, 2,4-dinitrophenol, 2,4,5-trichlorophenol, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, 4,6-dinitro-2-methylphenol, and pentachlorophenol.

8.4.3.3.3 The average relative response factors for semivolatiles must be calculated for all compounds. A system performance check must be made before this calibration curve is used. The minimum average relative response factor 0.050 for the SPCCs. For semivolatiles, the SPCCs are N-nitroso-di-n-propylamine, hexachlorocyclopentadiene, 2,4-dinitrophenol, and 4-nitrophenol.

8.4.3.3.4 The CCCs for semivolatiles are acenaphthene, 1,4-dichlorobenzene, hexachlorobutadiene, N-nitroso-di-n-propylamine, Di-n-octylphthlate, fluoranthene, benzo(a)pyrene, 4-chloro-3-methylphenol, 2,4-dichlorophenol, 2-nitrophenol, phenol, pentachlorophenol, and 2,4,6-trichlorophenol. The percent difference of relative standard deviation for CCCs must be less than or equal to 30% for initial calibration and 25% for continuing calibration.

8.4.3.3.5 Continuing calibration check for semivolatiles is 50 nanograms and must be analyzed every 12 hours.

8.4.3.4 For samples analyzed for pesticides/PCBs under the SOW dated February 1988 for Organics, the following shall apply:

8.4.3.4.1 Retention windows must be established for pesticides for each pesticide/PCB target compound. Retention time for 4,4'DDT must be $\geq$ 12 minutes.

8.4.3.4.2 Calibration factors for compounds in evaluation mixes (aldrin, endrin, and dibutylchlorendate, and 4,4'-DDT) must be less than 10% on columns used for quantitation. If DDT is greater than 10%, then it is quantified on confirmation column. DDD and DDE must also be plotted.

8.4.3.4.3 Percent breakdown of endrin or 4,4'-DDT must not exceed 20%.

8.4.3.4.4 The 72 hour sequence in Table 8.4 is to be followed for pesticide/PCB analysis.

8.4.3.4.5 The retention time sift for dibutylchlorendate must be evaluated for each sample and must

be less than 2.0% difference for packed columns, less than 1.5% for widebore capillary columns, and less than 0.3% for narrow-bore capillary columns.

8.4.3.5 For samples analyzed for metals under SW-846, the requirements listed under Section 8.4.3.1 will apply with the following exceptions:

8.4.3.5.1 ICV/CCV for graphite furnace must be ± 20 percent of known value.

8.4.3.5.2 Preparation blank requirements follow those listed in Section 11.4.1.5.

8.4.3.5.3 CRDL calibration standards are not required for samples analyzed under SW-846.

8.4.3.5.4 If the sample concentration is sufficiently high, an analysis if a 5-fold dilution of the original sample should agree within 10%. If not, matrix interference should be suspected.

8.4.3.5.5 Graphite furnace analysis requires duplicate injections of the original sample and at least one analytical spike at the instrument.

8.4.3.5.6 Physical properties such as flash point, BTUs, specific gravity, viscosity, and corrosivity towards steel are analyzed in duplicate, where sufficient sample is available.

8.4.3.5.7 Detection limits for EP Toxicity and TCLP shall be determined as in Section 8.4.3.1.11.

8.4.3.6 Dioxins/furans shall be analyzed by modified EPA Method 8280 and shall be analyzed in accordance with the following guidelines:

8.4.3.6.1 Initial calibration is required before any samples are analyzed.

8.4.3.6.2 Routine calibration at 200 ng/mL is used to check column performance.

8.4.3.6.3 Isotopic criteria are given in Table 8.5.

8.4.3.6.4 Relative response factors are calculated for all analytes.

8.4.3.6.5 GC column performance must be demonstrated every 12 hours through performance check solution for isomer-specific analysis only.

8.5 RADIOLOGICAL LABORATORY INSTRUMENTATION AND EQUIPMENT

8.5.1 Instruments and equipment included in calibration schedules include, but are not limited to:

* Instrumentation
* Glass and automatic pipettors
* Thermometers
* Laboratory balances

8.5.2 Calibration records shall include, as appropriate:

* Type and unique identification number of equipment
* Calibration frequency and acceptable tolerances
* Identification of calibration procedures used (employed)
* Identification of personnel/organizations performing calibrations
* Certification or statement of calibration provided by manufacturer or external agency
* Statement of calibration acceptance or failure

8.5.3 The following radiological instruments shall be calibrated or background checked in accordance with the applicable laboratory's approved SOP.

Note: Each radiological laboratory subcontractor's SOPs must be approved before work begins. Special attention during the approval process shall be directed to ensuring the

compatibility of the SOPs of different laboratory subcontractors so that the analytical results will be compatible.

8.5.3.1 Liquid scintillation counting systems

8.5.3.2 Alpha spectrometer systems

8.5.3.3 Alpha/beta counting systems

8.5.3.4 Germanium spectroscopy systems

8.5.3.5 Alpha scintillation counting instruments

8.5.4 All measuring and test equipment will be calibrated through the use of referenced standards at prescribed intervals prior to analysis of samples.

8.5.5 Calibrations shall be verified through the use of NIST or NIST-traceable standards of a source differing from that used to calibrate the instrument, where such standards exist. If no national standard exists, the basis for the reference standard used shall be documented.

TABLE 8.1

Initial and Continuing Calibration Verification
Control Limits for Inorganic Analyses

Analytical Method	Inorganic Species	Percent Low Limit	Recover High Limit
ICP/AA	Metals	90	110
Cold Vapor AA	Mercury	80	120
Other[1]	Cyanide	85	115

1 - This also includes non-CLP parameters such as Ammonia, TKN and Nitrate-Nitrogen, Chloride, Fluoride, Phenol, Sulfate, TOC, TOX, Sulfide, And Tl. Phosphorus.

Table 8.2

BFB Key Ions and Abundance Criteria

Mass	Ion Abundance Criteria
50	15.0 - 40.0 percent of the base peak
75	30.0 - 60.0 percent of the base peak
95	base peak, 100 percent relative abundance
96	5.0 - 9.0 percent of the base peak
173	less than 2 percent of mass 174
174	greater than 50.0 percent of the base peak
175	5.0 - 9.0 percent of mass 174
176	greater than 95.0 but less than 101.0 percent of mass 174
177	5.0 - 9.0 percent of mass 176

-5195

Table 8.3

DFTPP Key Ions and Abundance Criteria

Mass	Ion Abundance Criteria
51	30.0 - 60.0 percent of mass 198
68	less than 2.0 percent of mass 69
70	less than 2.0 percent of mass 69
127	40.0 - 60.0 percent of mass 198
197	less than 1.0 percent of mass 198
198	base peak, 100 percent relative abundance
275	10.0 - 30.0 percent of mass 198
365	greater than 1.00 percent of mass 198
441	present but less than mass 443
442	greater than 40.0 percent of mass 198
443	17.0 - 23.0 percent of mass 442

Table 8.4

72 Hour Sequence for Pesticide/PCB Analysis

1. Evaluation Standard Mix A
2. Evaluation Standard Mix B
3. Evaluation Standard Mix C
4. Individual Standard Mix A*
5. Individual Standard Mix B*
6. Toxaphene
7. Aroclors 1016/1260
8. Aroclor 1221*
9. Aroclor 1232**
10. Aroclor 1242
11. Aroclor 1248
12. Aroclor 1254
13. 5 samples
14. Evaluation Standard Mix B
15. 5 samples
16. Individual Standard Mix A or B
17. 5 samples
18. Evaluation Standard Mix B
19. 5 samples
20. Individual Standard Mix A or B
21. 5 samples
22. Repeat above sequence must end with the analysis of both Individual Standard Mix A <u>and</u> B regardless of number of samples analyzed

* Individual Standard mix A and B may be one mixture.

** Aroclors 1221 and 1232 must be analyzed at least once per month on each instrument and column.

Table 8.5

Criteria for Isotopic Ratio Measurements for PCDDs and PCDFs

	Selected ions (m/z)	Relative Intensity
PCDDs		
Tetra	320/322	0.65-0.89
Penta	358/356	0.55-0.75
Hexa	392/390	0.69-0.93
Hepta	426/424	0.83-1.12
Octa	458/460	0.75-1.01
PCDFs		
Tetra	304/306	0.65-0.89
Penta	342/340	0.55-0.75
Hexa	376/374	0.69-0.93
Hepta	410/408	0.83-1.12
Octa	442/444	0.75-1.01

9.0 LABORATORY ANALYTICAL PROCEDURES

The laboratory analytical procedures required for the FMPC Work Plan are described in the following sections.

9.1 Chemical Analyses

9.1.1 USEPA approved procedures shall be used for all analyses for which such methods exist. See Table 9.1.

9.1.1.1 For the analysis of groundwater and soil/sediment for HSL and TCL inorganics and organics, the references listed in Section 4.3 will be utilized. See also Section 8.4.

9.1.1.2 For EP Toxicity, TCLP, PCBs, and Herbicides the reference listed in Section 4.3 will be utilized. See also Section 8.4.

9.1.1.3 Physical properties shall also follow the references listed in 4.3 unless there is no procedure listed. Physical properties not found in SW-846 shall be performed in accordance with ASTM procedures. See also Section 8.4.

9.1.1.4 Dioxins/furans shall be analyzed by modified EPA Method 8280. See Section 8.4.

9.1.2 Detection limits

9.1.2.1 The required detection limits for parameters analyzed under CLP protocol shall be less than or equal to those listed in Table 9.2.

9.1.2.2 The required detection limit for parameters analyzed under protocol listed in SW-846 shall be less than or equal to those listed in Table 9.3, except for EP Toxicity and TCLP metals which are analyzed by ICAP (with the exception of Hg) in accordance with Figure 2-6A and 2-6B, Chapter 2, SW-846. The detection limit shall be determined as in Section 8.4.

9.1.2.2.1 The detection limit is not to be confused with the practical quantitation limit, which is highly dependent upon matrix.

9.2 Radiological Analyses

Note: The radiological laboratory subcontractor's SOPs must be approved before work begins. Special attention during the approval process shall be directed to ensuring the compatibility of the SOPs of different laboratory subcontractors so that analytical results will be compatible.

Laboratory SOPs will be prepared, approved and utilized for the following.

9.2.1 For the determination of Gross Alpha and Gross Beta activity.

9.2.2 For the determination of Uranium (Isotopic and Natural) and Thorium (Isotopic, 230, 232) activity, SOP RSL.

9.2.3 For the determination of Total Uranium.

9.2.4 For the determination of Radium (Isotopic, 226, 228) and Actinium (Isotopic, 230, 232) activity.

9.2.5 For the determination of Lead 210 activity.

9.2.6 For the determination of Polonium 210 activity.

9.2.7 Sample prep.

9.2.8 Detection Limits

9.2.8.1 The required detection limits for radiological parameters are listed in Table 9.4.

9.2.8.1.1 The detection limit is not to be confused with the practical quantitation limit, which is highly dependent upon matrix.

Table 9.1

Methods

Parameter	NPDES	RCRA	CLP
Physical Properties			
pH	150.1[1]	9040[1]	---
	-----	9041	---
	-----	9045[2]	---
Inorganics Non-metallics			
Chloride	325.2	9251	---
	325.3*	9252*	---
Cyanide	335.3	9012	---
	335.2	9010	353.2CLPM
Fluoride	340.2	----	---
Nitrogen-NH_3	350.2	----	---
Nitrogen-TKN	351.3	----	---
Nitrogen-NO_3	353.2	9200	---
Nitrogen-NO_2	353.2	----	---
Orthophosphate	365.1	----	---
Orthophosphate	365.3*	----	---
Tl. Phosphorus	365.1	----	---
Tl. Phosphorus	365.3*	----	---
Sulfate	375.2	9036	---
Sulfide	376.1	9030	---
Ion Chromatography	300.0[3]	----	---
Organic			
Organic Carbon	415.2	9060	---
Organic Halides	-----	9020	---
Phenolics (Tl)	420.2	9066	---
	420.1*	9065*	---

Table 9.1

Methods

Parameter	NPDES	RCRA	CLP
Metals			
Aluminum	200.7	6010	200.7CLPM
Antimony	200.7	6010	200.7CLPM
Arsenic	206.2	7060	206.2CLPM
Barium	200.7	6010	200.7CLPM
Beryllium	200.7	6010	200.7CLPM
Boron	200.7	6010	---
Cadmium	200.7	6010	200.7CLPM
Calcium	200.7	6010	200.7CLPM
Chromium	200.7	6010	200.7CLPM
Chromium^{6+}	218.4	7197	---
Cobalt	200.7	6010	200.7CLPM
Copper	200.7	6010	200.7CLPM
Iron	200.7	6010	200.7CLPM
Lead	239.2	7421	239.2CLPM
Lithium	200.7	6010	---
Magnesium	200.7	6010	200.7CLPM
Manganese	200.7	6010	200.7CLPM
Mercury	245.1[1]	7470[1]	245.1CLPM
	245.5[2]	7471[2]	---
Molybdenum	200.7	6010	---
Nickel	200.7	6010	200.7CLPM
Potassium	258.1	7610	258.1CLPM
Selenium	270.2	7740	270.2CLPM
Silver	200.7	6010	200.7CLPM
Sodium	200.7	6010	200.7CLPM
Thallium	279.2	7841	279.2CLPM
Vanadium	200.7	6010	200.7CLPM
Zinc	200.7	6010	200.7CLPM
Characteristics			
Corrosivity	-----	1110	---
Reactivity(CN)	-----	7.3.3.2**	---
Reactivity(S^{2-})	-----	7.3.4.1**	---
EP Toxicity	-----	1310	---
TCLP	-----	----***	---

Table 9.1

Methods

Parameter	NPDES	RCRA	CLP
Organics:			
Volatiles	624	8240	624CLP
Semivolatiles	625	8270	625CLP
Pesticides	608	8080	608CLP
Dioxins/ Dibenzofurans	613	8280	------

Miscellaneous Methods[4]

	ASTM Method
Viscosity	D-445
BTU Content	D-240-76
	D2015-85
Ash Content	D-482
	D-3174-82
Sulfur Content	------

Specific Gravity	D-369-84
	D-70-82

1 - Method for aqueous samples
2 - Method for soils/sediments
3 - Anions included in Ion Chromatography include: Br^-, Cl^-, F^-, I^- and SO_4^{2-}.
4 - ASTM procedures

• Alternate method for use as a secondary
** Section reference (no method number)
*** 40 CFR Part 268, Appendix I

Table 9.2

Metals

Parameter	Contract Required Detection Limit[1] ug/L (water)	mg/kg (soil/sediment)[2]
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1
Cadmium	5	1
Calcium	5000	1000
Chromium	10	2
Cobalt	50	10
Copper	25	5
Iron	100	20
Lead	3	0.6
Magnesium	5000	1000
Manganese	15	3
Mercury	0.2	0.04
Nickel	40	8
Potassium	5000	1000
Selenium	5	1
Silver	10	2
Sodium	5000	1000
Thallium	10	2
Vanadium	50	10
Zinc	20	4
Cyanide	10	2

1 - Higher detection limits may be utilized under the following circumstances:

If the sample concentration exceeds five times the detection limit of the instrument, the value may be reported even though the instrumental detection limit may not equal the contract required detection limit.

2 - Estimated detection limit based on a 1 gram sample diluted to 200 mL.

(continued)

Table 9.2

Organics

Contract Required Quantitation Limits*

Parameter	Quantitation Limits** ug/L (water)	mg/kg (soil/sediment)
Volatiles		
1. chloromethane	10	10
2. bromomethane	10	10
3. vinyl chloride	10	10
4. chloroethane	10	10
5. methylene chloride	5	5
6. acetone	10	10
7. carbon disulfide	5	5
8. 1,1-dichloroethene	5	5
9. 1,1-dichloroethane	5	5
10. 1,2-dichloroethene (tl)	5	5
11. chloroform	5	5
12. 1,2-dichloroethane	5	5
13. 2-butanone	10	10
14. 1,1,1-trichloroethane	5	5
15. carbon tetrachloride	5	5
16. vinyl acetate	10	10
17. bromodichloromethane	5	5
18. 1,2-dichloropropane	5	5
19. cis-1,3-dichloropropene	5	5
20. trichloroethene	5	5
21. dibromochloromethane	5	5
22. 1,1,2-trichloroethane	5	5
23. benzene	5	5
24. trans-1,3-dichloropropene	5	5
25. bromoform	5	5
26. 4-methyl-2-pentanone	10	10
27. 2-hexanone	10	10
28. tetrachloroethene	5	5
29. toluene	5	5
30. 1,1,2,2-tetrachloroethane	5	5

(continued)

Table 9.2

Organics

Contract Required Quantitation Limits*

Parameter	Quantitation Limits** ug/L (water)	mg/kg (soil/sediment)
31. chlorobenzene	5	5
32. ethyl benzene	5	5
33. styrene	5	5
34. xylenes (tl)	5	5
Semivolatiles		
35. phenol	10	330
36. bis(2-chloroethyl)ether	10	330
37. 2-chlorophenol	10	330
38. 1,3-dichlorobenzene	10	330
39. 1,4-dichlorobenzene	10	330
40. benzyl alcohol	10	330
41. 1,2-dichlorobenzene	10	330
42. 2-methylphenol	10	330
43. bis(2-chloroisoprpyl)ether	10	330
44. 4-methylphenol	10	330
45. n-nitroso-di-n-propylamine	10	330
46. hexachloroethane	10	330
47. nitrobenzene	10	330
48. isophorone	10	330
49. 2-nitrophenol	10	330
50. 2,4-dimethylphenol	10	330
51. benzoic acid	50	1600
52. bis(2-chloroethoxy)methane	10	330
53. 2,4-dichlorophenol	10	330
54. 1,2,4-trichlorobenzene	10	330
55. naphthalene	10	330
56. 4-chloroaniline	10	330
57. hexachlorobutadiene	10	330
58. 4-chloro-3-methylphenol	10	330
59. 2-methylnaphthalene	10	330

(continued)

Table 9.2

Organics

Contract Required Quantitation Limits*

Parameter	Quantitation Limits** ug/L (water)	mg/kg (soil/sediment)
60. hexachlorocyclopentadiene	10	330
61. 2,4,6-trichlorophenol	10	330
62. 2,4,5-trichlorophenol	50	1600
63. 2-chloronaphthalene	10	330
64. 2-nitroaniline	50	1600
65. dimethyl phthalate	10	330
66. acenaphthylene	10	330
67. 2,6-dinitrotoluene	10	330
68. 3-nitroaniline	50	1600
69. acenaphthene	10	330
70. 2,4-dinitrophenol	50	1600
71. 4-nitrophenol	50	1600
72. dibenzofuran	10	330
73. 2,4-dinitrotoluene	10	330
74. diethylphthlate	10	330
75. 4-chlorophenyl-phenylether	10	330
76. fluorene	10	330
77. 4-nitroaniline	50	1600
78. 4,6-dinitro-2-methylphenol	50	1600
79. n-nitrosodiphenylamine	10	330
80. 4-bromophenyl-phenylether	10	330
81. hexachlorobenzene	10	330
82. pentachlorophenol	50	1600
83. phenanthrene	10	330
84. anthracene	10	330
85. di-n-butylphthlate	10	330
86. fluoranthene	10	330
87. pyrene	10	330
88. butylbenzylphthlate	10	330
89. 3,3'-dichlorobenzidine	20	660
90. benzo(a)anthracene	10	330
91. chrysene	10	330

(continued)

Table 9.2

Organics

Contract Required Quantitation Limits*

Parameter	Quantitation Limits** ug/L (water)	mg/kg (soil/sediment)
92. bis(2-ethylhexyl)phthlate	10	330
93. di-n-octylphthlate	10	330
94. benzo(b)fluoranthene	10	330
95. benzo(k)fluoranthene	10	330
96. benzo(a)pyrene	10	330
97. indeno(1,2,3-cd)pyrene	10	330
98. dibenzo(a,h)anthracene	10	330
99. benzo(g,h,i)perylene	10	330
Pesticides/PCBs		
100. a-BHC	0.05	8.0
101. b-BHC	0.05	8.0
102. d-BHC	0.05	8.0
103. g-BHC	0.05	8.0
104. heptachlor	0.05	8.0
105. aldrin	0.05	8.0
106. heptachlor epoxide	0.05	8.0
107. endosulfan I	0.05	8.0
108. dieldrin	0.10	16.0
109. 4,4'-DDE	0.10	16.0
110. endrin	0.10	16.0
111. endosulfan II	0.10	16.0
112. 4,4'-DDD	0.10	16.0
113. endosulfan sulfate	0.10	16.0
114. 4,4'-DDT	0.10	16.0
115. methoxychlor	0.50	80.0
116. endrin ketone	0.10	16.0
117. a-chlordane	0.50	80.0
118. g-chlordane	0.50	80.0
119. toxaphene	1.00	160.0
120. Aroclor 1016	0.50	80.0

(continued)

Table 9.2

Organics

Contract Required Quantitation Limits*

Parameter	Quantitation Limits** ug/L (water)	mg/kg (soil/sediment)
121. Aroclor 1221	0.50	80.0
122. Aroclor 1232	0.50	80.0
123. Aroclor 1242	0.50	80.0
124. Aroclor 1248	0.50	80.0
125. Aroclor 1254	1.00	160.0
126. Aroclor 1260	1.00	160.0

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

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits based on dry weight as required, will be higher.

Table 9.3

Ground Water Monitoring Detection Limit[1]

Parameter	ug/L (water)
Metals[2]	
Cadmium	2
Anions	
Bromide	1000
Chloride	1000
Cyanide	10
Fluoride	1000
Ammonia-Nitrogen	300
Nitrate-Nitrogen	300
Nitrite-Nitrogen	300
Phenolics	50
POC	10
POX	5
Sulfate	1000
Sulfide	1000
TOC	1000
TOX	5
Organics	
Dioxins/Dibenzofurans	10 ppt per congener
Volatile Organic Compounds	10 ug/L (nominal)
Semivolatile Compounds	20 ug/L (nominal)

1 - Specific quantitation limits are highly matrix dependent. The detection limits listed are not always achievable.

2 - Other metals detection limits for water are identical to those listed in Table 7.1

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Table 9.4

Matrix	LLD (All Isotopes)
Air	1 pCi/mL
Sludge	1 pCi/g
Soil	1 pCi/g
Water	1 pCi/L
Urine	1 ug/L*
Fecal	1 ug/sample*

* Bioassay samples shall be analyzed for total Uranium.

Table 9.5

Holding Times

CLP Inorganics[1]:

Mercury: 26 days VTSR[2] for soil and water
Cyanide: 12 days VTSR[2] for soil and water
All other metals: 180 days VTSR[2] for soil and water

CLP Organics[3]:

Volatiles: 10 days VTSR[2] for soil and water
Base Neutral/Acid Extractable:
Extraction: 5 days for water; 10 days for soil[2]
Analysis: 40 days from extraction for soil and water
Pesticides/PCBs: Same as for BNAE

Table 9.5

Holding Times

Name	Maximum Holding Time
SW-846 Methods (RCRA):	
Physical Properties	
pH	Analyze immediately
Inorganic Non-metallics	
Chloride	28 days
Cyanide	14 days
Nitrogen-NO_3/NO_2	28 days
Sulfate	28 days
Sulfide	7 days
IC	
Bromide	28 days
Chloride	28 days
Fluoride	28 days
Iodide	28 days
Sulfate	28 days
Organic	
Organic Carbon	28 days
Organic Halides	28 days
Phenolics	28 days
Metals	
Hexavalent Chromium	24 hours
Mercury	28 days
All other metals	6 months

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Table 9.5

Holding Times

Name	Maximum Holding Time
SW-846 Methods (RCRA):	
Organics	
Volatiles	14 days[4]
Base Neutral/Acid Extractable	7 days until extraction 40 days after extraction
Pesticides/PCBs	7 days until extraction 40 days after extraction
Dioxins/Dibenzofurans	7 days until extraction 40 days after extraction

600/4-79-020 Methods (NPDES):

Name	Maximum Holding Time
Physical Properties	
pH	Analyze immediately
Inorganics, Non-metallics	
Chloride	28 days
Cyanide	14 days
Fluoride	28 days
Nitrogen-NH_3	28 days
Nitrogen-TKN	28 days
Nitrogen-NO_3	28 days
Nitrogen-NO_2	28 days
Orthophosphate-P	48 hours
Total Phosphorus	28 days
Sulfate	28 days
Sulfide	7 days

Table 9.5

Holding Times

Name	Maximum Holding Time
600/4-79-020 Methods (NPDES):	
IC	
Bromide	28 days
Chloride	28 days
Fluoride	28 days
Iodide	28 days
Sulfate	28 days
Organics	
Total Organic Carbon	28 days
Total Phenolics	28 days
Metals	
Hexavalent Chromium	24 hours
Mercury	28 days
All other metals	6 months

1 - SOW 7/88
2 - Validated Time of Sample Receipt
3 - SOW 2/88
4 - Preserved with HCl to a pH of less than 2.

10.0 DATA REDUCTION, VALIDATION, AND REPORTING

The following procedures summarize the practices to be routinely used by the laboratory for data reduction, validation, and reporting. Numerical analysis, including manual calculations, mapping, and computer modeling will be documented and subjected to quality control review and peer review. Records of numerical analyses will be legible and complete enough to permit reconstruction of the work by a qualified individual other than the originator. The Data Management Plan is presented in Volume IV of the Work Plan. The Data Validation Program is described in Appendix A of this QAPP.

10.1 LABORATORY DATA REDUCTION SCHEME

10.1.1 Analytical

10.1.1.1 Analysis-specific calculations may be found in the individual laboratory SOPs. SOPs will reference appropriate regulatory requirements, including calculations.

10.1.1.2 Data is reduced from raw instrumental data to the final data package or Certificate of Analysis by the following process:

10.1.1.2.1 Data is generated for a particular sample on the analytical instrument. For a sample that has several analytes for which to be analyzed, this process of acquisition is performed for every analyte, unless several analytes can be

performed at the same time (e.g., metals by ICAP).

10.1.1.2.2 For a particular group of analytes (eg., metals), raw data generated for a particular sample is then gathered. In this example raw data from ICAP, graphite furnace, flame AA, and cold vapor analyses for a particular sample are utilized to generate results sheets which list all results of analytes requested for that sample.

10.1.1.2.3 Results sheets are then gathered from all sections (Metals, Wet Chemistry, GC, and GCMS), where applicable, and forwarded to the Laboratory Project Manager, who compiles them to generate Certificates of Analysis.

10.1.1.2.4 The steps in 10.1.1.2.1 through 10.1.1.2.3 may be combined or broken down further and are for illustrative purposes only.

10.1.1.2.5 Section 10.1.1.2.3 does not apply to CLP packages. These packages are generated in the individual sections and are

then forwarded complete to the Project Manager, who generates case narratives utilizing data submitted.

10.1.1.2.6 The Laboratory Project Manager is responsible for generation of the Certificate of Analysis and Case Narratives for CLP data packages.

10.1.1.2.7 Filing management of records will be in accordance with the guidelines in the individual laboratory SOPs.

10.1.2 Radiological

10.1.2.1 Analysis-specific calculations may be found in the individual laboratory SOPs.

10.1.2.2 Data is reduced from raw instrumental data to the final data package or Certificate of Analysis by the following process:

10.1.2.2.1 Data is generated for a particular sample by one or more instruments depending on the analyses required.

10.1.2.2.2 Raw data from each analysis is used to generate a result sheet.

10.1.2.2.3 Result sheets are forwarded to the Laboratory Project Manager who assembles results

for all analyses for each sample.

10.1.2.2.4 Assembled results are forwarded to the Database Manager who supervises the entry of results onto the computer database. Certificates of Analysis are generated from this database.

10.1.2.2.5 Filing and management of records will be in accordance with the guidelines in the individual laboratory SOPs.

10.2 LABORATORY DATA VERIFICATION

10.2.1 Data verification procedures for the laboratories are found in applicable SOPs. Laboratories are responsible for precision, accuracy, and completeness of packages as they pertain to individual data packages.

10.2.2 The principle criteria used to verify data, and to identify outliers for both laboratories are those given in Section 14.0 of this QAPP.

10.2.4 The laboratory will maintain at its facility, the complete CLP documentation package for all samples as described in SOW 7/88 for inorganics and SOW 2/88 for organics.

10.2.5 Non-CLP analysis shall include at least the following documentation:

* Internal Chain-of-Custody
* Original COC

* Original RFA
* Log book records
* Copy of final internal raw summary sheets from which data is entered
* Information needed to quantify results: blanks, standards values, continuing calibration checks, and raw sample responses
* Reconstructed Ion Chromatogram (RIC)
* Identified compound mass spectra
* Internal detail documentation supporting internal quality assurance and assessment of precision and accuracy, e.g., replicates, duplicates, matrix spike, matrix spike duplicates, trip blanks, and method blanks.

10.3 LABORATORY REPORTING

10.3.1 Raw data is processed as in Section 8.1.

10.3.2 A Certificate of Analysis is generated from the steps outlined in Section 8.1. and contains information about analytical tests performed, date and condition of sample received, results, methodology, and quality of data reported.

10.3.3 The EDT (Electronic Data Transfer) is generated from the Certificate of Analysis or CLP result forms. The data entered is reviewed for accuracy by a person other than the one responsible for entering the data.

10.4 FIELD DATA VALIDATION

Field data generated in accordance with the project-specific work plan will primarily consist of radiological screening data, field temperature, pH, and specific conductance data, and data associated with soil boring advancement, monitoring well installation and development, and geophysical logging and soil classification. This data will be validated by review of the project documentation. The review process is described in Appendix A of this QAPP.

10.5 ENGINEERING ANALYSIS AND CALCULATIONS

Analysis activities performed in the office shall be completely documented and the resulting documentation formally checked.

10.5.1 NUMERICAL ANALYSIS PROCEDURES

Analysis activities shall be performed in a planned and controlled manner. Performance responsibility rests with the Deputy Director/Technical. Prior to initiating the activities, the Deputy Director/Technical shall discuss the scope of the work, contractual and regulatory requirements, and applicable QA/QC procedures with assigned personnel. Applicable QA/QC Procedures review, will be done by the QA Officer.

To provide evidence of satisfactory work performance and the basis for information transmitted externally, analyses and their results shall be completely documented. Documentation may include calculations, computer programs, logs, drawings, and tables.

10.5.1.1 Calculations

Calculations shall be legible and in a form suitable for reproduction, filing, and retrieval. Documentation shall be sufficient to permit a technically qualified individual to review and understand the calculations and verify the results.

Calculations shall be performed on standard calculation paper whenever possible. All calculation pages shall be individually identified, with the exception of large computer output. Calculation paper provides spaces for the originator's name and date of work, the checker's name and date, calculation subject, project number, and page number. All of this information shall be completed for each page. For extra pages, such as large graphs, this information shall also be included. Calculations should, as appropriate, include a statement of calculation intent, description of methodology used, assumptions and their justification, input data and equation references, numerical calculations including units, and results. Input data may include:

- Regulatory requirements;
- Performance and operational

requirements under various conditions;
- Material, geological, environmental, and geotechnical requirements;
- Results of field and laboratory testing or calculations; and
- Information obtained from external personnel or literature and site data surveys.

Computer printout that becomes an integral part of the calculations shall be references in the calculations by run number or other unique means of identification.

At the end of calculations, the results should be summarized if this will provide clarity.

10.5.1.2 Computer Programs

Computer programs used for analysis and graphic display of project results shall be documented and verified in accordance with applicable requirements. Computer output shall be dated and clearly identified as to contents. Large sets of output shall be labeled with project name and number, program used, analysis title, and the user's name.

10.5.1.3 Logs, Drawings, and Tables

The results of analysis activities may be presented in logs (e.g., subsurface soil

logs), drawings, and tables of various forms. The format of logs and tables shall be governed by the information to be presented. Drawings shall be uniquely identified by drawing or figure number and appropriate title. Standardized symbols and nationally accepted drafting standards shall be used. References to other drawings and sources of information shall be provided as necessary.

Drawings shall be signed and a dated by the draftsperson performing the work and the responsible member of the project group who has checked the drawing. For drawings produced by the computer assisted drafting (CAD), a file copy of drawing print will be used to record these signatures, and the names of the signatories will be printed and the drawing by the CAD process. Revisions shall be noted on the drawing original (file copy of CAD drawings) with a revision number and a brief note describing each revision. The note shall be signed and dated by the draftsperson performing the work and the responsible member of the project group who has checked the revision.

Indication of final drawing and revision approval shall be through signing and dating of the drawing original or CAD file copy by the project director or a member of the project staff delegated this responsibility by the project director. Approval does not indicate checking, but only approval for issue. Drawings are not issued without completion of the checking cycle as evidenced by the checker's signature.

10.5.2 Analysis verification

Calculations, computer program input, logs, drawings, and tables shall be formally checked using the standard process outlined in the following sections.

10.5.2.1 Calculations

For calculations, assignments for checking shall be made or approved by the project director. Verification shall be performed by an individual(s) other than the person(s) who performed the original work or specified the method or input parameters to be used. The individual(s) selected shall have technical expertise in the calculation subject.

It is emphasized that a numerical check is not sufficient. The checker is responsible for every item on every sheet--including the completion of the title block and page numbers. To properly check calculations:

- The originator supplies the designated checker with a machine copy of the calculations. Originals should not leave the originator's possession until they are ready for final checker signing. Laboratory-Specific Attachments and Standard Operating Procedures may provide for the checker to make his checks on the original.

- The checker marks the calculation copy with a yellow marker for all items approved.

- If the checker disagrees, for any reason, the checker crosses through the item with a red marker and writes the recommended correction or comment above it.

- The checker initials and dates all pages of the checkprints.

- The checker returns the checkprints to the originator who, in turn, reviews all recommended changes. If a disagreement exists, the originator adds comments to the checkprints using a third color and then confers with the checker until all differences are resolved.

- The originator corrects the calculation originals so they agree

with the checkprints. A one-to-one correspondence between the originals and checkprints must exist.

- The originator gives the originals and checkprints to the checker who compares them to verify agreed-to corrections have been made.

- When the checker is satisfied, he signs and dates the originals.

10.5.2.2 Procedures for Data Entry and Verification

The following procedures apply to all scientific and technical information entered to the Fernald Information System for use in the Remedial Investigation/Feasibility Study.

10.5.2.2.1 **MANUAL DATA ENTRY**

All information contained on field data collection forms as identified by the on-site QA officer are to be forwarded to the data entry staff subsequent to documented field QA procedure. The data are to be manually entered via keyboard to the designated master database computer. Access to the master database will be governed by system security procedures.

The initial entry of each data element is termed "first key". All first keyed data will be rekeyed by an individual other

than the person performing the first key. Exception may be made in those cases where sufficient time has elapsed between entries to preclude re-entry by memory. In such cases, elapsed time should be at least two weeks.

System software will, as a series of screen prompts, flag any differences in any character between the first key and second key. At that time, a choice must be made between the two entries. Questions about the choic should be referred to the Data Entry Coordinator. Where questions persist, the form is to be returned to the appropriate field team for clarification.

10.5.2.2.2 **LOCATION COORDINATES/ ELEVATIONS**

Location identification for all data shall be by State Planner Coordinates. This applies to all sample collection locations and all well locations. Elevation data shall be reported relative to Mean Sea Level.

All elevation or coordinates data shall be derived from the official survey data maintained as part of the official

Project record. This information is entered to the master database from the survey records after their check according to documented quality assurance procedures for that activity. Incoming survey sheets, whether containing new data or corrections, must be forwarded to the Data Entry Coordinator for doublekey entry and manual verification as in Section 4.0 below.

10.5.2.2.3 **MANUAL VERIFICATION**

All data entered by keyboard will be manually verified. This will be accomplished by comparing a system-generated hardcopy report to the original field form. In all cases, the system-generated report used for manual verification will mimic the field form as closely as possible and will state the page number of the field form to which it corresponds. Exception is made in the case of radiation survey data due to the field form design and to internal programs necessary to uniquely identify each reading per a given set of coordinates. Special instructions as attached are to be provided to each person manually verifying those data.

In all cases, each data element as checked against the field form will be marked on the system-generated form with a check mark if correct. If incorrect, the error will be noted on the system-generated report and on the Error Computation form (example format attached). Both will be forwarded to the Data Entry Coordinator. Where the error is due to keypunch, the Data Entry Coordinator will make the appropriate correction. Where the error results from inaccuracy or omission on the field form itself, the Data Entry Coordinator will contact the appropriate field personnel to correct and document the change on the field form. The appropriate correction will then be made to the master database. System software provides for an automatic date and initial record of any changes made after first or second key.

10.5.2.2.4 **VERIFICATION DOCUMENTATION**

All forms submitted for data entry are to be stamped with a place for the initials and date of each person performing first key, second key and manual verification.

In addition, both a full signature and printed name are required of the individual performing manual verification for each page of field form entered to the system.

The system-generated report used for manual verification, the original copy of the error computation form, and the manual verification affidavit are to be maintained in the master on-site hardcopy project files along with the original field forms.

10.5.2.3 Drawings

Drawings shall be checked like calculations (Section 10.5.2.1) using yellow and red markers. Checkprints of the same drawing shall be marked CP1, CP2, etc., to show progression of the checking process.

If a drawing is revised, the entire checking process shall be repeated for the revised areas only. A new checkprint shall be prepared. Under no circumstances shall revisions be made without the formal checking procedure.

10.5.2.4 Logs and Tables

Final subsurface logs shall be verified by the responsible member of the project group. The verification shall provide that changes from the original field representative's logs to the final log sheets are consistent with the results of the laboratory testing or other investigations. The final log sheets shall be checked in the same manner as all calculations or drawings, with the checker signing and dating all checkprints.

In addition, all final tables presenting information, data, or the results of analyses shall be checked using the standard process (Section 10.5.2.1). Checkprints of the same table shall be marked CP1, CP2, etc., to show progression of the checking process.

INSTRUCTIONS AND TEMPLATE FOR MANUALLY VERIFYING RADIATION MEASUREMENTS: WALKOVER DATA

YOU WILL BE GIVEN A COMPUTER PRINT-OUT CONTAINING RAD MEASUREMENTS WALKOVER DATA DISPLAYED DIFFERENTLY FROM THE FIELD FORMS THAT WERE USED TO RECORD THE DATA ORIGINALLY. EACH FIELD FORM HAS ITS OWN UNIQUE PAGE NUMBER. IT WILL CORRESPOND TO PAGE NUMBER UNDER THE TITLE ON THE COMPUTER PRINT-OUT. MAKE SURE THEY MATCH.

EACH FIELD FORM CONTAINS A GRID OF 16 CELLS. THIS SQUARE REPRESENTS A 100 FT AREA OF THE FMPC. THE COMPUTER HAS ASSIGNED A CODE TO EACH 100 FT GRID AND TO EACH OF THE 16 CELLS WITHIN IT. THE FIRST FOUR CHARACTERS REFER TO THE 100 FOOT GRID. THESE WILL BE FOLLOWED BY A HYPHEN FOLLOWED BY A 2-DIGIT CODE. THE 2-DIGIT CODE CORRESPONDS TO THE 16 CELLS. THE ORDER IN WHICH THEY ARE REPRESENTED IS GIVEN IN THE FOLLOWING DIAGRAM.

-13	-14	-15	-16
-09	-10	-11	-12
-05	-06	-07	-08
-01	-02	-03	-04

CHECK THE READING(S) FOR EACH CELL ON THE FIELD FORMS BY THE CODE ON THE COMPUTER PRINT-OUT IN THE ORDER SHOWN IN THE DIAGRAM.

COMPARE ALL OTHER DATA AS GIVEN ON BOTH SHEETS. PLACE A CHECK BY EACH AND EVERY DATA ELEMENT.

COMPLETE A SIGNATURE RECORD FOR EVERY SHEET THAT YOU VERIFY.

RI/FS ERROR COMPUTATION
ALL UNITS IN SINGLE KEY STROKES

PAGE ____ OF ____

DATA CATEGORY_____

TYPE OF FIELD FORM_____

SAMPLE

COMPLETED BY_____

DATE_____

PAGE NO.	GRID I.D.	CHARACTERS PER PAGE	DATA ENTRY ERRORS	??????? ERRORS	TOTAL ERRORS	COMMENTS
1						
2						
3						
4						
5						
6						
7	D781	393	0	0	0	
8	D671	408	0	0	0	
9						
10						
TOTALS						

5195

ATTACHMENT #1
SECTION 10.0
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11.0 INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

Internal QC checks are performed to verify the resulting quality of the measurement tasks of the field and laboratory investigation and associated tasks.

11.1 TRAINING

Training requirements are described in Section 3.1.

11.2 PROCUREMENT/CONTROL OF SUBCONTRACTORS

Requirements for Procurement/Control are described in Section 3.2.

11.3 QUALITY ASSURANCE REVIEW OF REPORTS, PLANS, AND SPECIFICATIONS

Requirements for QA review of reports, plans and specifications are addressed in Sections 3.3 and 15.0

11.4 QUALITY CONTROL CHECKS AND PROCEDURES

This section describes the QC operations that must be performed to satisfy the analytical requirements of the contract. All QC operations for samples analyzed in accordance with the USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, 7/88 and the USEPA Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, 2/88 shall follow the QC requirements listed in Sections 11.4.1 and 11.4.2. Radiological QC requirements are described in approved laboratory manuals, procedures, and SOPs.

Analyses performed under SW-846, Test Methods for Evaluating Solid Waste shall conform to guidelines established in Section 8.

11.4.1 INORGANIC QUALITY CONTROL

QC procedures have already been described with the appropriate analytical procedures listed in Section 9.0. The purpose of this section is to augment those QC procedures and to summarize the minimum requirements for inorganic analysis.

Accordingly, the following QC operations must be performed for analysis of samples under the SOW 7/88:

- Initial calibration;
- Initial calibration verification (ICV);
- Continuing calibration verification (CCV);
- Initial calibration blank (ICB);
- Continuing calibration blank (CCB);
- Preparation (method) blank;
- ICP interference check sample;
- ICP serial dilution;
- Matrix spike (preparation);
- Duplicate sample (preparation);
- Analytical (instrumental spike) graphite furnace;
- Method of standard additions (MSA);
- Laboratory control samples;

11.4.1.1 Initial Calibration

For atomic absorption systems, calibration (working) standards are prepared fresh each time an analysis is to be made. The instrument is calibrated with at least three standards and a blank. For atomic absorption, one calibration standard must be at the contract required detection limit (CRDL), with the exception of mercury. The calibration standards must be prepared using the same types and concentrations of acids used in the preparation of samples. The instrument is calibrated by aspirating the standards

starting with the blank, in order of concentration (lower concentrations are aspirated first.

Cyanide, calibration shall be 3 standards and a blank, with one standard at the CRDL.

ICP analyses shall be calibrated in accordance with manufacturer's instructions and shall have one standard analyzed at two times the CRDL which must be run at the beginning and end of a run or every 8 hours, whichever is more frequent.

11.4.1.2 Initial Calibration Verification (ICV)

After the systems listed above have been calibrated, the accuracy of the calibrations are verified and documented for every analyte through the analysis of USEPA solutions, NIST SRMs, certified or primary standards. These solutions have known concentrations which are used to verify the calibration of the instrument. If the EPA, NIST, or certified or primary standard are not available, calibrations shall be verified through an independently prepared solution from a source differing from that used to calibrate the instrument.

If the (ICV) recovery is not within the limits set in Table 8.1, the analysis shall be terminated, the problem corrected, the instrument recalibrated, and the calibration reverified. The ICV must be run for each wavelength used for analysis.

11.4.1.3 Continuing Calibration Verification (CCV)

To ensure calibration accuracy during analytical runs, one of the following standards is to be used for continuing calibration:

- USEPA solutions;
- NIST SRMs;
- A laboratory-prepared standard solution.

This standard must be analyzed at every wavelength used for analysis at a frequency of 10% (every 10 samples) or every 2 hours during an analytical run, whichever is more frequent. It must be run before sample analysis (after ICV) and at the end of the analytical run and must be at or near the mid-range levels of the calibration curve.

If the CCV recovery is not within the limits established in Table 8.1, the instrument must be recalibrated and the preceding 10 analytical samples or all analytical samples analyzed since the last CCV meeting requirements must be reanalyzed.

11.4.1.4 Calibration Blank (ICB/CCB)

A calibration blank (acid blank) is analyzed each time the instrument is calibrated (part of the calibration curve), at the beginning (ICB) and end of a run, and for every 10 samples analyzed (CCB). If the absolute value of the ICB exceeds the CRDLs listed in Table 9.2, the analysis must be terminated, the

problem corrected, the instrument recalibrated, and the ICB reanalyzed. If the CCB exceeds the CRDLs listed in Table 9.2, the analysis must be terminated, the problem corrected, the instrument recalibrated, and all samples analyzed since the last CCB meeting requirements must be reanalyzed.

11.4.1.5 Preparation (Method) Blank

At least one preparation (method) blank must be analyzed during an analytical run. The preparation blank consists of deionized waterprocessed through the entire sample preparation procedure. The frequency of preparation blank shall be one per twenty per matrix analyzed or every time samples are prepared, whichever is more frequent. The preparation blank is used to ascertain whether sample concentrations reflect contamination in the following manner:

- If the absolute value of the concentration of the blank is ≤CRDL, no correction of the sample result is performed.
- If any analyte concentration is present in the preparation blank above the CRDL, then the lowest concentration for that analyte in any of the associated samples must be ten times (10X) the concentration of that in the blank. Otherwise, all samples associated with that blank with a concentration of less than ten times (10X) the amount present in the preparation blank must be redigested and reanalyzed. Under no circumstances is the sample concentration to be corrected for the blank value.
- If the concentration of the blank is below the negative CRDL, then all samples reported below 10X CRDL associated with that blank must be redigested and reanalyzed.

11.4.1.6 ICP Interference Check Sample Analysis

To verify interelement and background correction factors, an ICP Interference Check Sample (ICS) must be run at the beginning and end of an analytical run or twice every 8 hours, whichever is more frequent. The ICS consists of two solutions: Solution A (ICS-A) and ICS-AB. Solution A consists of the interferents, and Solution AB consists of analytes mixed with the interferents. The ICS run consists of running both solutions consecutively, (with A first) at every wavelength used for analysis. The results of the ICS must fall within the limits of ±20%. If not, terminate the analysis, correct the problem, recalibrate the instrument, and reanalyze all samples analyzed since the last ICS meeting the requirements. The amount of analyte and interferent is given on page E-9 of the Statement of Work.

11.4.1.7 ICP Serial Dilution Analysis

Prior to reporting concentration data for the analyte elements, the laboratory must analyze and report results of the ICP Serial Dilution Analysis. This analysis must be performed on a sample from each matrix for every twenty samples analyzed or for every 14 day period, whichever is more frequent. If the analyte in the sample is sufficiently high minimally a factor of 50 above the IDL in the original sample, the results of a 5-fold dilution of the sample should agree within 10% of the original determination after correction for dilution. If the results do not agree within 10%, a chemical or physical interferent must be suspected, and the data for all affected analytes in the samples received associated with that serial dilution must be flagged "E".

11.4.1.8 Matrix Spike Analysis

The spiked sample is designed to provide information about the effect of the sample matrix on the digestion and measurement methodology. The spike is added before the digestion and prior to any distillation steps (i.e., CN). The frequency of matrix spike is one per twenty per matrix or every 14 days, whichever is more frequent. Samples identified as field blanks may not be used for the matrix spike sample. The amount of analyte to be spiked is given on page E-11 of the Statement of Work. If two analytical methods are used to obtain the reported values for the same element, then spike samples must be run by each method used. If the spike recovery is not within 75-125% recovery, the analyte is flagged "N" and an instrumental spike must be run on the sample for that element if the method used is AA, ICP, or CN. The 75-125% criteria does not apply to silver or to samples that have an analyte concentration in excess of 4 times the spike concentration and shall be reported unflagged. The equation for determining the spike recovery is given on page E-10 of the Statement of Work.

11.4.1.9 Duplicate Sample Analysis

The frequency of duplicate analysis is one duplicate per twenty per matrix or every 14 days, whichever is more frequent. Samples identified as field blanks may not be used for duplicate analysis. If two analytical methods are used for the same element, then duplicate analyses must be run by each method used. The RPD is generated by using the equation on page E-12 of the Statement of Work.

11.4.1.10 Graphite Furnace Analysis

Graphite furnace shall require that all samples, spikes, standards, and blanks have duplicate injections performed. Instrumental spikes shall be performed on all samples but the matrix spikes and the calibration verifications and calibration blanks. Instrumental spikes shall be at two times the CRDL given in Table 9.2. Analysis shall proceed in accordance with the flow chart on page E-15 of the Statement of Work. For concentrations greater than the CRDL, duplicate injections shall agree within 20% or they shall be repeated. If still out on reinjection, flag "M". The "M" flag applies to the instrumental spike also. If the preparation blank analytical spike recovery is not within 85-115%, the spiking solution must be verified by respiking and rerunning the blank once. If the recovery is still out, correct the problem and reanalyze all analytical samples associated with that blank. An analytical spike is not required on the predigestion spike.

The following spiking scheme will determine how the furnace analyte is quantified:

1) If the spike recovery is less than 40%, the sample must be diluted and rerun with another spike. Dilute the sample by a factor of 5-10 and reanalyze. If, after dilution, the spike result is still <40%, report data and flag with an "E".

2) If the spike recovery is greater than or equal to 40% and the sample absorbance is less than 50% of the spike absorbance, report results to the IDL. If the spike recovery is less than 85 or greater than 115%, flag the data "W".

3) If the sample absorbance is greater than 50% of the spike absorbance and the spike recovery is between 85-115% recovery, report the results to the IDL.

4) If the sample absorbance is greater than or equal

to 50% of the spike and the spike recovery less than 85% or greater than 115%, the sample must be run by the Method of Standard Additions (MSA).

11.4.1.11 Method of Standard Additions

The Method of Standard Additions (MSA) shall be performed if the criteria in 4) above are met. The following additional requirements are to be met when performing MSA:

1) Data from the MSA must be within calibration range.

2) The sample and three spikes must be analyzed consecutively. Only single injections are required.

3) Spikes must be prepared such that spike 1 is approximately 50% of sample absorbance; spike 2 is approximately 100% of sample absorbance; and spike 3 is approximately 150% of sample absorbance.

4) MSAs must be clearly identified in the raw data documentation. Reported values obtained from MSA must be flagged "S" if the correlation coefficient is 0.995 or above.

5) If the correlation coefficient is less than 0.995, the analysis must be repeated once. If still out, use the run with the best MSA and flag data "+".

6) The LCS for graphite furnace shall not be analyzed by MSA.

11.4.1.12 Laboratory Control Samples

Laboratory Control Samples (LCS) are analyzed at a frequency of one per twenty per matrix or every time samples are analyzed, whichever is more frequent. The LCS may be obtained from the EPA or from companies having certified reference standards or they may be prepared from NIST standards. If the percent recovery of the LCS does not fall between 80 and 120% (except for antimony and silver)the analysis must be terminated, the problem corrected, and the samples associated with that LCS for that

analyte must be redigested and reanalyzed. For cyanide analysis, the distilled mid-range calibration standard may be used as the aqueous LCS. An LCS is not required for mercury. The concentration of an analyte in the LCS by Graphite Furnace must not be quantified by MSA.

11.4.2 ORGANIC QUALITY CONTROL

The following section summarize the QC requirements described in Exhibit E of the reference cited in Section 9 for analysis by GCMS and GC. Specifically, the following QC operations must be performed:

- Tuning and GCMS mass calibration;
- Calibration of the GCMS system;
- Continuing calibration of the GCMS system;
- Preparation (method) blank analysis;
- Surrogate spike analysis;
- Matrix/matrix spike analysis;
- Pesticide/PCB requirements.

11.4.2.1 Tuning and GCMS Mass Calibration

Prior to initiating data collection, the GCMS must be tuned to meet the mass spectral abundance criteria. This is accomplished through the use of DFTPP for semivolatiles and BFB for volatiles.

Decafluorotriphenylphosphine (DFTPP)

Each GCMS used for the analysis of semivolatiles or pesticide/PCB compounds must be hardware tuned to meet the abundance requirements listed in Table 8.3 for a 50 nanogram injection of DFTPP. This standard may be analyzed separately or as part of a calibration standard. The criteria must be demonstrated daily or for every 12 hour period, whichever is more frequent, and before samples are analyzed. Background subtraction should be straightforward and designed only to eliminate column bleed or

instrument background ions. Background subtraction actions resulting in spectral distortions for the sole purpose of meeting method specifications are contrary to QA objectives and are unacceptable. Instrument conditions during tuning must be consistent with those used in sample analysis. The exception is that temperature programs may vary.

Bromofluorobenzene (BFB)

Each GCMS system used for the analysis of volatiles must be hardware tuned to meet the abundance requirements listed in Table 8.2 for a maximum of 50 nanogram injection of BFB. These criteria must be demonstrated daily or for every 12 hour period, whichever is more frequent. Background subtraction should be straightforward and designed only to eliminate column bleed or instrument background ions. Background subtraction actions resulting in spectral distortions for the sole purpose of meeting method specifications are contrary to the objectives of QA and are unacceptable. Instrument conditions during tuning must be consistent with those used in sample analysis. The exception is that temperature programs may vary.

Documentation of the mass calibration shall be in the form of a bar graph spectrum and as a mass listing.

11.4.2.2 Calibration of the GCMS System

Prior to the analysis of samples and after tuning criteria have been met, the GCMS system must be initially calibrated at a minimum of 5 concentrations to determine the linearity of the response. Typical linear ranges are: 0 to 400 nanograms (ng) for base neutrals, 0 to 1000 ng for phenols, and 0 to 100 ng for volatiles. Once the system has been calibrated, the calibration must be reverified every 12 hours or daily, whichever is more frequent.

Volatiles

Initial calibration of volatiles is required at 20, 50, 100, 150,and 200 µg/L. Surrogate and internal standards shall be used with each calibration standard. If an analyte saturates the system at 200 µg/L and the GCMS is calibrated to achieve a detection sensitivity of no less than 5 µg/L, the laboratory must document this on Form VI and proceed with a 4 point calibration for that specific analyte. Secondary ion quantification is permissible only when there are sample interferences present with the primary ion. Analyze all method blanks and standards under the same conditions as the samples. Analyze each calibration standard and tabulate the area of the primary characteristic ion against concentration for each compound including all contract required surrogate compounds. The relative retention times of each compound in each calibration run should agree within 0.06 relative retention time units.

Semivolatiles

Initial calibration is required at 20, 50, 80, 120, and 160 totaling. If an analyte saturates the system at the 160 ng level and the system is calibrated to achieve a detection sensitivity of no less than the CRQL, the laboratory must document this on form VI and proceed with a 4 point curve for that analyte. The use of secondary ion for quantification is allowed when there are sample interferences with the primary ion. Nine compounds require only a 4 point initial calibration: benzoic acid, 2,4-dinitrophenol, 2,4,5-trichlorophenol, 2-nitroaniline, 3-nitroaniline, 4-nitroaniline, 4-nitrophenol, 4,6-dinitro-2-methylphenol, and penta-chlorophenol. Analyze all method blanks and standards under the same conditions as the samples. Analyze each calibration standard and tabulate the area of the primary characteristic ion against concentration for each compound including all contract required surrogate compounds. The

relative retention times of each compound in each calibration run should agree within 0.06 relative retention time units.

Response Factor (RF) Calibration

Using Table 2.1, page E-14/VOA or Table 2.2, page E-33/SV of the Statement of Work, calculate the RF for each compound at each concentration level using Equation 1 on page D-21/VOA for volatiles and Equation 1 on page D-33/SV for semivolatiles in the Statement of Work.

Using the RF from the initial calibration, calculate the percent relative standard deviation for compounds listed as calibration check compounds (CCCs) (Sections 8.4.3.2.4 and 8.4.3.3.4.) using the equation in Section 5.3.4 on page D-21/VOA of the Statement of Work.

The relative percent standard deviation for each individual calibration check compound must be less than 30%. This criteria must be met for the initial calibration to be valid.

A system performance check compound must be performed to check that the minimum response factors are met before the calibration is used. The SPCCs are listed in Sections 8.4.3.2.3 and 8.4.3.3.3. When the relative RSD for CCCs and the minimum RF for the SPCCs have been met, the system is ready for sample analysis.

11.4.2.3 Continuing Calibration of the GCMS System

System Performance Check

A calibration standard containing all volatiles or semivolatiles with the associated surrogates and internal standards must for every 12 hours of analysis or once daily, whichever is more frequent. The RF data from the continuing calibration SPCCs are compared with the initial calibration SPCCs. The minimum RF for

volatiles SPCCs is 0.300 (.250 for bromoform); the minimum RF for semivolatiles SPCC is 0.05. If these minimums are not met, the system must be evaluated and corrective action taken before analysis may begin.

Calibration Check

After the system performance check is met, the calibration check compounds are used to check the validity of the initial calibration. If the percent difference for any compounds is less than 25% for CCCs, the calibration is considered valid. If the criteria are not met for one or more compounds, corrective action must be taken. If all corrective action fails to correct the problem, then a new 5 point calibration curve must be generated.

The concentration level for continuing calibrations for volatiles is 50 µg/L.

The concentration level for semivolatiles is 50 ng (except for the 9 compounds listed in Section 11.4.2.2 - Semivolatiles which will be analyzed at 80 ng.

11.4.2.4 Preparation (Method) Blank Analysis

A method blank is a volume of deionized water, or a purified solid matrix (when available) processed through the entire analytical sequence of extraction, concentration, and analysis. The method blank volume or weight must be approximately equal to the sample volumes or weights being processed. The method blank analysis must be performed for every 20 samples per matrix or every time samples are prepared, whichever is more frequent.

Blanks are subject to the following criteria:

1) The method blank for volatiles must contain no more than 5 times the CRQL of common laboratory

contaminants. These contaminants are methylene chloride, acetone, and toluene.

2) The method blank for semivolatiles must contain no more than 5 times the CRQL for common phthalate esters.

3) For all other compounds, the method blank must contain less than the CRQL of any single compound.

If the blank fails one of the three criteria listed above, all samples processed with that blank must be reprocessed and reanalyzed.

11.4.2.5 Surrogate Spike Analysis

Surrogate standard determinations are performed on all standards, samples and blanks. All samples and blanks are fortified with surrogate compounds prior to purging or extraction in order to monitor preparation and analysis of samples.

Surrogate spike recovery must be evaluated for acceptance by determining whether the concentration (measured as a percent recovery) falls inside the contract required recovery limits. See Table 4-2.

Method Blank Surrogate Recovery

The laboratory must take corrective action if any of the following exist in the preparation blank:

1) one surrogate compound is outside the required limits for volatiles, or

2) if one semivolatile surrogate is outside the required limits.

Corrective action should include, at a minimum: checking of calculations, checking of internal standard and surrogate king solutions, and instrument performance. If these do not locate the

problem then reinjection and repurge of volatiles, or reextraction and reanalysis of semivolatiles is required.

Sample Surrogate Spike Recovery

The laboratory must take corrective action if the following occur:

1) Recovery of any one surrogate compound is outside the required recovery limits, or

2) Recovery of any one surrogate in either the base neutral or acid extract is below 10 percent, or

3) Recovery of two compounds in either the base neutral or acid extract are outside recovery limits.

Corrective action should include: checking calculations, checking internal standard and surrogate spiking solutions, and checking instrument performance. If these do not locate the problem, the samples must be repurged and reanalyzed for volatiles or reextracted and reanalyzed for semivolatiles.

11.4.2.6 Matrix Spike/Matrix Spike Duplicate Analysis (MS/MSD)

Matrix Spike/Matrix Spike Duplicates (MS/MSD) are analyzed at the frequency of one set per twenty per matrix or every 14 days, whichever is more frequent. MS/MSD recoveries are calculated using the equation given in Section 4.5.1.2.

RPDs are generated through the use of equation given in Section 4.4.1.2.

The compounds used for spiking and their advisory limits for recovery are given in Table 4-1.

11.4.2.7 Pesticide/PCB Requirements

The following minimum QC requirements must be met for validation of Pesticide/PCB analytical results:

- Preparation blanks must be prepared as required in Section 11.4.2.4 and meet contaminant requirements.
- MS/MSD must be performed as described in Section 11.4.2.6.
- All standards, samples, blanks, and MS/MSD must be fortified with dibutylchlorendate surrogate.

11.4.2.8 Retention Time Windows

Before performing any sample analysis, the laboratory must establish retention time windows for all pesticide/PCB compounds, under the constraint that retention time windows must be under proper oven temperature and flow rate to ensure that 4,4'-DDT has a retention time of >12 minutes. Retention time windows are generated as follows:

1) Each time a new column is installed, make 3 injections of all single-component pesticide mixtures multi-response pesticides, and PCBs throughout a 72 hour period. Response should be approximately half-scale. These injections should be made at roughly equal intervals during the sequence (i.e, beginning, middle, and end).

2) Verify the retention time shift for DBC in each standard. The shift should be <2% for packed columns, and <0.3% for capillary columns. If this criterion is not met, continue injecting replicate standards to meet this criterion.

3) Calculate the standard deviation of the 3 absolute retention times for each single component pesticide using Equation 4.2 on page E-56/Pest of the Statement of Work. For multi-response peaks or PCBs, choose one major peak from the envelope and calculate the standard deviation of the 3 absolute retention times for that peak.

4) The standard deviations performed in 3) shall be used to determine the windows for subsequent 72-hour sequences. Apply ± 3 times the standard deviations in 3) to the retention times of all pesticide/PCB compounds determined in the first analysis of any given 72-hour sequence. This range then defines the windows for the remainder of the sequence. The absolute retention time of the first analysis of a particular compound is the center of the retention time window. Do not use the retention time generated in 3) as the center.

5) If the retention for a particular pesticide/PCB is less than 0.01 minutes use the following as windows:

a) ± 1% of the initial retention time for the compound for packed columns or b) ± 0.75% of the initial retention time for the compound for capillary compounds.

11.4.2.9 Linear Range

Linear range is determined through the analysis of 3 standards of each pesticide at 3 different concentrations, one of which must be near, but above, the CRQL and the other two at concentrations which define the working range of the instrument. These standards are to be injected consecutively at the beginning of the sequence.

Using the responses of the 3 injections, calculate the calibration factors for each compound using the equation 4.1 on page E-55/Pest of the Statement of Work. The relative percent difference of the calibration factors must be less than or equal to 10% for aldrin, endrin, 4,4'-DDT, and DBC. If only DDT exceeds 10%, it must be plotted on a standard curve.

Linear range requirements for confirmation GC analysis are ≤ 10% RSD for the initial evaluation mixes, and then ≤ 15% RSD for

alternating standards if quantitation is to be performed. If only confirmation is to be performed, then the alternating standards must be ≤ 20% RSD.

11.4.2.10 Breakdown of Endrin and 4,4'-DDT

Evaluation of the chromatogram of the analysis of Eval Mix B for the appearance of peaks in addition to the 4 main peaks indicates that either endrin or 4,4'-DDT is degrading. This degradation is calculated using equation 4.3 for DDT and 4.4 for endrin on page E-56/Pest of the Statement of Work. The breakdown for either compound must be ≤ 20% for analysis to continue. If the endrin and DDT peaks coelute (OV-1 column or equivalent), then a total breakdown is calculated using equation 4.5 on page E-57/Pest of the Statement of Work. The combined breakdown must not exceed 20% for analysis to continue.

11.4.2.11 Dibutylchlorendate (DBC) Shift

When the above has been satisfactorily completed, samples are analyzed in the sequence given in Table 8.4. The retention time shift for DBC must be evaluated for each sample. The retention time shift must be < 2% difference for packed columns between the initial standard analysis and any sample or standard subsequently analyzed during the 72-hour sequence. The percent difference for wide bore capillary columns must be < 1.5% and < 0.3% for narrow bore capillary columns. Retention time shifts that do not meet the criteria for percent difference shall be flagged "*" on Form 8E. The percent difference is calculated using Equation 4.8 on page E-60/Pest of the Statement of work.

11.4.3 RADIOLOGICAL LABORATORY ANALYSIS QUALITY CONTROL

Radiological laboratory QC will ensure that the required analysis, QC sample checks, and verification of the results are performed and that the acceptability of the results is known and verifiable.

11.4.3.1 Duplicate Sample Analysis

At least one duplicate sample will be run in every twenty samples. The results of these analyses will be used to determine method precision, which will be recorded on radiological analysis quality control sample forms and control charts as the "normalized range" for the parameters tested, in accordance with Section 4.4.2.

11.4.3.2 Spike and Matrix Spike Analysis

At least one sample in every twenty will be an aliquot of DI water or actual sample spiked prior to analysis with the parameters of interest to determine the percent bias. The result of these analyses will be recorded on radiological analysis quality control sample forms and control charts as the "normalized deviation" for the parameters tested, in accordance with Section 4.5.2.

11.4.3.3 Method and Field Blank Analyses

At least one sample in every twenty will be a method blank analyzed for the pertinent radiological parameters. The method blank will consist of a quantity of distilled or deionized water appropriate to the analysis.

Field blanks will be prepared by sample collection teams by filling sample containers with distilled water and shipping them

to the lab along with the actual samples. The field blanks accompany the samples through collection and shipment to the laboratory and are stored with the samples. Field blanks are analyzed to monitor for possible sample contamination during collection, shipment, and storage.

11.5 FIELD QUALITY CONTROL

Field activities are the responsibility of the assigned manager. Prior to initiating field work, the manager shall discuss the scope of work, contractual and regulatory requirements, and applicable QA/QC procedures with assigned personnel. At the request of the manager, this may be done by the QA Officer or senior members of the project staff.

Once in the field, field personnel are responsible for all daily QC activities. Included in this responsibility shall be the supervision of subcontractors.

11.5.1 PERFORMANCE DOCUMENTATION

To provide evidence of satisfactory work performance the basis for subsequent activities and information transmitted external to ASI, the results of field investigations and sampling shall be completely documented. Whenever possible, information shall be recorded on a standardized form. Documentation shall include a daily log of project activities and the appropriate subsurface logs, test and survey data forms, monitoring/sampling equipment installation records, photographs, and field collection and sampling custody forms.

Members of the project staff working in field operations shall keep a daily log of project activities. Each page of the Field

Activity Daily Log (Figure 5-1) shall be signed by the person preparing the log. Items to be included in the daily log, as appropriate, are:

- Project identification;
- Field activity subject;
- General work activity;
- Unusual events;
- Changes to plans and specifications;
- Visitors on site;
- Subcontractor progress or problems;
- Communication with the client or others;
- Weather conditions; and
- Personnel on site.

Copies of the Field Activity Daily Logs should be sent to the site manager and the on-site technical manager, approximately on a weekly basis. After review of the logs, they should be routed to other members of the project staff as needed. If the logs are not submitted as required, it is the responsibility of the site manager, or designee, to contact the field personnel.

As part of field activities, a photographic record should be prepared. Photographs should be in color. As examples, photographs should be taken of the general site layout, geologic features, field equipment and installations, sampling stations, and field testing. When test pits or trenches are dug, photographs should be taken of the subsurface profiles, if possible.

Photographs are to be identified by the project number, date taken, and a brief description. This may be done individually on the back of each photograph or in an album in which the photographs are mounted. Album photographs must be labeled with individual descriptions and dates taken.

Before photographs are taken, the client should be contacted to determine their policy concerning photographs.

Appropriate test survey and equipment installation data forms shall also be prepared. All requested information and all data spaces on forms shall be addressed. If not applicable, not available or not required, requested information should be designated as such. Errors or incorrect data shall not be obliterated, but shall be lined through with a single horizontal line with the correct entry placed above or adjacent to the original, and initialed and dated next to the corrected entry by the person making the correction.

During the performance of the field program, a copy of the field records will be sent to the responsible managers, with the original being placed in the central file at the project site office. These copies can provide adequate documentation of work activities should the originals be destroyed, lost, or stolen.

The process for initiating and obtaining variances (changes) from approved field procedures and plans (including this QAPP) is described in Section 16.4.

11.5.2 VALIDATION OF FIELD DATA

Field data shall be formally validated in accordance with Appendix A of this QAPP.

12.0 QUALITY ASSURANCE AUDITS/SURVEILLANCES

To verify project activity compliance with QAPP requirements, the Project QA Officer is responsible for scheduling and conducting planned and documented QA audits and surveillances. Audits will, as a minimum, consist of the evaluation of the QA program and procedures, the effectiveness of their implementation and a review of associated project documentation. Surveillances will, as a minimum, monitor/observe ongoing project activity and work areas to verify item and/or activity conformance to specified requirements. Audits/Surveillances will be scheduled, planned and documented. Audits for this project will, as appropriate, cover laboratory activities, field operations and documentation, and final reports. Auditing will be performed in accordance with the auditing organizations Quality Assurance Manual and any applicable project procedures.

Contractor internal audits are performed in accordance with established Laboratory Manuals and/or specific attachments. System audits are performed to evaluate all components of the measurement systems to determine their proper selection and use. Performance audits are conducted periodically to determine the accuracy of the total measurement system(s) or component parts thereof.

12.1 AUDIT/SURVEILLANCE PERSONNEL

Project and laboratory audits are performed by the Project QA Officer and/or qualified QA audit personnel. Technically, qualified personnel (e.g., technical specialists) may be assigned to the audit as team members at the discretion of the

Project QA Officer and/or Lead Auditor. Audit teams may consist of one or more auditors, however, they will always include a lead auditor.

Project Surveillances are performed by the Project QA Officer or designated surveillance personnel. Surveillance personnel shall be technically cognizant of the activity being monitored/observed.

Qualifications of audit and surveillance personnel shall be documented.

Audits and surveillances shall be performed by personnel who do not have direct responsibility for performing the activities being audited or surveilled.

12.2 AUDITS

12.2.1 PRE-AUDIT ACTIVITIES

Pre-audit activities consist of audit scheduling; identification of audit subject and scope, selection of an audit team; development of an audit plan and checklist(s); and providing audit notification to the audited organization(s).

Audits will be scheduled in a manner to provide coverage and coordination with project and laboratory ongoing activities and at a frequency commensurate with the status and importance of the activity. Schedules may be revised as necessary. Scheduled audits may be supplemented by additional audits as deemed necessary.

As with scheduling, when determining activities to be audited, consideration shall be given to ensure that, in the aggregate,

adequate coverage of both field and laboratory activities is obtained. Definition of the scope of each audit shall be responsive to the activity status/importance and required validity/acceptability of its product and supporting documentation (e.g., records, reports, etc).

The audit team shall be selected in accordance with Section 12.1.

Audit plans shall be developed by the Lead Auditor (assisted as required by team members), for each audit. Plans shall identify the audit scope, applicable requirements, audit personnel, activities to be audited, organization(s) audited, audit schedule, and identification of audit checklists.

Checklists shall be prepared by the auditors and used during conduct of the audits. They shall be developed to accomplish the review of necessary items and to document the results of the audit.

The Project Director (or Laboratory Manager) will be formally notified in advance of the scheduled audit. The notification, as a minimum, documents the audit date/length, any associated meetings, the auditing organization and identifies the auditors, audit subject and intended scope.

12.2.2 AUDIT CONDUCT

Audits shall be conducted in accordance with the written checklists. If for some reason, portions of the audit scope were not addressed during the audit, documentation of this fact will be recorded in the audit report.

Pre and post audit meetings between auditors and Project (Laboratory) management and personnel shall be held in order to review the purpose and scope of the audit, establish personnel contacts and present audit results.

During an audit and upon its completion, the auditors will discuss the findings with the individuals audited and cite corrective actions to be initiated. Minor administrative findings which can be resolved to the satisfaction of the auditors during an audit are not required to be cited as items requiring corrective action. All findings that are not resolved during the course of the audit and findings affecting the overall quality of the project, regardless of when they are resolved, shall be noted on the audit checklists.

12.2.3 POST AUDIT ACTIVITIES

Following completion of an audit, the auditors shall prepare and submit a formal audit report to the Project (laboratory) Director. This report shall serve to notify management of audit results. The report may also be sent to other project management, individuals contacted during the audit, and the management of any affected subcontractor.

The report shall be prepared as soon as possible (within 30 days) after the audit and contain, as appropriate:

- Date(s) of the audit;
- Identification of audit participants;
- Identification of activities audited;
- Audit results;

- Description of items requiring corrective action and, if possible, the means of correction;
- Directions for audit response, in writing.

Completion of all required corrective action shall be verified by the auditors through written communication, reaudit, or other appropriate means. After acceptance and verification of corrective actions, an audit closure report shall be issued to the same individuals receiving the audit report.

After acceptance and verification of all corrective actions, an audit closure report is issued by the Lead Auditor or Designee.

12.3 SURVEILLANCES

12.3.1 PRE SURVEILLANCE ACTIVITIES

Surveillances are scheduled by the Project QA Officer by selecting project activities based on the project/program schedule. Scheduling may occur on a daily or weekly basis, in order to provide adequate activity coverage in response to project task assignments.

Activity procedures or surveillance checklists, if applicable, are prepared by surveillance personnel with the concurrence of the Project QA Officer.

Actual date and time of surveillance is coordinated with involved project personnel by surveillance personnel.

12.3.2 SURVEILLANCE CONDUCT

Surveillance personnel utilize applicable activity procedure/surveillance checklist and monitors/observes performed activity. In-process documentation of observations is effected as required and evaluation as to activity conformance to specified requirements is made.

12.3.3 POST SURVEILLANCE ACTIVITIES

Surveillance personnel prepare a report documenting surveillance results. Observations identified during the surveillance which do not constitute a nonconformance require a response by the cognizant manager or designee on the surveillance report. Nonconformances identified during the surveillance will constitute cause to initiate a nonconformance report (NCR). The NCR number will be documented in the report. The surveillance report, when completed, and having received Project QA Officer approval, may be distributed to appropriate project personnel.

Once the report is issued the surveillance is considered closed, in that if nonconformances were identified, their tracking to closure is controlled by the NCR process, and no further action associated with the surveillance is required.

12.4. PROJECT/LABORATORY RESPONSE TO AUDIT REPORTS

When audit reports request project/laboratory response and corrective action, such response with proposed corrective actions and their scheduled completion dates shall be made in writing under the signature of the Project Director/Laboratory Manager. The

response shall clearly state the corrective action taken or planned. If all corrective actions have not been completed prior to issuance of the audit response, a scheduled date for completion shall be provided. It is noted that all requests for corrective action must be addressed to the satisfaction of the QA Officer.

These written responses shall be transmitted to the auditor or designee within the time frame specified by the audit report or its transmittal letter. If such time frame cannot be met, it is the responsibility of the Project Director/Laboratory Manager to provide written justification of and request for a response extension. This request for extension should be transmitted to the auditor or designee by the original response date stipulated in the audit report or its transmittal letter.

It is the Project Director's/Laboratory Manager's responsibility to ensure that all corrective action, as required by the audit report, be undertaken and completed on schedule. If required, the DOE QA Officer, or designee, is empowered to stop work in accordance with the process defined in Section 3 of this QAPP.

13.0 PREVENTIVE MAINTENANCE

Preventive maintenance is an organized program of actions taken to maintain proper instrument and equipment performance and to prevent instruments and equipment from failing during use. An adequate preventive maintenance program increases reliability of a measurement system. A preventive maintenance program considers the following:

1) Instruments, equipment, and parts thereof that are subject to wear, deterioration, or other change in operational characteristics in the absence of routine maintenance;

2) Spare parts necessary to minimize down time; and

3) Optimum frequency of maintenance.

The implementation of a preventive maintenance program is dependent upon the specific instruments and equipment used within a laboratory or field program. Therefore, this section does not attempt specific instrument or equipment requirements but, rather, sets minimum guidelines for maintenance practices. The field and laboratories will implement a preventative maintenance program that complies with the guidelines presented in this section.

Within the laboratory, the laboratory manager is responsible for the preparation and documentation of the program. Specific individuals within the laboratories shall be responsible for the effective implementation of the program and quality assurance personnel shall be responsible for the review of implementation to verify compliance. For field operations, the assigned Manager is responsible for preparation, implementation, and documentation of the program. The Project QA Officer will approve the field program and review its implementation to verify compliance.

The preventive maintenance program shall include the following:

1) A complete listing of the instruments and equipment that require preventive maintenance;

2) The frequency of maintenance considering manufacturer's recommendations and previous experience

with the particular piece of equipment, generally stated in terms of daily, weekly, monthly, etc;

3) A list of spare parts peculiar to each instrument or piece of equipment necessary to preclude long down time;

4) Service contracts as necessary;

5) The items to be checked or serviced during maintenance and the directions for performing maintenance.

Preventive maintenance activities shall be performed in accordance with approved laboratory or field SOPs for each type of equipment or instrument. These activities shall be further documented through individual instrument files and shall include the following:

1) Spare parts list;

2) External service contracts, where applicable; and

3) Records of periodic maintenance performed.

Records of maintenance are documented through maintenance logs, which are maintained at the instrument and service report forms, which are maintained in the instrument files.

14.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

14.1 Analytical Laboratory

14.1.1 It is the responsibility of analysts, in consultation with group supervisors, to evaluate recoveries of surrogates and matrix spikes and precision of duplicates utilizing control charts provided.

14.1.2 The control limits are defined as the mean $\pm$ 3σ. The warning limits are defined as the mean $\pm$ 2σ.

14.1.3 Those recoveries and/or relative percent differences (RPDs) which are found by control charts to be "out-of-control" shall be evaluated using all information pertinent to the recoveries/RPDs in question. Pertinent information includes but is not limited to: preparation blanks, laboratory control samples, matrix interferences present (if any), concentration of the spiking compound present in the original sample, homogeneity of the sample, and the matrix of the sample.

14.1.4 The assessment of data precision, accuracy, and completeness, aside from verification via control charts, is an integral part of the laboratory data verification process.

14.1.4.1 After data has been generated by instrumentation, it is submitted to a peer (another analyst or group supervisor) for review. This initial review is a complete review for transcript errors, calculation errors, etc. This process of review also includes a check for completeness of the presentation of data.

14.1.4.2 A secondary review is then conducted by the Group Supervisor, Laboratory Manager, or Laboratory Project Manager of at least 20% of data presented. This step also includes a review of comparability with historical results and representativeness.

14.1.4.3 Tertiary review is a quality assurance function that is performed on a minimum of 5% of analytical data. This QA review includes technical QA and editorial QA reviews.

14.2 Radiological Laboratory

14.2.1 It is the responsibility of analysts, in consultation with supervisors, to evaluate precision and accuracy of results utilizing control charts.

14.2.2 "Normalized" range and deviation statistics are used for the evaluation of laboratory process control:

14.2.2.1 Normalized range analysis statistics are obtained by scaling the statistical output to a normalized mean range of 1 and a normalized standard deviation of 1. Control limits are defined as 0 and +4 (mean plus 3σ). Warning limits are defined as +3 (mean plus 2σ) and +4 (mean plus 3σ).

14.2.2.2 Normalized deviation statistics are obtained by scaling the statistical output to a normalized mean of 0 and a normalized standard deviation of 1. Control limits are defined as $\pm$ 3 (mean plus $\pm$ 3σ). Warning limits are defined as $\pm$ 2 (mean plus $\pm$ 2σ).

14.2.3 Results which are found to be "out-of-control" by control charts shall be evaluated using all information pertinent to the result in question. Pertinent information includes but is not limited to: preparation blanks, laboratory control samples, matrix interferences (if any), activity of the radionuclide spike present in the sample, homogeneity of the sample, and the sample matrix.

14.2.4 The assessment of data precision, accuracy, and completeness, aside from validation via control charts, is an integral part of the data verification process.

14.1.4.1 After data has been generated by instrumentation, it is submitted to a peer (another analyst or supervisor) for review. This initial review is a complete review for transcription errors. Calculation errors, etc. This process of review also includes a check for completeness of the presentation of data.

14.1.4.2 A secondary review is conducted by the QCC of at least 20% of data presented. This step also includes a review of comparability with historical results and representativeness.

14,3 Criteria for Evaluation of QC Sample Results

14.3.1 "Out-of-control" situations include but are not limited to:

* Any point outside the upper or lower control limit;
* Any two points in succession between the upper/lower warning limit and the upper/lower control limit;
* Eight consecutive points above or below the mean listed on the control charts;
* Any five point trend upward or downward; or
* Any long-term trend that deviates from historical trends.

14.4 <u>Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness for Field Validation</u>

The field data validation program is described in Appendix A of this QAPP.

15.0 DOCUMENT CONTROL

Project specific documents and drawings which are considered controlled documents, are prepared, reviewed, approved, revised, and distributed in accordance with the requirements of this section. Documents, drawings, etc. which are to be so controlled must be identified. A document, drawing, etc. identification list shall be established and maintained for those document types, shown in Figure 15-1, with an asterisk. The quality related documents listing will be maintained by the Project QA Officer; the Project Specific Documents listing is maintained by the Project Director or his/her designee; and the Drawings, Computer Graphics and Maps listing is maintained by the Deputy Director/Technical.

15.1 REVIEW AND APPROVAL OF DOCUMENTS AND DRAWINGS

Prior to implementation or use, project controlled documents and drawings must be reviewed, approved and distributed by personnel as identified in Figure 15-1.

Approval of these documents and drawings will be denoted by a signature and date. All documents and drawings, requiring DOE review and/or approval, will be reviewed and approved by other designated personnel before they are submitted to DOE. Copies of documents or drawings released for any purpose before they have gone through the complete review and approval process, will require the document to be marked "DRAFT" and the drawing to be marked "PRELIMINARY".

15.2 DISTRIBUTION

Controlled documents and drawings, etc. will be distributed to personnel as the need is identified. Personnel responsible for

DOCUMENT CONTROL RESPONSIBILITY MATRIX	PROJ. DIRECTOR	PROJ. QAO	DEP. DIR./TECH.	WMCO QAO	DOE COTR	PREPARER	CHECKER
QUALITY RELATED DOCUMENTS	RA	RAD	RA	RA	RA		
QA PROJECT PLAN	RA	RAD	RA	RA	RA		
WORK PLAN	RA	RAD	RA	RA	RA		
SAMPLING PLAN	RA	RAD	RA	RA	RA		
HEALTH AND SAFETY PLAN	RA	RAD	RA	RA	RA		
COMMUNITY RELATIONS PLAN	RA	RAD	RA	RA	RA		
DATA MANAGEMENT PLAN	RA	RAD	RA	RA	RA		
PROJECT SPECIFIC DOCUMENTS	RAD		RA	RA	RA		
DRAWINGS	RAD		RA			S	S
COMPUTER GRAPHICS	RAD		RA			S	S
MAPS	RAD		RA			S	S

LEGEND:
R = REVIEW
A = APPROVE
D = DISTRIBUTION
S = PREPARER/CHECKER SIGNATURE

FIGURE 15-1

controlled distribution are identified in Figure 15-1. Delegation of distribution activities must be documented.

Distributed documents will be identified by a copy control number unique to each recipient. (For drawings, graphics and maps, this may not be practical).

Personnel responsible for controlled distribution shall maintain a distribution list containing the document distributed; control number; and copy holder name and mailing address.

If controlled documents and drawings, etc., become obsolete or are no longer needed, instructions as to their disposal shall be issued to copy holders.

Uncontrolled issue of any of the documents addressed in this section shall be so identified, on the copy, in a conspicuous manner.

Distribution of documents, drawings, etc. revisions and addenda shall be made to all original issue copy holders in the manner described above. The transmittal of revisions/addenda shall include instructions for revision inclusion and superseded material disposition. Each limited revision (see 15.3 below), will be transmitted by a revision log sheet that lists all revised pages for that revision. The log sheet is to be filed in the front of the revised document section. Evidence of the document transmitted, the recipient, and transmittal date shall be maintained, to document distribution.

15.3 REVISION OF DOCUMENTS AND DRAWINGS

Whenever a controlled document or drawing is revised, the review and approval of the revision will be in accordance with the requirements of the original document or drawing.

Document revisions may be accomplished by either 1) a complete revision, where the entire text is replaced, or 2) a limited revision, where only affected pages are replaced.

The document table of contents will be revised when affected by a limited revision.

15.3.1 REVISION LEVEL

The QA Project Plan revision level indicator for complete revisions will consist of the revision number (e.g., 4, 5, 6 etc.) and the revision date on the title page/signature page and all subsequent pages. For a limited revision, each revised page (and the table of contents, if affected), shall be identified with the current complete revision number and sequential decimal suffix (e.g., 4.1, 4.2, etc.) and the revision date.

For all other document revisions, both complete and limited, the revision level will be indicated by date only.

15.3.2 REVISED TEXT/PAGES

When necessitated by the change, additional pages will retain the original page number with a sequential suffix (e.g., page 4.1 of 6). Each revised page in both complete and limited revision will have a vertical line in the right hand margin adjacent to the

revised material. Document title pages and signature pages are not required for limited revisions.

15.3.3 REVISION REVIEW/APPROVAL

Complete revisions shall include appropriate approval cover sheets. Reviews and approvals, if not documented on reissued approval cover sheets, shall be documented in another manner (e.g., associated DCR approval signature blocks) to attest to review and approval in accordance with the requirements of the original document.

15.3.4 REVISING DRAWINGS, COMPUTER GRAPHICS, MAPS, ETC.

Revisions to such documents shall, as a minimum, be denoted by displaying the consecutive revision number, revision date, and review/approval signatures in the appropriate fashion. Distribution shall be made in accordance with the applicable requirements of 15.1 and 15.2 above, to users of the portrayed contents who require current information/data to perform work activities.

15.4 INITIATING CHANGES TO DOCUMENTS

Changes to approved plans and procedures are likely to be necessary during the course of project performance as a result of new information or events that occur during performance. Changes to previously approved plans and procedures must be approved before the change is implemented.

A Document Change Request (DCR) is the only means of initiating a revision to a previously approved project-specific controlled document. DCRs are recorded on the DCR form shown in Figure 15-2. Review and approval of DCRs shall be in accordance with the requirements of the original document before they are implemented.

DOCUMENT CHANGE REQUEST

This form is used to initiate permanent change to controlled distributulon project-specific procedures.

REQUEST # _____
Issue Date _____
Page ___ of ___
Do Not Write in this Block

REQUESTOR: _____ PHONE #: _____ REQUESTED DATE: _____

DCR TITLE: _____ DOCUMENT AFFECTED: _____

VOLUME #: _____ SECTION/PAGE #: _____ REV. DATE _____

CHANGE JUSTIFICATION:

CONTENT OF CHANGE

IMPLEMENTATION DATE:

☐ EFFECTIVE DATE _____

☐ OTHER _____

REQUIRED APPROVALS:

PROJECT DIRECTOR	Date	WMCO ENVIRONMENTAL MANAGER	Date
PROJECT QA OFFICER	Date	WMCO QA OFFICER	Date
DEPUTY DIRECTOR/TECHNICAL	Date	DOE COTR	Date

TO BE COMPLETED BY DOE

A. Prior EPA notification required?	☐ YES	☐ NO
B. Prior EPA approval required?	☐ YES	☐ NO
C. Immediate implementation?	☐ YES	☐ NO

Figure 15-2

For DCRs that involve changes to analytical laboratory activities, review by the responsible laboratory director is also required. The Project Director or the Project QA Officer may request oral approval from the other signatories when necessitated by circumstances. If the other signatories orally approve and consent for the DCR to be signed for them, the Project Director or Project QA Officer may sign their own name in the other person's signature space and write "for" before the person's title below the signature space.

DCRs are initiated as follows:

- The requestor (normally the person who identified the need for change) completes the DCR form up the to the EFFECTIVE DATE OF CHANGE.

- The requestor forwards the DCR to the Project QA Officer for evaluation.

- The Project QA Officer upon concurrence with the DCR enters a number in the REQUEST NO. space and also signs and dates the DCR in the appropriate space. If Project QA Officer does not concur, he/she resolves the disagreement with the requestor.

- The Project QA Officer enters the pertinent information in a DCR status and tracking log (Figure 15-3) that shows the DCR number, requestor, request date, subject matter, affected document and section number(s), transmittal and return date from each signatory, distribution date to each document holder, and issue date of revised pages to the document.

- The Project QA Officer makes a copy of the DCRs and forwards the original to the Project Director with a request to review, approve and return to the Project QA Officer. The date is recorded in the DCR status and tracking log.

- When the signed DCR is returned from the Project Director, the Project QA Officer makes the appropriate entry in the DCR status and tracking log, and repeats the forwarding process until all required signatures have been obtained. If any signatory refuses to sign the DCR, that signatory is responsible for communicating to the Project QA Officer the reasons for not signing. The Project QA Officer coordinates the resolution of the disagreement of the DCR, consulting with the Project Director as necessary. In the event that a decision is made to not proceed with the issue of the DCR, the Project QA Officer notifies the requestor and all signatories who have previously signed the DCR of this decision. An appropriate entry to this effect is made in the DCR status and tracking log.

- When all required signatures have been obtained, the Project QA Officer issues the DCR to all holders of controlled copies of the affected document(s). The change described by the DCR is to be implemented on the date specified in the EFFECTIVE DATE OF CHANGE space on the DCR.

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- The effective date of change and issuance of the DCR is dependent on DOE addressing the section at the bottom of the DCR for EPA notification, EPA approval, or immediate implementation.

Each controlled document copyholder who receives an approved DCR is responsible for inserting a copy of the DCR in the front (or other appropriate location) of the affected document(s). Until revised document pages are issued, the DCR serves as the controlled document copy holder's official notification that the document has been changed as described in the DCR.

Subsequent to issuing a DCR, the Project QA Officer will, as soon as feasible, issue revised document pages incorporating the change described in the DCR. Upon receipt and incorporation of the revised pages into the appropriate document, the DCR is to be removed from the document.

15.5 VARIANCES

A variance is a prior-approved action to be performed in variance to the requirements of an approved controlled procedure or drawing and does not impact the quality of the work. Variances do not, in themselves cause revision to controlled documents, however, may cause the initiation of a DCR. The variance process is detailed in Section 16.4.

Document Change Control Status Log Page ___ of ___

DCR #	Date Orig	Orig.	Doc.	Title	ASI Comp	To WMCO	DOE Approve

Figure 15-3

16.0 NONCONFORMANCE, CORRECTIVE ACTION AND VARIANCES

16.1 NONCONFORMANCES

A nonconformance is a deficiency in characteristic, documentation, or procedure that renders the quality of an item, data or activity unacceptable or indeterminate. Unapproved deviations from approved project plans and/or procedures constitute a nonconformance. Variances, as defined and addressed in section 16.4 are not nonconformances. Nonconformances may be identified by:

- Project Staff
  During the performance of field investigation and testing, supervision of subcontractors, performance of field inspection, and preparation and verification of numerical analyses;

- Laboratory Staff
  During the preparation for and performance of laboratory testing, audits, calibration of equipment, and QC activities; or

- QA Officer
  During the performance of surveillances and other quality assurance activities.

Project site nonconformances will be documented on a Nonconformance Report (NCR) form, Figure 16-1.

FERNALD
RI/FS

NONCONFORMANCE REPORT

NCR No._____
Page _____
Date: _____

1. REQUIREMENTS

2. NONCONFORMANCE DESCRIPTION

☐ CAR Rec'd

Identified by: _____ Date: _____

3. DISPOSITION ☐ Accept ☐ Reject ☐ Resample ☐ Flag Data

Technical Justification:

Dispositioned by:_____ Date: _____

Accept by: _____ Date: _____
Project QA Officer

4. PROPOSED CORRECTIVE ACTION, INCLUDING INITIATION AND COMPLETION DATES

To Be Performed by: _____ Date of Completion: _____

CONCUR: _____ Date: _____
Project Director

_____ Date: _____
Project QA Officer

5. CORRECTIVE ACTION TAKEN (IF DIFFERENT FROM THAT PROPOSED)

6. CORRECTIVE ACTION COMPLETE

Performed by:_____ Date: _____

QA Verified by: _____ Date: _____

Figure 16-1

16.1.1 SITE NCR REPORTING PROCESS

Nonconformances are reported and processed as follows:

- The person responsible for reporting the nonconformance (the initiator) completes Parts 1 and 2 of the NCR by noting the appropriate requirement and describing the nonconformance including, as appropriate, the date(s) and time(s) of day of occurrence and identification, persons involved, project activity being performed, equipment involved, source of the requirement that was not complied with, and if known, the probable adverse impact of the nonconformance on the quality or completeness of project data. The person signs and dates part 1.

NOTE: Use continuation pages as necessary to complete Part 1 and subsequent parts of the NCR. Identify all material on continuation pages with the part number and title (i.e., for Part 1 continuation "Part 1, Nonconformance Description-Continued"). Number each continuation page in the upper right corner of page (e.g., ___ of ___).

The reporting person signs and dates Part 2 and forwards the NCR to the Project QA Officer for distribution to the cognizant project management for nonconformance dispositioning.

- The Project QA Officer evaluates Parts 1 and 2 to determine that the condition or occurrence described represents a nonconformance and, if corrected, action is required. If he concurs that it is a nonconformance, he enters an NCR number and date in the spaces provided near the top of the NCR form and evaluates Parts 1 and 2 for adequacy and completeness. Any disagreements are resolved with the initiator, and as appropriate, the Project Director and/or the person(s) or organization(s) proposed to perform the corrective action. The Project QA Officer enters the pertinent information in an NCR status log (Figure 16-2) that shows, as a minimum, the NCR number, the dates of NCR initiation and closure, the NCR subject and person/organization responsible for action.

- Cognizant project management reviews Parts 1 and 2 description and as required, consults with the NCR

initiator and/or other project personnel and dispositions the nonconformance, (accept as it requires technical justification; flagged data requires identification of the flag to be used as described in Appendix A Data Validation) the cognizant person signs and dates Part 3. The dispositioner enters the proposed corrective action (Part 4) for resolving the nonconformance, after consulting with the initiator's supervisor, the Project Director, or the Project QA officer, as appropriate. Initiation and completion dates for the proposed corrective action are included whenever appropriate. The names of the person(s) and/or organizations proposed to perform the corrective action are entered in the **TO BE PERFORMED BY** space.

- The NCR is then returned to the Project QA Officer.
- When the Project QA Officer is in agreement with Parts 3 and 4, he signs and dates Parts 3 and 4.
- The Project QA Officer makes a copy of the NCR and transmits the original to the Project Director with a request to review and concurrence and return to the Project QA Officer as soon as feasible. If the Project Director concurs, signs and dates part 4.
- When the signed NCR is returned from the Project Director, the Project QA Officer distributes copies of the NCR to all affected parties, including the initiator, the person(s)/organization(s) responsible for performing corrective actions, the Project Director, and the DOE COTR. The NCR original is placed in the project files.

NOTE: Copies of NCR's which could affect laboratory activities shall be distributed to those laboratories as deemed appropriate.

16.1.2 Nonconformances identified during laboratory operations will be documented as specified in the specific laboratory procedures. The QC Coordinator maintains a log of laboratory nonconformances and their closure.

NOTE: Laboratory Management shall send copies of documents which identify nonconformances and corrective action requests (CAR) generated during laboratory activities in support of the RI/FS together with corrective action measures employed, to the project for the Project Director's and

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NCR LOG

Page _____ of _____

NCR #	DATE INIT	DATE CLSD	INITI-ATOR	SUBJECT	QA CODE	RESPONSE FOR ACTION

Figure 16-2

Project QA Officer's review and concurrence prior to nonconformance and/or CAR closure.

16.2 CORRECTIVE ACTION

Corrective action measures are required to rectify identified conditions that render the quality of process or activity unacceptable or indeterminate if left uncorrected. The need for such measures may be identified during:

- Performance and system audits,
- Interlaboratory/interfield comparison studies
- Nonconformance reporting
- Surveillances and QA program audits

Additionally, the need for corrective action is based on predetermined limits for acceptability. Corrective actions may include resampling, reanalyzing samples, or auditing laboratory procedures. Laboratory procedure define those predetermined limits for data acceptability beyond which corrective action is required, the corrective action process, and identifies personnel responsible for initiating and approving corrective actions.

Corrective action measures shall be completed in an expeditious manner and verified as adequate as soon as practicable. Corrective action completion and verification activities shall be documented.

16.2.1 PROJECT SITE CORRECTIVE ACTION

Corrective action for nonconformances is performed, completed and verified as follows:

- When the person(s) or organization(s) responsible for performing corrective action receive a copy of the "issued" NCR, appropriate action is taken to initiate and complete the corrective by no later than the scheduled dates. If the scheduled dates are not met, the Project Director and Project QA Officer are notified prior to those dates.

- When the corrective action is complete, the performing person(s) or organization(s) complete Part 5 of the NCR by describing any corrective actions different from that proposed in Part 4. If the corrective action taken is the same as that proposed, "Same as proposed" is entered in Part 5.

- The person performing or responsible for the corrective action signs the **PERFORMED BY** space of Part 6 on the original of the NCR (if available) or on a copy, enters the date that Part 6 was signed, and forwards the signed NCR to the Project QA Officer.

- Completion of corrective actions for nonconformances will be verified by the Project QA Officer. Following verification, the Project QA Officer will sign the original of the NCR in Part 6 and make the appropriate entry in the NCR log.

16.2.2 LABORATORY CORRECTIVE ACTION

The QC Coordinator is responsible for verifying completed corrective action and logging completion date.

16.3 EVALUATION OF RECURRING NONCONFORMANCES

As each NCR is received, the Project QA Officer and Laboratory QA Representative will determine if it describes a recurring nonconformance. For each recurring nonconformance, they will coordinate an evaluation to determine the cause and will initiate any action required to prevent further recurrences. The Project QA Officer and Laboratory QA Representative, with the assistance of the Project and Laboratory Directors, as appropriate, will ensure that the evaluation and results are properly documented.

The Project Director will notify WMCO of recurring nonconformances which could impact the results of the work and indicate the corrective action taken or planned.

16.4 VARIANCES

A variance is a prior-approved action to be performed in variance to the requirements of an approved procedure or drawing and does not impact the quality of work performed. Variances are not nonconformances. Variances must be approved by the Project Director and the Project QA Officer before they are implemented. Variances are documented on the Variance Request (VR) Form shown in Figure 16.3 and logged on the Variance Request Log, Figure 16.4. Variances do not result in revisions to project specific documents, (however may cause initiation of a DCR) and are a means of accomplishing on-the-spot changes in the implementation of project specific procedures when the change is necessary for work to proceed. The variance is a one-time change that is valid only for the specific activity described in the VR.

Variance Request forms are processed as follows:

- The person identifying the need for the variance (the requestor) completes the VR form shown in Figure 16-3 through the **REQUESTED BY** entry, except for the variance number, which is supplied by the Project QA Officer.
- The requestor obtains the signatures of the Project Director and the Project QA Officer. When necessary, the Project Director and/or the Project QA Officer can orally give their approval to the requestor. In this instance, the requestor notes on the VR, in an area other than in the approval signature spaces, that oral approval has been

granted, along with the approvers names and the date and time that approval was granted. Written approval must be obtained by the requestor within 5 working days. When obtaining the approval of the Project QA Officer, the requestor also obtains the VR number and enters it on the VR.

- When approvals have been obtained, the change described on the VR can be implemented.
- In cases of oral VR approval, the requester obtains written approval of the Project Director and/or Project QA on the original VR.
- The original VR is provided to the Project QA Officer for appropriate distribution and forwarding to the project files. The Project QA Officer also evaluates the VR to determine whether or not a revision to the project-specific document is required, and, if appropriate, issues a DCR within 10 working days.

The Project QA Officer is responsible for maintaining a log (Figure 16.4) that shows for each issued VR, the number, dates initiated and approved, the responsible individual, and the effected document and section.

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VARIANCE REQUEST

VR. No. _____

Page _____

Date: _____

VARIANCE (INCLUDE JUSTIFICATION)

APPLICABLE DOCUMENTS(S) AND SECTION NO.(S)

REQUESTED BY: _____

Approved by: _____
PROJECT DIRECTOR

_____
PROJECT QA OFFICER

Figure 16-3

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VARIANCE LOG

PAGE _____ OF _____

VARIANCE NUMBER	DATE INITIATED	APPLICABLE DOCUMENTS AND SECTIONS	RESP. INDIV.	APPROVAL DATE

Figure 16-4

18.0 RECORDS ADMINISTRATION

This project requires the administration of on-site, laboratory, and off-site office project record files. The responsible organization, at each location, shall establish a records management system in accordance with the requirements of this section. The systems shall provide requirements for the preparation, control and retention for all project-related records. Record control shall include receipt from external sources, transmittal and transfer to storage. Retention shall include receipt at storage areas, indexing and filing, storage and maintenance, and retrieval.

18.1 RECORD PREPARATION

On-site and off-site originated records generated in support of the Project RI/FS shall be legible, accurate and complete; shall provide sufficient information to permit identification to item(s) or activity (ies) to which they apply; and shall be authenticated by preparer's signature and completion date.

When appropriate, corrections may be made to records by authorized personnel (e.g., originating personnel/organization). Corrections are made by single-lining through the incorrect information/data, making the correct entry and initialing and dating the revised entry.

18.2 RECORD CONTROL

18.2.1 Incoming

Incoming project-related materials (e.g., correspondence, data, sketches, logs, authorizations, or other information) will be routed to the Project Director, or designee, after the original is marked with the date received. The Project Director, or designee, will then determine which personnel will review the materials and route the materials [material copy(ies), if practical] accordingly.

As soon as practical, incoming correspondence originals will be placed in the project central file. If the correspondence is required by project personnel for reference, a copy should be made rather than holding the original. Correspondence which is quality-related will be routed to the Project QA officer.

Communications relative to the project which are initiated by third parties (e.g., media, interested individuals and groups) will be referred directly to designated DOE representative(s) without comment, unless directed otherwise.

18.2.2 OUTGOING

Project-related materials transmitted externally including correspondence, reports, drawings, and sketches will be appropriately reviewed, approved, and, as required, signed prior to transmittal. Project outgoing correspondence will, as a minimum, be signed by the Project Director, or a key level designee. If joint signatures are desirable, the originator of the correspondence, may also sign. QA correspondence will be signed by

the Project QA Officer. Outgoing project correspondence and reports should be read by the Project Director, or designee, prior to issue. The office copy of project correspondence should bear routing information and be routed to the Project QA officer, if quality related.

Records transmitted between the site and/or remote offices or locations shall be adequately protected from damage and loss during transfer (e.g., hand carrying, making copies prior to shipment).

18.3 PROJECT CENTRAL FILES RECORD RETENTION

Following receipt of information from external sources, completion of the field phases of the project, completion of analyses, and issuance of reports; associated records shall be submitted to the on-site project central files. They shall include records generated by subcontractors. Records submitted to the on-site file, with the exception of correspondence, placed in folders or binders, or otherwise secured for filing.

18.3.1 Records Facility

The Project Central Files shall be located in an area which, as a minimum, adequately provides for:

- Suitable environment to prevent record deterioration, damage and loss,
- Controlled personnel access,
- Steel file cabinets,

- Protection against excess moisture and temperature extremes, and
- Where practical, record review area.

18.3.2 Records Handling

The Project Central Files and the records contained therein shall be maintained by designated personnel. Such personnel are responsible for:

- Review of incoming records for proper conditions for filing, (e.g., in accordance with the requirements of Section 18.1),
- Indexing records prior to filing.
- Filing of records, in folders, binders, etc.
- Maintaining sign-out sheet capability for removed files.

18.3.3 Records Index

A numbered index for the project on-site file shall be prepared and maintained. The index shall list the individual file numbers and identify the records therein to facilitate location of records. The index shall be located in the records area.

The project records index system consists of the following major categories:

0.0 Reference Material
1.0 Description of Current Situation
2.0 Work Plan Requirements
3.0 Site Investigation
4.0 Site Investigation Analysis
5.0 Lab and Bench-Scale Studies

6.0 Remedial Investigation Reports
7.0 Project Management
8.0 Community Relations
9.0 Federal Facilities Compliance Agreement (FFCA) Task 9 Other Work
10.0 FMPC Feasibility Study Work Plan
11.0 Initial Development of Remedial Alternatives
12.0 Initial Screening of Alternatives
13.0 Detailed Analysis of Alternatives
14.0 Evaluation and Selection of Preferred Alternatives
15.0 Draft Feasibility Study Reports
16.0 Final Feasibility Study Reports
17.0 Records of decision

18.4 OFF-SITE OFFICE PROJECT FILES

Appropriate requirements for off-site office control and retention of records generated as a result of this project shall be followed. A file, similar to the on-site file will be established and maintained by the office personnel under the direction of the appropriate office manager.

Upon completion of the project or project phase, the off-site office project file will be transferred to, and integrated with, the on-site files.

18.5 LABORATORY FILES

Laboratories will maintain record systems for documents pertinent to testing performance. These systems will provide record control and retention similar to that outlined for the on-site office files.

18.6 FINAL DISPOSITION

Upon completion of the project, the original of all laboratory data and records will be turned over to DOE. Upon approval by DOE, laboratory data files and records will be microfilmed for archival storage. Laboratories will be allowed to retain copies of their project data and records for their file.

17.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Project Management is apprised of the performance of measurement systems, data quality, results of quality assessment activities and, if applicable, repetitive and/or significant QA problems. These reports are periodic summaries, (e.g., monthly QA reports, surveillance/audit summaries, charts/graphs portraying overall project/laboratory quality statistics, etc.) as opposed to the normal daily distribution of documents generated during the course of project or laboratory activities (e.g., NCR's, analytical reports, audit and surveillance reports, etc).

17.1 REPORTS TO LABORATORY MANAGEMENT

The laboratory QC Coordinator provides periodic quality reports to the Laboratory Manager. These reports include, as a minimum, but are not limited to:

- Assessment of measurement data accuracy, precision and completeness,
- Results of performance and system audits of laboratory activities,
- Laboratory QC checks for effectiveness and,
- Significant quality problems and their resolutions.

NOTE: The Laboratory Manager is responsible for the distribution of copies of laboratory-generated quality reports to the Project Director and Project QA Officer.

17.2 REPORTS TO PROJECT MANAGEMENT

The Project QA Officer provides periodic quality reports to the Project Director. These reports include, as a minimum, but are not limited to:

- Assessment of the adequacy of quality related project activities,
- Results of surveillances and audits of project activities, and
- Significant quality problems and their resolutions.

NOTE: The Project Director is responsible for the distribution of copies of project-generated quality reports to the appropriate Laboratory Manager, when reports contain information vital to the laboratory's completion of assigned tasks.

17.3 PROJECT REPORT INCLUSION

The final report for each phase of the project must include a separate QA section which summarizes data quality information contained in the periodic reports.

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REMEDIAL INVESTIGATION
AND
FEASIBILITY STUDY
FEED MATERIALS PRODUCTION CENTER

DATA VALIDATION PROGRAM

October 4, 1990

U.S. Department of Energy
Oak Ridge Operations Office

DATA VALIDATION PROGRAM
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LIST OF ABBREVIATIONS/ACRONYMS

ANSI	American National Standards Institutes
ASI	Advanced Sciences, Inc.
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BFB	Bromofluorobenzene
CC	Chain-of-Custody (form)
CCC	Calibration Check Compound
CCS	Contract Compliance Screening
CCV	Continuing Calibration Verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	Calibration Factor
CLP	Contract Laboratory Program
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
DCR	Document Change Request
DFTPP	Decafluorotriphenylphosphine
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DVP	Data Validation Program Document
DVT	Data Validation Team
EPA	U.S. Environmental Protection Agency
FADL	Field Activity Daily Log
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Materials Production Center
GC/EC	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatograph/Mass Spectrometer
ICB	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICS	Interference Check Sample
ICV	Initial Calibration Verification
IS	Internal Standards
IT	International Technology
LCS	Laboratory Control Sample
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSA	Method of Standard Addition
m/z	The ratio of mass (m) to charge (z) of ions measured by GC/MS
NCP	National Contingency Plan
OADS	Organic Analysis Data Sheet
OU	Operable Unit
PCB	Polychlorinated biphenyl
PE Sample	Performance Evaluation Sample

PIC	Pressurized Ionization Chambers
QAMS	Quality Assurance Management Staff
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RIC	Reconstructed Ion Chromatogram
RFA	Request for Analysis (form)
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
RRF	Relative Response Factor
RRT	Relative Retention Time
RSD	Relative Standard Deviation
RT	Retention Time
SARA	Superfund Amendments and Reauthorization Act
SAS	Special Analytical Services
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SOW	Statement of Work
SPCC	System Performance Check Compound
SV	Semivolatile analysis
TCL	Target Compound List
TIC	Tentatively Identified Compound
VOA	Volatile Organic Analysis
VTSR	Validate Time of Sample Receipt
WMCO	Westinghouse Materials Company of Ohio

PREFACE

The Feed Materials Production Center (FMPC), a 1050-acre site located about 20 miles northwest of downtown Cincinnati, Ohio, is a government-owned, contractor-operated facility which was used for the production of pure uranium metals for the U.S. Department of Energy (DOE). The principal operations consisted of metal fabrication and the processing of accumulated plant residues and miscellaneous feed materials obtained from other DOE sites. As a result of these activities both radioactive and non-radioactive wastes were generated, and in 1985 the U.S. Environmental Protection Agency (EPA) expressed major concern over the potential environmental impacts associated with these wastes. In 1986, a Federal Facility Compliance Agreement (FFCA) was jointly signed by DOE and EPA, which required that the environmental impacts associated with past and present activities at the FMPC be adequately investigated such that appropriate remedial response actions could be formulated, assessed, and implemented.

In response, a site-wide Remedial Investigation and Feasibility Study (RI/FS) is being conducted pursuant to Section 106 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and in conformance with EPA's Guidance on Remedial Investigations Under CERCLA, and Guidance on Feasibility Studies Under CERCLA. The RI/FS is also consistent with the guidelines, criteria, and considerations set forth in the National Contingency Plan (NCP) and the Superfund Amendments and Reauthorization Act of 1986 (SARA).

Over the past several years, contractors have conducted preliminary evaluations to facilitate the scoping of the RI/FS Work Plan, as well as the actual remedial investigations (RIs) at selected site locations called operable units (OUs). The purpose of the RI is to determine the nature and extent of any release (or threat of release) of hazardous or radioactive substances, pollutants, or contaminants, and to gather the necessary data to support the development of the feasibility study (FS). Typical RI activities entail the collection and analysis of surface and subsurface soil samples, surface water and groundwater samples, and the performance of radiological screening and various geotechnical tests to confirm and characterize the extent of organic (volatiles, semi-volatiles, PCBs, and pesticides), inorganic (metals), and radioactive contamination. The purpose of the FS is to develop and evaluate remedial action alternatives to protect public health and the environment from these characterized substances, pollutants, or contaminants. The EPA will select the remedy or remedies based on the findings and recommendations of the FS.

It is this end use of the data - the technical evaluation and decision-making - that requires the validation of the RI-generated data. For the purpose of the FMPC RI/FS Project, the definition and application of the term validation will comply with the EPA's Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (QAMS-005/80), which states: " . . . data validation is a systematic process for reviewing a body of data against a set of criteria to provide assurance that the data are adequate for their

intended use." The requirement for data validation is addressed in Section 4 (Volume I) of the FMPC RI/FS Work Plan, the Data Management Plan (Volume IV of the Work Plan), and Section 10 of the Quality Assurance Project Plan (QAPP) (Volume V, Rev. 3 of the Work Plan). This document supplements and amplifies the requirements presented in Section 10 of the QAPP.

The purpose of the FMPC RI/FS data validation program is to provide assurance that the data used in FMPC RI/FS processes are qualified and adequate for their intended uses.

The purpose of this FMPC RI/FS Data Validation Program Document (DVP) is to provide the following:

- A description of the data validation process, its methodology, and the documentation generated.
- Guidelines for documenting and resolving those review findings which may affect the data's usability.
- Data validation authority, responsibility, and reporting structure.
- A plan for validation of RI/FS data generated before November 30, 1990.

I. INTRODUCTION

Validation Terminology

The terms "verification," "validation," and "evaluation" are often used interchangeably. This is understandable because the terms as defined in Webster's Dictionary are almost identical. However, according to QAMS-005/80, verification is but one important aspect of the validation process.

"Verification" is an ongoing, routine checking by technical, analytical, and clerical personnel on small sets of data to determine if the data have been accurately quantified, recorded, and transcribed; if prescribed procedures have been complied with; if the data appear suitably complete; and if the data appear to be reasonable and consistent, based on what is already known about the characteristics of the site being investigated.

"Validation" is an after-the-fact, independent, systematic process which compares a body of data against a set of performance objectives or data quality objectives (DQOs) to determine consistency with, and applicability to, specific purposes. All of the DQOs are contained in either the QAPP and/or Laboratory Data Validation Guidelines for Evaluating Organic Analysis, U.S. EPA, February 1988 and the Laboratory Data Validation Guidelines for Evaluating Inorganic Analysis, U.S. EPA, July 1988.

Whereas validation stamps data as reliable or "good" data, "evaluation" determines its technical usefulness. Upon completion of validation, OU personnel perform a technical evaluation, which entails the reduction, tabulation, manipulation, interpretation, and environmental fate and transport modeling/evaluation. These activities result in the production of technical reports.

FMPC RI/FS Data Validation

For the FMPC RI/FS project, data validation means:

1. Reviewing documentation of field measurements and observations, analytical results, and associated QA/QC information to ensure that the data were gathered and analyzed according to appropriate, predefined criteria specific to the analyses performed and results/information requested.

2. Identifying and correcting/rationalizing data discrepancies/deficiencies.

3. Characterizing the data with respect to their usability.

Data validation includes:

1. Accomplishment of field sampling and laboratory analysis QC procedures under existing project and laboratory QA programs.

2. Data results and documentation review by the data validation team and others using specific checklists and procedures to verify compliance with pre-determined sampling/data-gathering requirements, verify adequacy of laboratory analyses against established criteria, document discrepancies and deficiencies, and recommend data qualifiers (signifying the data's conformance to QC requirements).

3. Reconciliation of discrepant and deficient data by field managers, project technical personnel, data requestors, and data users to determine/decide the data's validity with respect to their intended use.

4. Review of data discrepancies/deficiencies by the project QA officer to determine and accomplish any required project QA/QC system actions.

5. Assignment of appropriate data qualifiers (signifying the data's usability for a particular purpose) by project technical personnel and incorporation of the data qualifiers into the project database by data management personnel.

The entire data validation process requires participation by the data validation team, laboratory QA personnel, the project QA officer, project technical personnel, initial data requestors, data users, and database management personnel. Data validation results require approval of the project director.

The expected product of the data validation process is confirmation/certification that the data to be used are adequate for their intended use.

Data validation is complete when the project director approves use of the data for a particular purpose and appropriate qualifiers are incorporated in the project database.

This DVP is the FMPC RI/FS Project guidance for conducting the data validation process. The objective of the validation process is to provide assurance that a defensible data collection "road map" exists that can be used to trace and justify activities, analyses, and decisions based on the data. This assurance rests principally on the adequacy of:

- Sample collection procedures
- Sample tracking procedures
- Field and analytical instrument calibration
- Field and analytical quality control procedures

- Training and qualification of personnel
- Documentation

II. TECHNICAL APPROACH

To ensure that all data validation activities are conducted in a cost-effective, technically sound, and defensible manner, the following technical approach will be used:

- All validation activities will be conducted in accordance with this program, which addresses the technical, regulatory, and QA requirements for this RI/FS project. A listing of documents containing project guidance and requirements is provided in the References section of this program.

- Review checklists and procedures will be used to perform the data review. These checklists are directly traceable to the appropriate requirements and industry standards (e.g., ANSI, ASTM, ASME).

Checklist Development

The checklists in Appendix A were developed from DQO's in the FMPC QAPP, Lab Data Validation Functional Guidelines for Evaluating Organic and Inorganic Analysis, and other QA acceptance criteria for non-EPA methods.

Some of the key criteria or DQOs which are examined during laboratory analysis are as follows:

- Organics

  - holding times
  - gas chromatograph/spectrometer tuning
  - calibration
  - blanks
  - surrogate recovery
  - matrix spike/matrix spike duplicates
  - field duplicates

- Inorganics

  - holding times
  - calibration
  - blanks
  - field duplicates
  - matrix spike/matrix spike duplicates
  - furnace atomic absorption

- interference check sample
- inductively-coupled plasma interference check sample

- Radiochemical

  - blanks
  - replicates
  - relative standard deviation
  - spikes
  - percent bias exceeding control limits

To comply with official QAMS-005/80 guidance, data are of acceptable quality only if they meet specified DQOs for precision, accuracy, representativeness, completeness, and comparability. Upon completion of data validation by laboratory personnel (and before submittal of the certificate of analysis and completed data packages to the Project Office), the data are clearly flagged with code letters which represent laboratory data qualifiers.

Graded Approach

A graded approach will be used to determine what extent of validation effort is warranted, and will be based on:

1. Intended use for the data (level of confidence necessary)
2. Analytical level associated with the sample
3. Validation phase

1. Intended Use for the Data: In general terms, the key to determining the amount of validation effort required is two-fold - what is the intended use of the data, and what level of quality must be present to assure its usefulness (i.e., what level of confidence must be present). Once the data-use categories have been specified in the sampling plan, the intended use will help identify the level for each data category.

In practical project terms, this graded approach to quality (i.e., the level of precision, accuracy, representativeness, comparability, and completeness required) is driven in part by where in the investigative process the data are generated. For example, the quality required from an initial walk-on radiological screening to determine if anomalous levels of radiation are present differs significantly from that of determining the exact concentrations of thorium present, and if it has leached into a public water supply's aquifer.

2. Analytical Support Levels: The rigor of QA/QC testing and resultant documentation (and therefore the extent of verification and validation to be performed) directly relates to the level in which the data are placed. These five levels are described in Section 4.3 of the Data Quality Objectives for Remedial Response Activities: Development Process, (EPA/540/G-87/003). These five analytical support levels deal only with quality assurance levels and are not the same as validation levels:

- Level I - field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative, but results are available in real-time.

- Level II - field analyses using more sophisticated portable analytical instruments; in some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. The quality depends on the use of suitable calibration standards, reference materials, sample preparation equipment, and the training of the operator. Results are available in real-time or several hours.

- Level III - all analyses performed in an off-site analytical laboratory. Level III analyses may or may not use Contract Laboratory Program (CLP) procedures, but do not usually utilize the validation or documentation procedures required of CLP Level IV analysis. The laboratory may or may not be a CLP laboratory.

- Level IV - CLP routine analytical services. All analyses are performed in an off-site CLP analytical laboratory using CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

- Level V - analysis by non-standard methods. All analyses are performed in an off-site analytical laboratory which may or may not be a CLP laboratory. Method development or method modification may be required by specific constituents or detection limits. CLP special analytical services are Level V.

Examples of probable data levels for this project are:

- Level I - walk-on radiological screening data
- Level II - field data collected for pH and alkalinity
- Level III - data collected from SW-846 methods
- Level IV - routine RI/FS target compound list for soil and water (CLP)
- Level V - radiological samples

The quality assurance levels are incorporated into the check lists as presented in Appendix B of this Program.

3. Validation Phase: The QAPP, section fifteen, divides validation into two levels. The first is a verification of electronically transferred data against a laboratory hard copy of analytical results. This level either has been completed or is being completed as data are collected, and is not part of this effort. The second validation level is the technical analysis of data. This validation program is divided into two phases. The first phase deals with field data and is validated to quality assurance Levels I and II. The second phase deals with analytical results and is validated to quality assurance Levels III, IV, V. The analytical results are analyzed in discrete sets with associated quality control samples, and the validation will be performed on these individual and discrete sets of data.

The first phase of the validation process is a routine verification or checking that the appropriate procedures for field observations and measurements were specified and followed. If calibration has been completed, there is little need for technical judgment. This first phase typically covers the time from sample planning to the time the packaged sample is received and logged in at the laboratory.

The second phase is the verification or checking of analytical elements such as holding time, detection limit results, and calibration results against performance criteria or DQOs. It requires practical experience, on-site project knowledge, and technical judgment. It includes validation of laboratory analytical results (which are documented in the certificate of analysis and associated data package) and review of the laboratory's validation efforts by the data validation team.

The non-CLP analytical criteria used in the checklists are the same criteria in CLP where applicable. The rest of the data will be validated against established criteria in the QAPP. Data that are not covered by the QAPP or CLP will be validated on a case-by-case basis against documented criteria in the checklists.

The review of calibration and raw data of non-level IV (non-CLP) QA/QC review cannot be performed since raw data are not reported. Therefore the review areas concerning non-level IV (non-CLP) raw data shall be covered by internal and external audits of the laboratory for compliance to the QAPP.

The sequence of validation activities is illustrated in Figures 1 and 2 and described below:

Phase I Review (Field Measurements and Observations)

Step 1 Identify data (i.e., sample numbers, well numbers, etc.) to be validated.

Step 2 Obtain original completed field data forms/records.

Step 3 Review data in planned sequence using field data review instructions, procedures, and checklists (Appendix A-I).

Step 4 If data meet checklist requirements, field data validation process is complete. If data are discrepant or deficient, initiate Discrepancy/Deficiency Resolution Process.

Step 5 Report field data validation results to the project director by groups according to the review sequence. List all sample numbers, flag discrepant/deficient data samples, include copies of appropriate data validation deficiency reports (less review checklists).

Step 6 Retain copies of completed review checklists in DVT files. Replace original field data forms/records in FMPC project files.

Phase II Review (Laboratory Analyses)

Step 7 Obtain original completed laboratory certificate of analysis /data packages.

Step 8 Review data sets in planned sequence using laboratory analyses review instructions, procedures, and checklists (Appendices A-II through A-VI).

Step 9 If laboratory analyses and results meet review requirements, laboratory analysis validation process is complete. If laboratory analyses or results do not meet review requirements, initiate Discrepancy/Deficiency Resolution Process.

Step 10 Report laboratory data review results to the project director by groups according to the review sequence. List all sample numbers, flag discrepant/deficient/questionable samples, include copies of appropriate data validation deficiency reports (less review checklists).

Step 11 Retain copies of completed review checklists in DVT files. Replace original laboratory analyses and results in FMPC project files.

Figure 1

Phase I Review

(Field Measurements and Observations)

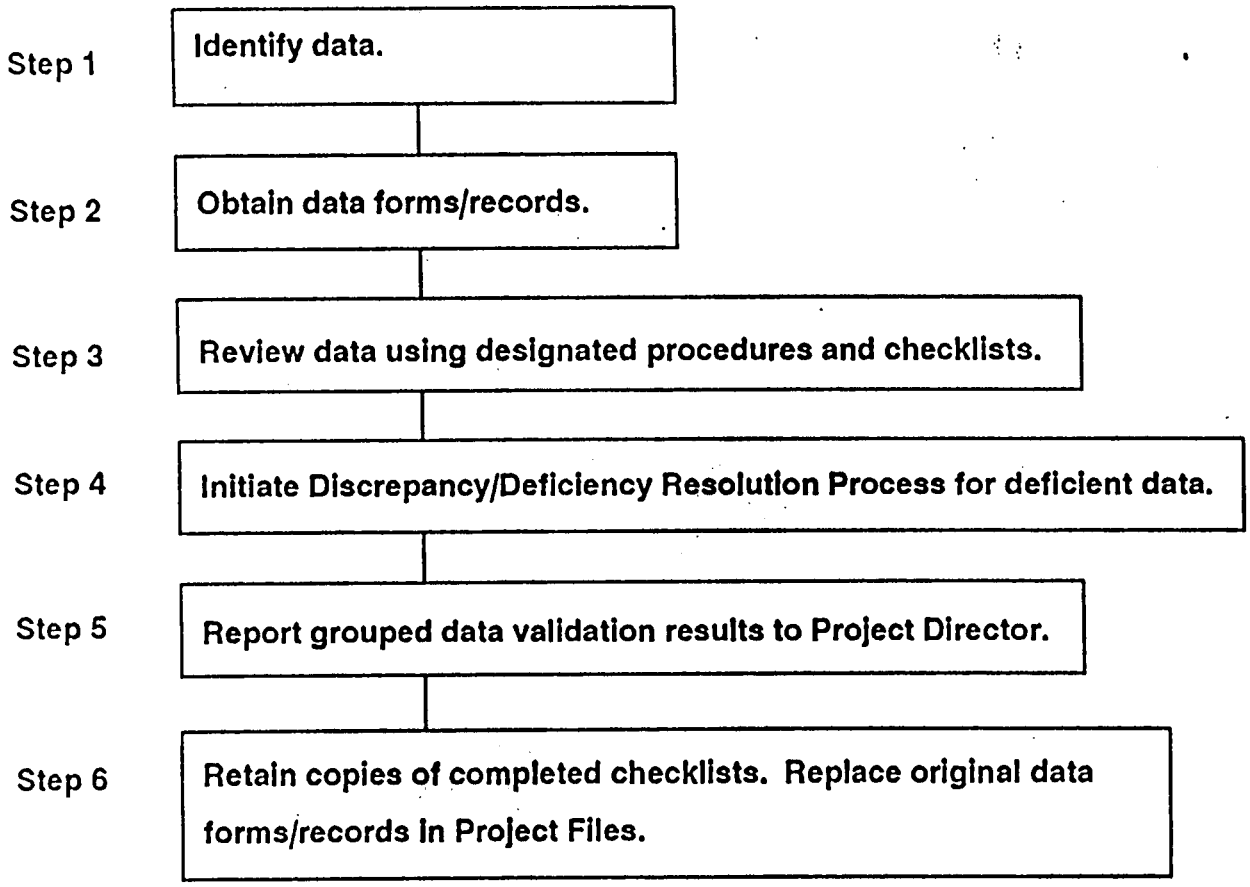

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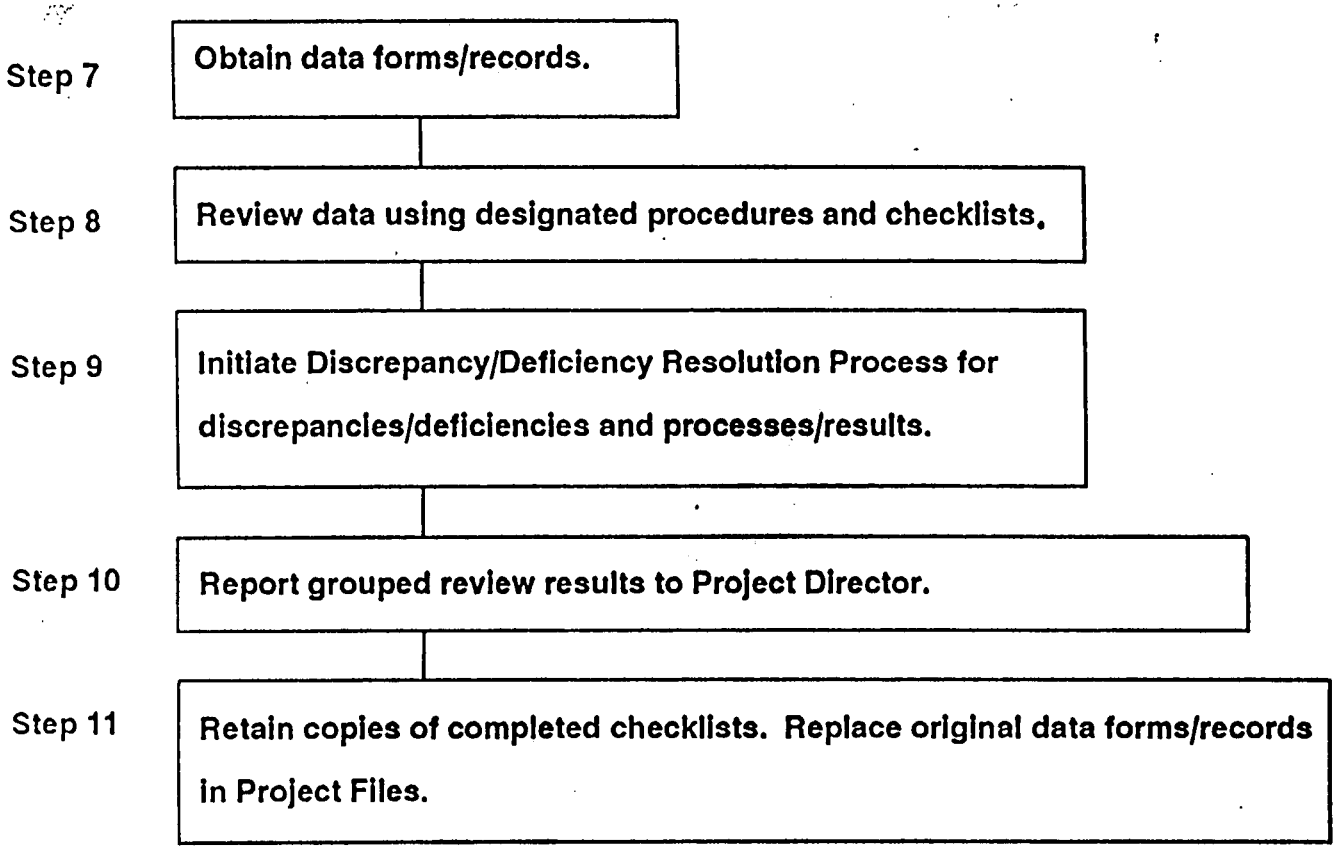
Figure 2

Phase II Review

(Laboratory Analyses)



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Phase I and II validation may result in data of questionable acceptability. This questionable acceptability may be due to the absence/insufficiency of one or more of the following requirements for quality data:

- Specified, adequate sample collection procedures and adherence to those procedures by trained personnel.
- Specified, adequate sample tracking procedures and adherence to those procedures by trained personnel.
- Specified, adequate field and analytical instrument calibration and adherence by trained personnel to the work plan and additional approved procedures on file in the Project QA office.
- Specified, adequate quality control procedures and adherence to those procedures by trained personnel.

Discovery of an absent or non-compliant attribute necessary to support the integrity of the data will result from the completion of the detailed review checklists contained in Appendix A.

The checklists ask many specific questions; however, an unacceptable answer to one does not necessarily indicate that the data are automatically bad or unusable. Specific guidance on the information to be provided for each major measurement parameter is provided in Section 5.10 of QAMS-005/80, "Data Reduction, Validation, and Reporting."

For checklist items which cause the reviewer to question the data's integrity, a formal evaluation/proposed resolution will be conducted, and the proposed resolution will be reviewed and approved by the Project Director. Documentation of the process will become part of the project files.

- All original project documentation, original validation documentation, and any reports summarizing or evaluating the validation effort shall be retained in the FMPC Project Files.
- DVT data validation/review reports to the project director according to the review sequence will document progress of the validation process.
- The validation process will be periodically inspected/surveilled by ASI/IT QA staff to monitor and document compliance with the DVP by the validation team, and to assess the team's effectiveness.

Discrepancy/Deficiency Resolution Process

1. The data validation team (DVT) will document discrepancies/deficiencies by filling out the FMPC RI/FS Data Validation Deficiency Report and attaching the appropriate, completed review checklist thereto.

2. DVT leader or technical representative will sign and date the deficiency report, and assure that the report is sequentially numbered and logged in the FMPC RI/FS Data Validation Deficiency Reports Log.

3. DVT member will deliver the completed, numbered, signed deficiency report to the project QA officer.

4. QA officer will review the deficiency report to determine Quality Assurance actions (non-conformance reports, field feedback program, etc.).

   A. If the identified discrepancy/deficiency is associated with field observations and measurements, the QA officer will assign the discrepancy/deficiency to field technical requirements manager to (1) find the missing information, (2) reaccomplish the procedure, or (3) explain the impact of the data discrepancy/deficiency on the validity of the data. The field technical requirements manager's signed and dated explanations/comments will be legibly printed in ink on the reverse side of page 2 of the deficiency report, and returned to the QA officer.

   B. For both laboratory analysis and field data discrepancies, QA officer will affirm initiation of appropriate QA/QC system actions, and sign and date the data validation deficiency report.

5. QA officer will deliver the DVT- and QA-signed deficiency report to the project deputy director/technical or project technical manager.

6. Deputy director/technical or the technical manager will review the deficiency report and attached checklist, and transmit the entire data validation package to the appropriate data user or initiator of the original data request.

7. Data user/initiator of original data request will review the data validation deficiency report (with its attached checklist and field manager comments, if applicable); make a definitive, signed recommendation regarding the deficient/discrepant data's validity for their intended use (legibly printed in ink on the reverse side of page 2 of the deficiency report); and return the entire package to the deputy director/technical or technical manager, as applicable.

8. Deputy director/technical or technical manager will review the data user's/initiator's recommendation on the deficient/discrepant data's validity for their intended use; comment on the recommendation, if necessary; sign the data validation deficiency report; and deliver the package to the project director.

9. Project director will indicate his concurrence with the data user's recommendation and/or his approval to use the deficient/discrepant data for a particular purpose by signing the data validation deficiency report.

10. Usability status of the data (identified by data qualifier assigned to each data sample number) will be entered in the RI/FS project database.

11. After data qualifiers have been entered in the project database, the approved/signed deficiency report will be placed in the project files.

Qualifier Code Identification

The following codes shall be assigned to data in order to identify confidence of identification and quantitation. These qualifiers are taken from the fundamental guide for organic and inorganic analysis validation:

Laboratory Data Validation Functional Guidelines for Evaluation Inorganic Analysis, U.S. Environmental Protection Agency, July 1, 1988, and

Laboratory Data Validation Functional Guidelines for Evaluating Organic Analysis, U.S. Environmental Protection Agency, February 1, 1988.

Codes Relating To Identification
(confidence concerning presence or absence of compounds):

U = Not detected. The associated number indicates approximate sample concentration necessary to be detected.

(NO CODE) = Confirmed identification.

B = Not detected substantially above the level reported in laboratory of field blanks.

R = Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.

N = tentative identification. consider present. Special methods may be needed to confirm its presence or absence. in future sampling efforts.

Codes Related To Quantitation
(can be used for both positive results and sample quantitation limits):

J = Analyte present. Reported value may not be accurate or precise.

K = Analyte present. Reported value may be biased high. Actual value is expected to be lower.

L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.

UJ = Not detected, quantitation limit may be inaccurate or imprecise.

UL = Not detected, quantitation limit is probably higher.

JB = Approximate data due to blank contamination.

III. AUTHORITY, RESPONSIBILITY, AND REPORTING STRUCTURE

Figure 3 shows the lines of authority and reporting structure for the FMPC RI/FS Data Validation Program.

The ASI/IT RI/FS Project Director will identify the project data to be validated. The Data Validation Team Leader is responsible for managing the data validation effort. He will advise the Project Director directly of overall validation progress. However, he will report specific validation deficiencies and recommendations to the Project Director through the Project QA Officer. The Project Director will review these results, direct resolution of data validation deficiencies, and approve the data's use for RI/FS technical evaluations and reports.

Overall responsibility for RI/FS project use of all data rests with the DOE RI/FS Project Manager. Data validation issues unresolvable at lower levels will be elevated to him/her through the project structure.

At the direction of the ASI Corporate Vice President, Advanced Technology and Special Projects, the ASI Project QA Officer will provide independent functional oversight of the data validation effort.

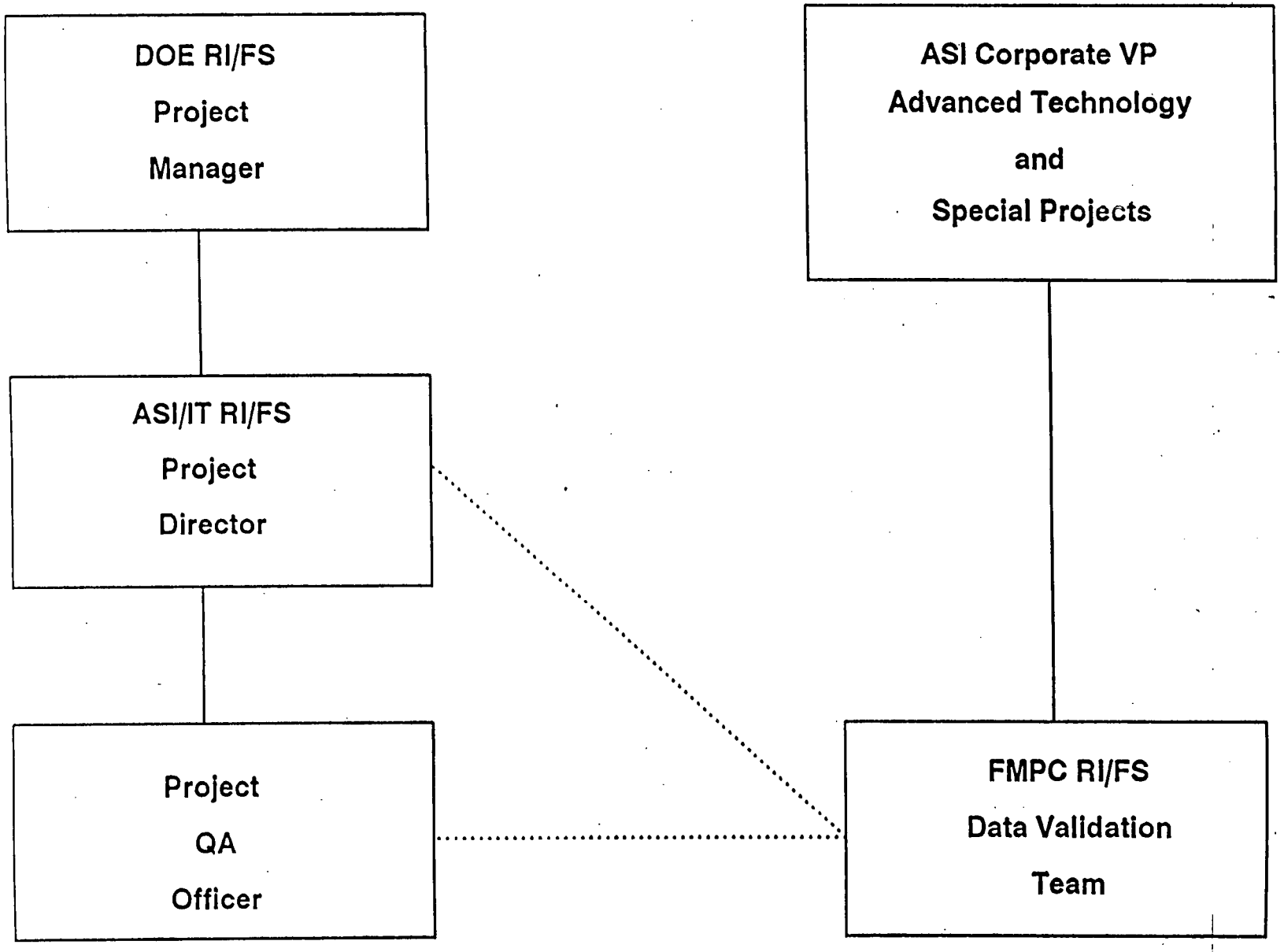
The ASI/IT Project Director will provide administrative, logistics, and funding support for the data validation effort.

Independent of Project Control

The DVT is responsible for reviewing the identified project data in accordance with this DVP. The DVT leader takes his direction from and reports directly to the ASI Corporate VP for Advanced Technology and Special Projects, but has a coordination/information responsibility to both the RI/FS Project Director and to the Project QA Officer. Except for general logistics support, the DVT functions independently of project control.

Figu 3

Data Validation Reporting and Coordination Structure



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IV. DVT ORGANIZATIONAL RESPONSIBILITIES AND FUNCTIONS

Figure 4 shows DVT internal organizational responsibilities.

The following specific functions are associated with the Figure 4 organizational responsibilities:

(1) Plan, assign, direct, coordinate, control,and report DVT activities and results; review and sign Data Validation Discrepancy Reports.

(2) Review DVP for technical adequacy; develop Phase I and Phase II checklists and procedures; advise DVT Leader on personnel qualifications and training; train DVT Phase I and Phase II validation personnel; review completed Phase I and Phase II checklists; recommend appropriate qualifiers for reviewed data; review and sign Data Validation Discrepancy Reports.

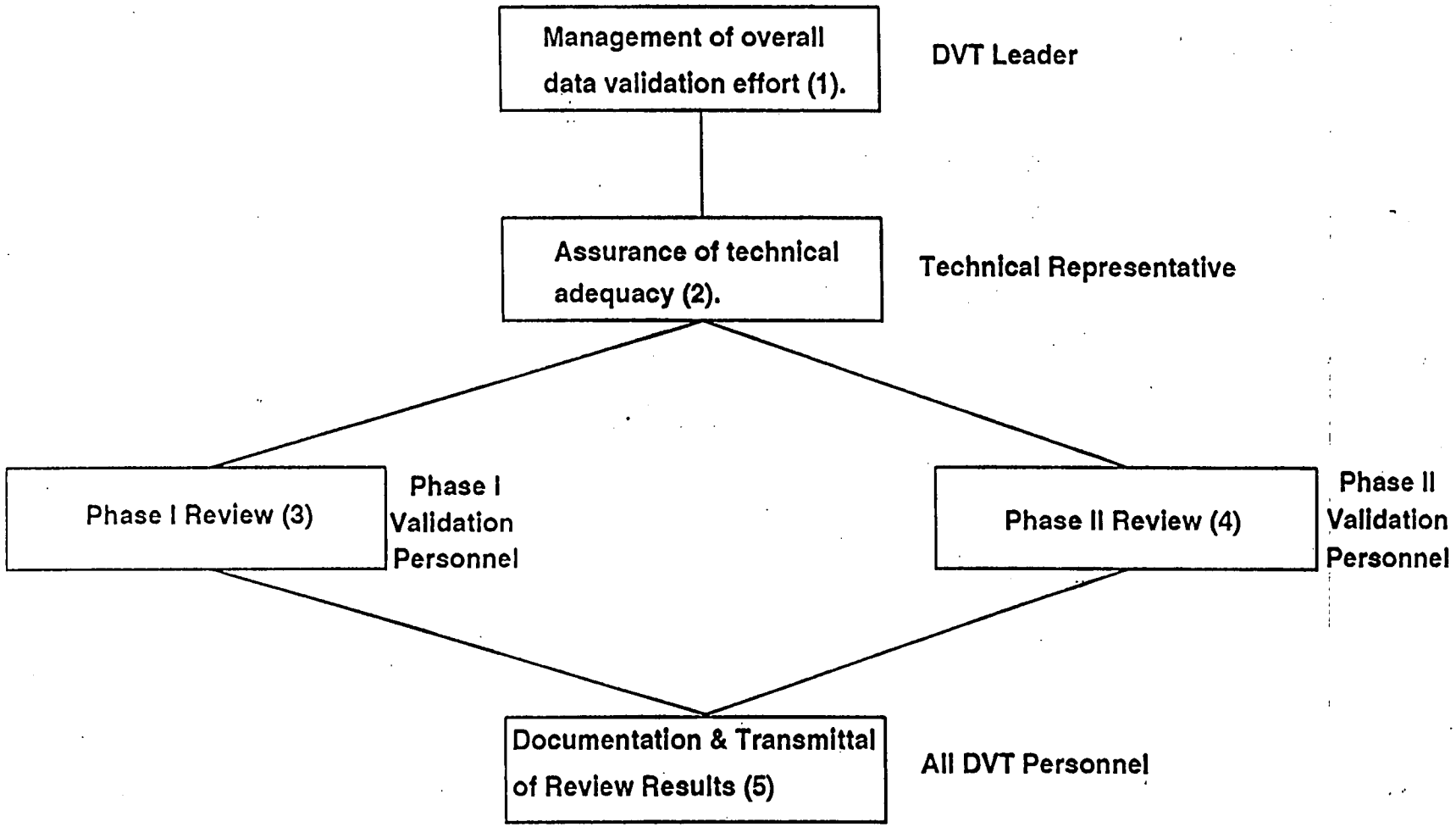
(3) Review and verify field measurements and observations in accordance with Phase I review procedures; complete Phase I review checklists; complete Data Validation Discrepancy Reports.

(4) Review, verify, and certify laboratory analyses in accordance with Phase II review procedures; complete Phase II review checklists; complete Data Validation Discrepancy Reports.

(5) Ensure DVT Leader/Technical Representative signature on completed Data Validation Discrepancy Reports; log discrepancy reports in Data Validation Discrepancy Report Log; copy all discrepancy reports and completed checklists for retention in DVT files; deliver completed discrepancy report/checklist package to Project QA Officer.

Figure 4

DVT Organizational Responsibilities



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V. DVT PERSONNEL QUALIFICATIONS AND TRAINING

Each team member will have training covering their responsibilities. The DVT technical representative will supervise training in the use of checklists.

DVT Basic Orientation/Training

DVT member basic orientation/training consists of:

- General field techniques briefing by ASI/IT Field Technical Requirements staff.
- FMPC RI/FS Work Plan, Vol. I, Section 4 (Technical Approach: Remedial Investigation) study and familiarity.
- FMPC RI/FS Quality Assurance Project Plan, Section 10 (Data Reduction, Validation, and Reporting) study and familiarity.
- ASI White Paper on Data Validation, June 1990, study and familiarity.
- View WMCO videotape: "ERA Cleanup".

Basic orientation/training for each DVT member will be documented on the Data Validation Team Member Basic Orientation/Training form (Appendix B). The completed form will be retained in DVT files.

The following list specifies DVT personnel experience and training requirements:

Leader

- Test team and project management experience
- Supervising senior engineer
- Complete DVT Training/Orientation Program

Technical Representative

- B.S. Chemist required, Masters Degree preferred
- Five years experience in analysis of organic and inorganic analysis
- Two years CLP experience
- Complete DVT Training/Orientation Program

Phase I Validation Personnel

- Bachelors Degree in Environmental Studies, Geology, or Chemistry
- Trained in use of FMPC RI/FS Data Validation Phase I checklists and procedures
- Complete DVT Training/Orientation Program

Phase II Validation Personnel

- B.S. Chemist, or related discipline with laboratory experience
- Two years experience in analysis of organic and/or inorganic samples
- One year CLP experience
- Trained in use of FMPC RI/FS Data Validation Phase II checklists and procedures
- Complete DVT Training/Orientation Program

VI. PLANNED DATA REVIEW SEQUENCE AND REPORTING

The DVT will review FMPC RI/FS field and laboratory data according to the following sequence:

1. OU4
2. Task 3.2.4 (groundwater)
3. Task 3.2.1 (subsurface soil)
4. Task 3.3 (surface water and sediment)
5. Task 3.4.1 (field radiation survey)
6. Task 3.4.2 (surface soil)
7. Task 3.7 (facilities testing)
8. Task 3.7.4 (facilities testing-soil)
9. Task 3.7.5 (geochemical)
10. Task 9.25 (WMCO RCRA groundwater)
11. Task 9.27 (WMCO RCRA groundwater and EMP)
12. Task 3.8 (Building 69 investigation)
13. Task 5.6 (Bench scale permeability)
14. Task 3.5 (biological)

When the DVT has completed each review (field data and laboratory analyses) of each section of data, the team leader will deliver a written report of each review to the project director. The DVT report will list the data sample numbers and flag the discrepant/deficient data samples, and will include copies of the appropriate DVT-generated Data Validation Deficiency Reports (less review checklists).

References

Data Management Plan, Volume IV of the FMPC RI/FS Task 2 Report Work Plan Requirements, March 1988.

Data Quality Objectives for Remedial Response Activities (Development Process), U.S. Environmental Protection Agency, March 1987.

Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80, 1980.

Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis, U.S. Environmental Protection Agency, July 1, 1988.

Laboratory Data Validation Functional Guidelines for Evaluating Organic Analysis, U.S. Environmental Protection Agency, February 1, 1988.

Quality Assurance Project Plan, Volume V of the FMPC RI/FS, Task 2 Report Work Plan Requirements, Revision 3, March 1988.

Quality Assurance Manual, IT Corporation Environmental Projects Group Analytical Services, Revision 1, February 1, 1988.

Quality Assurance Manual, IT Corporation Environmental Projects Group Engineering Operations, Revision 1, July 1, 1987.

Quality Assurance Manual Laboratory-Specific Attachment, IT Corporation Knoxville Laboratory (Middlebrook Pike), Revision 1, August 18, 1989.

Quality Assurance Manual Laboratory-Specific Attachment, IT Corporation Mixed Waste Laboratory, Revision 1, December 6, 1989.

Quality Assurance Manual Laboratory-Specific Attachment, IT Corporation Radiological Sciences Laboratory, Revision 0, August 1, 1987.

Sampling Plan, Volume I of the FMPC RI/FS Task 2 Report Work Plan Requirements, March 1988.

Work Plan Addendum, Production and Additional Suspect Areas, October 1989.

Work Plan for Conducting the Site-wide Remedial Investigation and Feasibility Study of the Feed Materials Production Center, FMPC RI/FS Task 2 Report Work Plan Requirements, March 1988.

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APPENDIX A
REVIEW CHECK LISTS AND INSTRUCTIONS

GENERAL INSTRUCTIONS

Data validation procedures for determining the acceptability of data generated during previous, recent, and ongoing studies for the FMPC RI/FS will follow the same criteria described in Section 10.0 and 11.0 of the project-specified QAPP. The DV Team Leader will assign individuals to validate the data. This effort will be accomplished in accordance with the method described in this appendix.

- Only the DV Team Leader can approve changes to original documents with concurrence of the Project Director.
- All changes shall have justification.
- Incorrect data shall be lined through and the correct value placed above or adjacent to it.
- It may be necessary to originate a new data report form. This requires all appropriate signatures.
- All data must be returned in a validation data package, appropriately identified as to its status.
- Response to problems resulting from the validation shall go through the resolution process and be signed off by the Project Director.
- Samples analyzed prior to the FMPC RI/FS and non-ASI/IT generated data will follow the same check lists and procedures, to the extent of documentation available.
- Data validation for geochemical data is covered under the field and analytical check lists.

APPENDIX A-I
FIELD MEASUREMENTS AND OBSERVATIONS

INSTRUCTIONS

The purpose of this instruction is to provide an organized method to review documentation of sampling performed in the RI/FS at FMPC. Checklists are contained herein to aid in identifying discrepancies and deviations to procedures contained in Volume 1 of the RI/FS Work Plan "Sampling Plan" and Volume V "Quality Assurance Project Plan" (QAPP).

Field measurements and observations generated in accordance with the project specific work plan will primarily consist of radiological screening data, field temperature, pH, and specific conductance data, and data associated with soil boring advancement, monitoring well installation and development, groundwater data, geophysical logging and soil classification, etc. These data will be validated by a review of the project documentation to check that all forms specified in the work plan and QAPP have been completely and correctly filled out and that documentation exists for the required instrument calibration. This review of documentation will be considered sufficient to certify that proper procedures have been followed during the field investigation per Section 10.2 of the QAPP. The DV Technical Rep shall certify that the data reports or forms have been adequately validated.

General Instructions

As each document is reviewed, record instances of the following:

- Use of "white out" on a document
- Changes and/or corrections not properly made

  NOTE: All corrections should be indicated by a single line through the entry, with initials and date of the individual making the correction. Note these occurrences on the checklists provided and reference the **particular document where this discrepancy or deviation occurred.**

Do not make corrections to any document being reviewed.

As each document is reviewed, complete each appropriate checklist. Traceability to each document reviewed is to be maintained. The reviewer shall also signify completion of the review by signature and date.

Obtain a copy of the filing system index to familiarize yourself with document locations.

Copies of the data base are available for your use. These copies cross reference various documents of a particular sample well number, or document control number.

Use the checklist provided to trace a particular sample from one document to another. An example of this is a sub-surface soil sample indicated on the boring log, sample collection log, chain-of-custody form (c-c), Request For Analysis form (RFA) and the Field Activity Daily Log (FADL) or Geologist Field Log.

The checklist is to be used as a guide to ensure that all requirements of the QAPP were implemented at the time the document was prepared. If no deviations are found on a particular document, the completion of a checklist is still required; if a discrepancy is found, the appropriate box on the checklist shall be marked and pertinent comments made. The checklist will be retained for further review by the DV Technical Rep to determine the effect that particular discrepancy has on data quality (if any). Documentation of discrepancies will also aid in determination of future corrective action.

References are made in this Appendix to appropriate sections of the QAPP. This is to aid the reviewer in determining all of the requirements which may apply to a particular document and drawing conclusions as to whether a discrepancy actually exists.

Be aware of Document Change Requests (DCRs), nonconformances, variances, audits, and surveillances that may impact the review.

As each document is reviewed, verify that calibration documentation exists for the required instrument at the time of usage.

As each document is reviewed, verify that training records exist for the field personnel involved in data collection and reporting.

All field measurements and observations forms or reports shall be checked for completeness. All space entries are to be filled out. There are to be no blank data entry spaces.

All field measurements and observations forms or reports shall be checked for accuracy. All spaces shall contain reasonable entries (e.g., temperature space shall contain a temperature reading, not a check mark).

Per data reporting format and protocols in Section 5.3 of the QAPP, all lines on the forms will be completed. The letter designation "NA" for not applicable or "NK" for not known will be used in all blank spaces. Also acceptable is a neat and precisely drawn arrow through applicable spaces from an "NA" or "NK." If some steps or procedures were not performed as described, the reason must be stated as completely as possible on the appropriate form or submitted as an attachment thereto.

General Validation Checklists (QA Levels I and II)

Field measurements and observations validation shall use the General Validation Checklists for each of the following data form or report.

A. Field Daily Activity Logs
B. Sample Collection Log
C. Chain of Custody
D. Request for Analysis
E. Training, procedures, nonconformances, variances, document change requests, audits, surveillances, and instrument calibrations

Specific Validation Checklist (QA Levels I and II)

Specific Validation Checklist will be used for each of the following data forms or reports.

A. Subsurface Soil Sampling
B. Well Construction and Development
C. Aquifer/Permeability Testing
D. Groundwater Sampling
E. Radiation Survey (Node and Walkover Surveys)
F. Surface Soil Sampling
G. Surface Water and Sediment Sampling

The general validation checklists are incorporated with the specific validation checklist as one line item where applicable. Biological samples will require that each of the general checklists be filled out.

Subsurface Soil Samples

A. Refer to the Specific Validation Checklist for Subsurface Soil Sampling.

B. Each soil boring log (QAPP Figure 5.8) contains the number of soil samples taken from that boring. Each sample should appear in the Sample Collection Log, C-C, RFA, and FADL (or field log). Make certain each form is correctly filled out by utilizing checklists for these forms. Alternately, if numerous discrepancies exist, make a copy of the document and circle the discrepancies with a red pen. Note this fact on the checklist and attach the copy.

C. Sections 4.3 through 4.5 of the Sampling Plan (Work Plan Vol. 1) provide background information for subsurface soil sampling. Section 5.2 of QAPP contains

drilling procedures. Section 7.1 of QAPP contains requirements for Sample Collection Logs, C-C and RFA. (NOTE: There are General Validation Checklists for each of these standard forms.)

D. **The RFA should indicate the type of analysis the sample should undergo.** Packaging requirements for subsurface soil samples are contained in Table 4-1 of the Sampling Plan, and should correspond to type of analysis requested on the RFA.

E. Radiological sampling requirements of subsurface soil is contained in 6.6.2 of QAPP.

Well Construction and Development

A. Refer to the Specific Validation Checklist for Well Construction and Development.

B. The following documents require review (for each well):

- FADLs (use General Validation Checklist)
- Figure 5-12 "Monitoring Well Installation Details"
- Figure 5-9 "Piezometer Installation Sheet," Note that construction should correspond with requirements contained within QAPP Section 5.3
- Figure 5-13 "Monitoring Well Completion Checklist"
- Figure 5-10 "Piezometer Sensitivity Test"
- Figure 5-16 "Monitoring Well Development"

C. Section 3.3 of the Sampling Plan contains background information relative to well construction.

D. QAPP Section 5.3 contains background information relative to monitoring well construction. QAPP Sections 5.4 and 5.5 contain requirements for well development and geophysical logging respectively.

Aquifer/Permeability Testing and Water Level Measurements

A. Refer to the Specific Validation Checklist for Aquifer Testing

B. The following documents require review (for applicable wells):

- FADLs (use General Validation Checklist)
- Figure 5-18 or Figure 5-19, "Falling Head" or "Constant Head" Permeability Test respectively
- Figure 5-1 "Piezometer Data Sheet"

C. Section 3.4 of Sampling Plan contains background information relative to aquifer testing and water level measurements.

D. QAPP Section 5.6 contains requirements for aquifer testing, and QAPP Section 6.1.2 contains requirements for water level measurements.

Groundwater Sampling

A. Refer to Specific Validation Checklist for Groundwater Sampling.

B. The following documents require review:

- Figure 6-1 "Water Quality Field Collection Report"
- C-C, RFA, FADL, Sample Collection Log (NOTE: Use General Validation Checklists for review of these standard documents.)

C. Section 3.5 of Sampling Plan contains information relative to groundwater sampling.

D. QAPP Section 6.1 contains requirements for groundwater sampling. Please pay particular attention to Section 6.1.1 -each sample type requires a specific container. The RFA, Sample Collection Log, and C-C forms should be correlated and the correct container type recorded for each sample.

E. QAPP Section 6.2 contains requirements for field analytical procedures. All documentation of analytical test performed on samples and field calibration should be properly recorded on the Water Quality Field Collection report.

Surface Soil Sampling

A. Refer to the Specific Validation Checklist for Surface Soil Sampling.

B. Each sample should appear in the Sample Collection Log, C-C, RFA, and FADL (or field log). Make certain each form is correctly filled out by utilizing General

Validation checklists for these forms. Alternatively, if numerous discrepancies exist, make a copy of the document and circle the discrepancies with a red pen. Note this fact on the checklist and attach the copy.

C. Sections 2.2 and 2.4 of the Sampling Plan (Work Plan Vol. 1) provide background information for subsurface soil sampling. Section 6.4 of QAPP contains sampling procedures. Section 7.1 of QAPP contains requirements for Sample Collection Logs, C-C and RFA. (NOTE: There are General Validation Checklists for each of these standard forms.)

D. **The RFA should indicate the type of analysis the sample should undergo.** Packaging requirements for surface soil samples are contained in Table 4-1 of the Sampling Plan, and should correspond to type of analysis requested on the RFA.

Biological Sampling

A. Refer to the Specific Validation Checklist for Biological Sampling.

B. Each sample should appear in the Sample Collection Log, C-C, RFA, and FADL (or field log). Make certain each form is correctly filled out by utilizing General Validation Checklists for these forms. Alternately, if numerous discrepancies exist, make a copy of the document and circle the discrepancies with a red pen. Note this fact on the checklist and attach the copy.

C. Section 6.3 of the Sampling Plan (Work Plan Vol. 1) provides background information for biological sampling. Section 7.1 of QAPP contain requirements for Sample Collection Logs, C-C and RFA. (NOTE: There are General Validation Checklists for each of these standard forms.)

Radiation Survey

A. Refer to the Specific Validation Checklist for Radiation Survey Sampling.

B. Each sample should appear in the Sample Collection Log and FADL (or field log). Make certain each form is correctly filled out by utilizing General Validation Checklists for these forms. Alternately, if numerous discrepancies exist, make a copy of the document and circle the discrepancies with a red pen. Note this fact on the checklist and attach the copy.

C. Sections 1.2 through 1.4 of the Sampling Plan (Work Plan Vol. 1) provide background information for subsurface soil sampling. Section 5.1 of QAPP contains radiation measurement procedures.

D. The following documents require review:

- FADLs (use general Validation Checklist)
- Figure 5-4, Shielded Delta-Gamma In-Situ Measurement, Background Assessment
- Figure 5-5, Shielded Delta-Gamma In-Situ Measurements, Field Radiation Measurements
- Figure 5-6, Gamma-Ray Exposure Rate Survey
- Figure 5-7, Exposure Rate Correlation Data, Entry Form - Site-Specific

Radiation survey measurements were performed utilizing: stationary Pressurized Ionization Chambers (PIC). Sodium Iodide Scintillation Detector (SPA-3) measurements at one meter above ground level, and SPA-3/FIDLER grid area walkover measurements. Four sets of differing criteria are shown below for each instrument used to quantify radiation emissions in the field.

A node is the intersection point of the 100' x 100' sampling grids. Radiation measurements were performed at nodes throughout the Fernald site.

E. Pressurized Ionization Chamber (PIC) Measurements

1. Review all exposure rates at each measurement location to determine if the exposure rates are in the appropriate ranges for each location.

   a. Exposure rates that are distant from known radiation-sources (i.e., waste storage area, thorium storage buildings, K-65 silos, etc.) should be within the normal background range of 5 to 15 μR/hr.

   b. Exposure rates near known radiation sources should increase with decreasing distance from the source.

2. Anomalies are to be investigated by reviewing field logs and other site records to determine if the source of the anomaly is present.

F. SPA-3 Measurements at One-Meter Height

1. Review of all readings to determine if they are in the expected range of 1×10^4 to 4.0×10^5 counts per minute (CPM).

2. Review plots and tables of data for discontinuities.

3. Calculate the ratio of exposure rate to count rate for all locations where both PIC and SPA-3 (at one-meter height) readings were made.

The exposure rate-to-counts per minute (ETC) range was generated from the observation that the majority of all calculated ETC ratios fell within the limits 2.0 to 9.0 x 10^{-4} μR/hr/CPM. All values outside the range are considered to be anomalous and must be reviewed by a Data Validation Technical Representative or by the Technical Advisory Group for resolution.

4. Anomalies are to be investigated by reviewing field logs and other site records to determine if the source of the anomaly is present.

G. SPA-3 Grid Area Walkover Measurements

1. Review all readings to determine if they are in the expected range of 3 x 10^4 to 16 x 10^4 counts for a two-minute integration for each 25' x 25' subgrid.

2. Review plots of data and tables for discontinuities.

3. Anomalies are to be investigated by reviewing field logs and other site records to determine if the source of the anomaly is present.

H. FIDLER Grid Area Walkover Measurements

1. Review all normalized readings to determine if they are in the expected range of 9 to 50 x 10^3 counts for a three-minute integration for each 25' by 25' subgrid.

2. Review plots of data and tables for discontinuities.

3. Anomalies are to be investigated by reviewing field logs and other site records to determine if the source of the anomaly is present.

The comparison of FIDLER instrument measurements from different FIDLER instrument assemblies was highly variable (six FIDLER instrument assemblies were used at Fernald). It was readily apparent that these measurements must be corrected to one instrument response (normalization of all FIDLER measurements to those of one instrument). Normalization of FIDLER measurements began July 8, 1988. It was not until June 6, 1990 that normalization factors for SPA-3 measurements were developed. At present, each instrument, SPA-3 and FIDLER, has been normalized. The Data Validation Plan will be changed as necessary to incorporate updated material.

The RFA should indicate the type of analysis the sample should undergo.

GENERAL VALIDATION CHECKLIST				TITLE: FIELD ACTIVITY DAILY LOG (QAPP 5.0)	
				DATE:	PAGE __ OF __
PROJECT:				LOCATION:	
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
PROJECT NAME & NO.					
FIELD ACTIVITY SUBJECT & DATE					
WORK ACTIVITY					
UNUSUAL EVENTS					
CHANGES TO PLANS & SPECS.					
VISITOR(S) ON SITE					
WEATHER CONDITIONS					
SUBCONTRACTOR PROGRESS					
COMMUNICATION WITH AGENCIES					
ASI/IT PERSONNEL ON SITE					
IMPORTANT PHONE CALLS					
SUPERVISOR SIGNATURE & DATE					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST				TITLE: AQUIFER/PERMEABILITY TESTING	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
PERMEABILITY TESTING CONDUCTED AND DOCUMENTED AS DESCRIBED IN SECT. 5.6 OF QAPP					
PERMEABILITY TEST DATA FORM COMPLETE AND CORRECT					
DIAGRAM OF EQUIPMENT USED TO CONDUCT TEST					
CALIBRATION DOCUMENTATION SUPPLIED BY VENDOR FOR EQUIPMENT (GAUGES, FLOW METERS, ETC.) COMPLETE					
IS PIEZOMETER DATA SHEET COMPLETE AND CORRECT?					
ARE WATER METER CALIBRATION RECORDS ON FILE AND COMPLETE					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST				TITLE: SURFACE WATER AND SEDIMENT SAMPLING	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
WATER QUALITY LOG COMPLETE CORRECT (QAPP SECT. 6.2)					
IF WATER QUALITY SAMPLE WAS COLLECTED PRIOR TO REVISION 3 OF THE WORK PLAN, IS SAMPLE COLLECTION DOCUMENTED IN ACCORDANCE WITH APPENDIX K OF THE WORK PLAN					
IS THE SAMPLE COLLECTION LOG COMPLETE & CORRECT (QAPP 7.1.3)					
IS THE CHAIN-OF-CUSTODY COMPLETE AND CORRECT?					
IS THE REQUEST FOR ANALYSIS COMPLETE AND CORRECT?					
IS THE FIELD ACTIVITY DAILY LOG COMPLETE AND CORRECT?					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST				TITLE: SURFACE SOILS SAMPLING	
				DATE:	PAGE __ OF __
PROJECT:					
SAMPLE/I.D.:				REMARKS/COMMENTS	
CHECKLIST ITEMS	YES	NO	N.A.		
CORRECT FORM USED					
UNIQUE SOILS SAMPLE NUMBERS					
SAMPLE LOCATION					
COLLECTOR'S INITIALS					
COLLECTION DATE AND TIME					
NORTHERLY/EASTERLY COORDINATES					
WAS THE SAMPLE RINSATE					
SAMPLE DEPTH/UNITS					
SAMPLE TYPE					
DEFINITION OF COMPOSITE					
SAMPLE MEDIA					
TEMPERATURE TO COOL/PUT TO 4oC					
IS THE SAMPLE SEQUENCE CORRECT					
IS THE SAMPLE A SPIKE OR BLANK					
ID OF THE SPIKE OR BLANK					
Is the Chain of Custody Complete and correct?					
Is the Request For Analysis Complete and Correct?					
Is the Field Activity Daily Log Complete and correct?					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST	TITLE: SUBSURFACE SOIL SAMPLING	
PROJECT:	DATE:	PAGE __ OF __
SAMPLE/I.D.:		

CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS
VISIUAL CLASSIFICATION OF SOILS (BORING LOG) COMPLETE AND CORRECT				
SAMPLE NUMBERS ON SAMPLE COLLECTION LOG CORRESPOND TO BORING LOG				
CALIBRATION RECORDS COMPLETE				
IS THE SAMPLE COLLECTION LOG COMPLETE & CORRECT (QAPP 7.1.3)				
IS THE CHAIN-OF -CUSTODY COMPLETE & CORRECT				
IS TGE REQUEST FOR ANALYSIS COMPLETE & CORRECT				
IS THE FIELD ACTIVITY DAILY LOG COMPLETE & CORRECT				

REVIEWED BY: DATE:	CONCURRENCE BY: DATE:

GENERAL VALIDATION CHECKLIST				TITLE: TRAINING, PROCEDURES, AUDITS, NONCONFORMANCES, SURVEILLANCES, VARIANCES, DOCUMENT CHANGE REQUEST	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
PROCEDURES APPROVED AT THE TIME OF DATA COLLECTION, ALSO DOCUMENT CHANGE REQUESTS					
PERSONNEL TRAINED TO PROCEDURES AND DOCUMENT CHANGE REQUESTS					
INSTRUMENTS CALIBRATED AT THE TIME OF COLLECTION					
THE FOLLOWING REQUIRE QA VERIFICATION:					
IMPACT ON DATA BY SITE AUDITS, NONCONFORMANCES, VARIANCES, OR SURVEILLANCES					
DEFICIENT CHARACTERISTICS FLAGGED FOR FIELD DATABASE					
ANY VARIANCES THAT MAY IMPACT DATA					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

GENERAL VALIDATION CHECKLIST	TITLE: REQUEST FOR ANALYSIS (QAPP 7.1.4)	
PROJECT:	DATE:	PAGE __ OF __
SAMPLE/I.D.:		

CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS
R/A CONTROL NO.				
C/C CONTROL NO.				
PROJECT NAME & NO.				
DATE SAMPLES WERE SHIPPED				
LAB DESTINATION & LAB CONTRACT				
UNIQUE SAMPLE NUMBER				
SAMPLE TYPE				
SAMPLE VOLUME				
PRESERVATIVE				
REQUESTED TESTING PROGRAM				
APPLICABLE SPECIAL INSTRUCTION				
TURN AROUND TIME INDICATED				
POSSIBLE HAZARD I.D. INDICATED				
ORIGINAL R/A RETURNED BY LAB				
CORRESPONDENCE TO LAB REPORT				

REVIEWED BY: DATE:	CONCURRENCE BY: DATE:

SPECIFIC VALIDATION CHECKLIST				TITLE: WELL CONSTRUCTION AND DEVELOPMENT	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS (QAPP 5.3)	YES	NO	N.A.	REMARKS/COMMENTS	
MONITORING WELL INSTALLATION DETAILS SCHEMATIC COMPLETE AND CORRECT					
PIEZOMETER INSTALLATION SHEET COMPLETE AND CORRECT					
MONITORING WELL DEVELOPMENT COMPLETION CHECK LIST COMPLETE AND CORRECT					
MONITORING WELL DEVELOPMENT FORM COMPLETE AND CORRECT					
PIEZOMETER SENSITIVITY TEST FORM COMPLETE AND ACCURATE					
CALIBRATION RECORDS COMPLETE					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

GENERAL VALIDATION CHECKLIST	TITLE: CHAIN OF CUSTODY (QAPP 7.1.2)	
PROJECT:	DATE:	PAGE __ OF __
SAMPLE/I.D.:		

CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS
PROJECT NAME/NUMBER				
LAB DESTINATION				
SAMPLE TEAM MEMBERS				
CARRIER/WAYBILL NO.				
SAMPLE NO.				
SAMPLE LOCATION & DESCRIPTION				
DATE & TIME COLLECTED				
SAMPLE TYPE				
CONTAINER TYPE				
DISPOSAL RECORD NO.				
CONDITION ON RECEIPT				
RA CONTROL NO.				
C/C CONTROL NO.				
SIGNATURE(S)				
ORIGINAL RETURNED FROM LAB				

REVIEWED BY: DATE:	CONCURRENCE BY: DATE:

GENERAL VALIDATION CHECKLIST				TITLE: SAMPLE COLLECTION LOG (QAPP 7.1.3)	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
UNIQUE SAMPLE NUMBER					
SAMPLE LOCATION					
COLLECTOR INITIALS					
DATA & TIME SAMPLE COLLECTED					
SAMPLE COORDINATES					
SAMPLE IDENTIFICATION					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST				TITLE: RADIATION MEASUREMENT (NODE SURVEYS)	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
CORRECT FORM USED					
SAMPLE ID NUMBER(S)					
LOCATIONS COORDINATES					
DATE/TIME OF SAMPLE COLLECTION					
LOCATION DESCRIPTION					
LISTING OF SAMPLING TEAM MEMBERS					
DESCRIPTION OF WEATHER CONDITIONS					
INSTRUMENT AND PROBE SERIAL/MODEL NUMBERS					
BACKGROUND RESULTS					
SAMPLE RESULTS					
*INSTRUMENT CALIBRATION DUE DATE					
IS THERE A QA REVIEW OF FORM?					
IS THE SAMPLE SEQUENCE CORRECT					
*(THIS CURRENTLY NOT BEING DOCUMENTED ON THE SURVEY SHEETS OR THE FIELD DAILY LOGS)					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST				TITLE: RADIATION MEASUREMENT (WALK OVER SURVEY)	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:				LOCATION:	
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
CORRECT FORM USED					
SAMPLE ID NUMBER(S)					
GRID AREA LOCATION					
DATE/TIME OF SAMPLE COLLECTION					
LOCATION DESCRIPTION					
LISTING OF SAMPLING TEAM MEMBERS					
COUNT TIME/UNIT OF COUNT					
INSTRUMENT AND PROBE SERIAL/ MODEL NUMBERS					
BACKGROUND RESULTS					
SAMPLE RESULTS					
INSTRUMENT CALIBRATION DUE DATE					
IS THERE A QA REVIEW OF FORM?					
IS THE SAMPLE SEQUENCE CORRECT					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST				TITLE: GROUND WATER SAMPLING AND FIELD ANALYTICAL DATA	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
WATER QUALITY FIELD COLLECTION REPORT COMPLETE (INCLUDING CALIBRATIONS)					
IS THE SAMPLE COLLECTION LOG COMPLETE & CORRECT (QAPP 7.1.3)					
IS THE CHAIN-OF-CUSTODY COMPLETE AND CORRECT?					
IS THE REQUEST FOR ANALYSIS COMPLETE AND CORRECT?					
IS THE FIELD ACTIVITY DAILY LOG COMPLETE AND CORRECT?					
TEMPERATURE (6.2.1)					
pH (6.2.2)					
SPECIFIC CONDUCTANCE (6.2.3)					
DISSOLVED OXYGEN (6.2.4)					
ALKALINITY (6.2.5)					
ALL READINGS RECORDED ON FIELD MEASUREMENT FORM (WATER QUALITY FIELD COLLECTION REPORT, QAPP FIGURE 6.1)					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

APPENDIX A-II
CLP LABORATORY DATA

ORGANIC DATA (QA Level IV)

The data packages are reviewed and the quality assurance performance data summarized by entering the data on the review lists and categorizing (flagging) the data according to the action criteria. The general criteria used to determine the performance were based on (but not limited to) an examination of:

- Holding times
- Field/Lab precision evaluation
- DFTPP and BFB performance results
- Initial and continuing calibration
- Blank analysis results
- Detection limit results
- Surrogate spike results
- Matrix spike results

Field Duplication: Positive results shall have recorded relative percent difference (RPD) values. IF RPD is greater than 20, the results shall be evaluated.

The assignment of qualifiers to the organic data shall be documented on a copy of the analytical report forms. Acceptable data shall have no qualifiers on the forms, but the reviewer shall have his/her initial and date at the low right of the forms indicating the data has been reviewed. The reviewer shall use the SOW for organic analysis and the Laboratory Data Validation Functional Guidelines for Evaluating Organics Analysis as reference for more detailed guidance.

Holding times:

Under 40CFR136 purgeable water samples unpreserved must be analyzed within 7 days for aromatics and 14 days for non-aromatics from time of collection. With hydrochloric acid preservative, samples must be analyzed within 14 days for volatiles. Extractables are to be extracted within 7 days of collection. If holding times are grossly exceeded, reviewer must use professional judgement to determine the reliability of the data. Soil samples have limited information concerning holding times. This validation review will use the water requirements as guide along with professional judgement.

GC/MS Tuning:

Tuning criteria will be reviewed. Spot checks on calculations will be performed where a computer performs computations, however, manual calculations shall be examined more thoroughly. Background subtraction will be examined.

TABLE A1 APPLICATION OF QUALIFIERS DUE TO SURROGATE OUTLIERS

Fraction	Number of Surrogates Outside Control Limits	Direction of Bias	Qualifier for Positive Results	Qualifier for Quantitation Limits
base neutral	2 or 3	all high	K	none
	2 or 3	all low	L	UL
	2 or 3	mixed high and low	J	UJ
	1 or more	less than 10 percent	L	R
acid	2 or 3	all high	K	none
	2 or 3	all low	L	UL
	2 or 3	mixed high and low	J	UJ
	1 or more	less than 10 percent rec.	L	R
volatile	2 or 3	all high	K	none
	2 or 3	all low	L	UJ
	2 or 3	mixed high and low	J	UJ
	1	low or high	J	UJ
	1 or more	less than 10 percent rec.	L	R

When DFTPP and BFB do not meet criteria, the reviewer shall refer to the EPA Functional Guidelines for Evaluating Organic Analysis, Section IID for evaluating the reliability of the data.

Surrogate Spike Recoveries:

If any two surrogates within a base/neutral or acid fraction (or one surrogate for the VOA fraction) are out of specification, or if any one base/neutral, acid or VOA surrogate has a recovery of less than 10%, then there should be a reanalysis with surrogate results still outside the criteria. In many cases the review may need to use informed professional judgement and Section V of the Functional Guidelines for Organics. For surrogate spike recoveries out of specification, Table A-1 is to be used as a guide to assign qualifiers to the data.

Matrix-Spike Recoveries:

Before the reviewer qualifies data, the reviewer should first try to determine to what extent the results of the MS/MSD affect the associated data. This determination should be made with regard to the MS/MSD sample itself as well as specific analytes for all samples associated with the MS/MSD. Using informed professional judgement, the data reviewer may use the MS/MSD criteria to determine the need for some qualification of the data.

Field Duplicates:

The positive results will be reviewed and RPD calculated.

Blanks:

There should be no contaminants present in the blanks. There are common lab contaminants listed below:

methylene chloride
acetone
toluene
2-butanone
common phthalate esters

Any compound (other than the above list) detected in the sample, which was also detected in any associated blank, must be qualified when the sample concentration is less than five times the blank concentration. For the above list, the results are qualified by elevating the

limit of detection when the sample concentration is less than 10 times the blank concentration. See the Functional Guidelines for Organics for more guidance.

Initial and Continuing Calibrations:

If errors are detected in the calculations performed a more comprehensive review and recalculation will be performed.

For initial and continuing calibration use the following for action guide.

If any TCL compound has an RF of less than 0.05 positive results for that compound will be flagged as biased low (L) and non-detects flagged as unusable (R).

If TCL compound has a % RSD of greater than 30% for initial calibration and % D of greater than 25% for continuing calibration, positive results will be flagged as estimated (J) and non-detects will be qualified using professional judgement.

Internal Standards Performance:

The internal standard (IS) area counts must not vary by more than a factor of two (-50% to +100%) form associated calibration standard. The retention time of the internal standard must not vary more than ±30 seconds from the associated calibration standard. If an IS retention time varies by more than 30 seconds, the chromatographic profile must be examined to determine if any false positive or negatives exist. The reviewer is to use professional judgement on rejecting data.

Compound Identification:

Calculations will be verified for positive results. The TCL compound (tentatively identified compounds) identified will be verified as outlined in the Functional Guidelines for Organics, Section IX & XI.

QUALITY ASSURANCE REVIEW
ORGANIC DATA PACKAGE

Project File: _____ Sampling Date: _____

Case Number: _____ Receipt Date: _____

SDG Number: _____ Number Samples: _____

Matrix: _____

The above data package has been reviewed and the quality assurance and performance data summarized. The general criteria used to determine the performance were based on an examination of:

* Holding Times
* Field/Lab Precision Evaluation
* DFTPP and BFB performance results
* Initial and Continuing Calibration
* Blank analysis results
* Detection Limit results
* Surrogate Spike results
* Matrix Spike results

Overall comments: _____

_____

_____

_____

_____

Definitions:
J - Approximate data due to other quality control criteria.
R - Reject Data due to blank contamination.
RR - Reject data due to other quality assurance criteria.
ND - Not detected.
NJ - Tentatively identified compound.

Reviewed by: _____ Date: _____

Concurred by: _____ Date: _____

Review based on SOW 10/86 Revised 7/87.

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I HOLDING TIMES

Date Received: _____	Date Sampled _____		CLP
VOA analysis date: _____	Holding Time: _____	(7W-7S)	(10W-10S)
BNA extraction date: _____	Holding Time: _____	(7W-7S)	(5W-10S)
P/P extraction date: _____	Holding Time: _____	(7W-7S)	(5W-10S)
BNA analysis date: _____	Holding Time: _____	(40)	(40)
P/P analysis date: _____	Holding Time: _____	(40)	(40)

Action: Results of compounds detected in samples not analyzed within the contract required holding times (CRHT) should be approximated (J'd or UJ'd). The reviewer may reject compounds in samples which were excessively beyond the CHRT.

Remarks: _____

_____

II DFTPP AND BFB PERFORMANCE RESULTS

____ Mass calibration is correct, verify from raw data.

____ The DFTPP performance results were reviewed and found to be within specified criteria and run every 12 hour period.

____ The BFB performance results were reviewed and found to be within specified criteria and run every 12 hour period.

____ Calculations checked from raw data?

The DFTPP/BFB performance result(s) was/were reviewed and the following abundances were found to fall outside the specified criteria:

Compound	m/z	Required Abundance	Actual Abundance
_____	____	_____	_____
_____	____	_____	_____

Remarks: _____

III SURROGATE SPIKE RECOVERIES

For any given fraction, determine the number of surrogate compounds with unacceptable recoveries per the total number of surrogates in that fraction. Check raw data to verify the recoveries on the Surrogate Recovery (Form II).

Client ID	ID	VOA	B/N	A	PEST

Surrogate actions:

	Percent Recovery		
	<10%	10% - CRR	>CRR
Positive result	J*	J*	J*
Non-detected compounds	R	J*	A

CRR = Contract required recovery range
Surrogate action should be applied when one VOA or two B/N surrogate recoveries do not meet contractual requirements.

If surrogate spike recoveries are out of specification on initial analysis, but meet criteria on reanalysis, report results based on results of reanalysis.

* See Table A-1 for more defined qualifiers for approximate or estimated result.

IV MATRIX-SPIKE RECOVERIES

For any given fraction, determine the number of unacceptable recoveries per the total number of matrix spike recoveries in that fraction. See Form III in data package.

Client ID	Lab ID	VOA	B/N	A	PEST

Matrix Spike Actions:

	Percent Recovery		
	<10%	10% - CRR	>CRR
Positive result	J*	J*	J*
Non-detected compounds	R	J*	A

CRR = Contract required recovery range

In general, matrix spike actions should be applied when 50% of the matrix spike recoveries per fraction do not meet the advisory limits. When the percent recovery does not meet advisory contractual limits for a matrix spike compound in both sets of duplicate spike sample results, the results of the compound in the unspiked sample should be qualified.

Matrix spike recoveries not within the advisory contractual limits should be applied only to the sample on which the spike was performed.

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V MATRIX SPIKE DUPLICATE ANALYSIS RESULTS

Matrix: _____

The relative percent difference (RPD) for each parameter was evaluated. The established advisory RPD criteria for each matrix spike compound is listed on Form III. When the RPD is greater than the advisory contractual limit for a matrix spike compound, the result for the compound in the unspiked sample should be approximated. In general, the results of the entire fraction for the unspiked sample may be approximated (J'd), when 50% of the RPDs are greater than the established Quality Control Limits.

Fraction	Compound	Sample Number	Dupl. Number	RPD

Remarks: _____

VI FIELD PRECISION RESULTS

Matrix: _____

VII BLANK ANALYSIS RESULTS

The blank analysis was reviewed. The contamination in the blanks are listed below.

A. Laboratory Blanks

Date	LAB ID #	FRACTION	COMPOUND	CONC., ppb	CRDL

B. Field Blanks

Date	LAB ID #	FRACTION	COMPOUND	CONC., ppb	CRDL

VII BLANK ANALYSIS RESULTS (CONT.)

C. BLANK ACTION TABLE

Action levels should be based upon the highest concentration of contaminant in any field or laboratory blank. The action level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor.

	Reject	Approximate	Accept
Common contaminants	<10x	10-20x	>20x
Other contaminants	<5x	5-10x	>10x

Common contaminants are compounds such as methylene chloride, acetone, toluene, 2-butanone and phthalates.

For example:
If 10 ppb of methylene chloride was the highest concentration detected in one of the laboratory blanks, the action level for a field sample would be calculated to be:

(conc. x dilution factor x action level factor)

a) 10 ppb x (10/1) x 10 = 1000 ppb
b) 10 ppb x (10/1) x 20 = 2000 ppb

Reject all concentrations less than 1000 ppb (ug/L).
Approximate results in samples between 1000-2000 ppb (ug/L).
Accept all results with concentrations greater than 2000 ppb.

Detection limits need not be adjusted for blank contamination in this data validation.

COMPOUND	MAX. CONC. DETECTED ppb	"R" up to	"J" between	SAMPLES AFFECTED

IX INITIAL AND CONTINUING CALIBRATION

____ IS within -50% to +100% area count of daily standard.

____ Retention time is within ±30 seconds of associated standard.

If an IS area count is outside range, flag all compounds as estimated (J) that are referenced to that IS. For non-detects flag as estimated (UJ). If area counts are very low and/or exhibits an abrupt drop-off, then flag non-detects as unusable (R).

A. Volatile Calibration Verification

Date of Initial Calibration: _____

Date of Continuing Calibration(s): _____

Spot check of raw data to verify calculations of RF, RSD, %D ____

Date	Instrument	QC Criteria OUT RF	%RSD	%D	Compounds (Results)	Samples Affected and Action
___	_____					
___	_____					
___	_____					
___	_____					
___	_____					

Action:

Calibration	Accept	Approximate(+)*	Approximate(+) and Reject(ND)
Initial	RF≥0.300(SPCC)+ RF≥0.05** RSD≤30%	RSD>30%	RF<0.300(SPCC) RF<0.05**
Continuing	RF≥0.300(SPCC) RF≤0.05** %D≤25	%D>25	RF<0.300(SPCC) RF<0.05**

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NOTE: * - Non-detected results are evaluated with professional judgement.
** - All other compounds.
(ND) - Non-detected compounds.
SPCC- System performance calibration compound.
RF - Response factor.
RSD - Relative Standard Deviation.
%D - Percent Difference.
+ - Bromoform RF≥0.250

Actions should be applied to all results in the volatile fraction when contractual and established advisory criteria are not met for the initial calibration. When continuing calibration requirements are not met, actions apply only to samples analyzed on the day the calibration was not met.

IX INITIAL AND CONTINUING CALIBRATION

B. Semi-volatile Calibration Verification

Date of Initial Calibration: _____

Date of Continuing Calibration(s): _____

Spot check of raw data to verify calculations of RF, RSD, %D

Date	Instrument	QC Criteria OUT RF	%RSD	%D	Compounds (Results)	Samples Affected and Action
___	_____					
___	_____					
___	_____					
___	_____					
___	_____					

Action:

Calibration	Accept	Approximate(+)*	Approximate(+) and Reject(ND)
Initial	RF≥0.05 RSD≤30%	RSD>30%	RF<0.05

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Continuing RF≥0.05 %D>25 RF<0.05
%D≤25

NOTE: * - Non-detected results are evaluated with professional judgement.
** - All other hazardous substance list compounds.
(ND) - Non-detected compounds.
SPCC- System performance calibration compound.
RF - Response factor.
RSD - Relative Standard Deviation.
%D - Percent Difference.

Actions should be applied to all results in the volatile fraction when contractual and established advisory criteria are not met for the initial calibration. When continuing calibration requirements are not met, actions apply only to samples analyzed on the day the calibration was not met.

IX INITIAL AND CONTINUING CALIBRATION

_____ Analytical sequence followed for primary analysis and confirmation analysis as outlined in SOW and Functional Guidelines for Organics.

_____ Verified positive results by GC/MS when greater than 10 μg/μL.

C. Pesticide Calibration Verification

_____ In evaluating linearity, it was noted that the percent relative standard deviation (%RSD) was less than 10% for the column used for quantitative determinations.

_____ The criteria for linearity was not met. Action: All associated quantitative results should be considered approximate and flagged (J).

_____ The percent difference (%D) between calibration factors during the twelve hour period was evaluated and found to be less than 15% for quantitation columns and less than 20% for confirmation columns.

_____ The %D was greater than specified criteria for the following compounds:

Date	Compound	%D	Column	Action

Action: Approximate (J) all positive results for samples with a %D greater than the specified criteria.

IX INITIAL AND CONTINUING CALIBRATION

C. Pesticide Calibration Verification

_____ The retention time (RT) for DDT was reviewed and found to be greater than 12 minutes.

_____ Upon review of DDT retention time, it was noted that the RT was less than 12 minutes. Action: Reject pesticide results due to poor resolution.

_____ Retention time windows (RT) were reported on Form IX and standard/sample results were found to be within established RT windows.

_____ Retention time windows were reported on Form IX. The following compounds had RTs which were outside the established windows:

Date	Compound	RT Window	RT	Action

Action: Positive sample results should be considered tentatively identified due to the RT not meeting the established window.

____ The total percent breakdown for DDT was <20%.

____ The total percent breakdown for endrin was <20%.

____ Breakdown for DDT was >20%. Action: Approximate all quantitative results for DDT flagged as biased low (L). If DDT not present, but DDD and DDE are positive, then flag DDT as unusable (R). Qualitative and quantitative results for DDD and DDE should be considered estimated and tentatively identified (N).

____ Breakdown for endrin was >20%. Action: Approximate all quantitative results for endrin and flag as estimated (J). Qualitative and quantitative for endrin ketone should be considered tentative (N).

IX INITIAL AND CONTINUING CALIBRATION

C. Pesticide Calibration Verification

____ A review of %D in RT for DBC indicated all standards and samples had a RT less than 2% for packed and 0.3% for capillary columns.

____ RT shift for DBC was reviewed and found to be outside specified criteria. The analysis should be considered unusable (R) for samples: _____

_____

_____

_____

_____

APPENDIX

A. Internal Standard Area Summary

For a given fraction, determine the number of internal standard compounds outside established limits per total number of internal standards in that fraction.

Client ID	Lab ID	VOA	BNAE

B. Editorial Corrections

The package for Project File _____ was reviewed for editorial accuracy in accordance with NQA-1 guidelines. Included in this review is a check for completeness, accuracy, proper xeroxing, initials and dates for line-throughs, absence of traceovers, absence of white-out, and complete filling out of all blocks on a given form.

_____ The package has been found to complete with respect to editorial accuracy.

_____ The package has been found to be in need of the following editorial corrections:

Page/Form #	Problem

INORGANIC DATA (QA Level IV)

The data packages are reviewed and the quality assurance performance data summarized by entering the data on the review lists and categorizing (flagging) the data according to the action criteria. The general criteria used to determine the performance were based on an examination of:

- Holding times
- Calibration Verification
- Field and lab blank
- Interference QC results
- Matrix spike & recovery results
- Laboratory precision results
- Field precision valuation
- Lab control sample results
- Detection limit results
- Standard addition results
- Serial dilution results
- Contract required detection limit (CRDL) results

Field duplicate analysis will be evaluated according to laboratory Precision Evaluation Sheet using the same criteria for lab duplicates.

All validation qualifiers shall be placed on the inorganic analytical report forms.

Holding Times and Preservation

The validity of results are based on the holding time of the sample from time of collection to time of analysis. The holding time is based on the date of collection, rather than verified time of sample receipt and date of digestion/distillation. The holding time and preservation requirements were established under 40CFR136. Qualify all results greater than Instrument Detection Limit (IDL) as estimated (J) and results less than IDL as estimated (UJ). Reviewer must use professional judgement to determine the reliability of the data. There is little data concerning holding times for soil samples. For soils the review will use water holding times and so state on review forms.

Calibration

Instruments must be calibrated daily and each time the instrument is set up. ICP analysis must have a blank and at least one standard to establish analytical curve. Atomic absorption analysis must have a blank and at least three standards one must be at CRDL to establish analytical curve. The absorbance data must have a correlation

coefficient of $\geq$0.995. At least one ICV and CCV %R is recalculated for each type of analysis, (ie GFAA, ICPs) using the following equation:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Found = concentration of each analyte measured in the analysis of the ICV or CCV solution.

True = concentration of each analyte in the ICV or CCV source.

Due to possible rounding discrepancies, allow results to fall within 1% of the contract windows (eg., 89-111%)

All data which does not have a daily calibration or the minimum number of standards shall be qualified as unusable (R). If the correlation coefficient is <0.995, qualify results >IDL as estimated (J), and results <IDL as estimated (UJ).

If the midrange cyanide standard was not distilled, qualify all associated results as estimated (J).

Blanks

The assessment of blank analysis results is to determine the existence and magnitude of contamination problems. The criteria for evaluation of blanks applies to any blank associated with the samples. If problems with any blank exists, all data associated with the set must be carefully evaluated to determine if there is an inherent variability in the data or if the problem is an isolated occurrence not affecting other data.

The blank summary (Form III) as well as the raw data for blanks shall be reviewed and verified that the results were accurately reported.

Action in the case of unsuitable blank results depends on the circumstances and origin of the blank. Sample results <IDL but <5 times the amount in any blank should be qualified as (U).

Any blank with a negative result whose absolute value is > IDL must be carefully evaluated to determine its effect on the sample data.

Cautions should be taken in comparing results of blanks. The weights, volumes, or dilution factors may vary due to basis of units used for samples. The reviewer may find it easier to work from the raw data when applying 5x criteria to soil sample data/calibration blank data.

The results must not be corrected by subtracting any blank value.

ICP Interference Check Samples (ICS)

An ICS must be run at the beginning and end of each sample analysis run (or a minimum of twice per 8-hour working shift, whichever is more frequent.) Result for the ICS solution AB analysis must fall within the control limits of ±20% of the true value.

Recalculate from raw data one or more recoveries using the following equation:

$$\text{ICR or } \%R = \frac{\text{Found Solution AB}}{\text{True Solution AB}} \times 100$$

Where:

Found Solution AB = concentration (in ug/L) of each analyte measured in the analysis of solution AB

True Solution AB = concentration (in ug/L) of each analyte in Solution AB

Check ICS raw data for results with an absolute value > IDL for those analytes which are not present in the ICS solution.

For samples with concentration of Al, Ca, Mg, and Fe which are comparable to or greater than their respective levels in the Interference Check Sample:

1) If the ICS recovery for an element is >120% and the sample results are < IDL, this data is available for use.

2) If the ICS recovery for an element is >120% and the sample results are > IDL, qualify the affected data as estimated (J).

3) If the ICS recovery for an element falls between 50 and 79% and the sample results are >IDL, qualify the affected data as estimated (J).

4) If sample results are <IDL, and the ICS recovery for that analyte falls within the range of 50-79%, the possibility of false negatives may exist. Qualify the data for these samples as estimated (UJ).

5) If ICS recovery results for an element fall <50%, qualify the affected data as usable (R).

If results >IDL observed for elements which are not present in the EPA provided ICS solution, the possibility of false positive exists. An evaluation of the associated sample

data for the affected elements should be made. For samples with comparable or higher levels of interference and with analyte concentrations that approximate those levels found in the ICS (false positive), qualify sample results >IDS as estimated (J).

If negative results are observed for elements that are not present in the EPA ICS solutions, and their absolute value is >IDL, the possibility of false negatives in the samples may exist. If the absolute value of the negative results is >IDL, an evaluation of the associated sample data should be made. For samples with comparable or higher levels of interferents, qualify results for the affected analytes <IDL as estimated (UJ).

In general, the sample data can be accepted if the concentrations of Al, Ca, Fe and Mg in the sample are found to be less than or equal to their respective concentrations in the ICS. If these elements are present at concentrations greater than the level in the ICS, or other elements are present in the sample at >10 mg/L, the reviewer should investigate the possibility of other interference effects by using Table 2 given on page D-22 of the 7/87 SOW. These analyte concentration equivalents presented in the Table should be considered only as estimated values, since the exact value of any analytical system is instrument specific. Therefore, estimate the concentration produced by an interfering element. If the estimate is >2X CRDL and also greater than 10% of the reported concentration of the affected element, qualify the affected results as estimated (J).

Matrix Spike Result

Samples identified as field blanks cannot be used for spike samples analysis. Spike recovery (%R) must be within the limits 75-125%. However, spike recovery limits do not apply when sample concentration exceeds the spike concentration by a factor of 4 or more.

Review spike recoveries and verify that results fall within the specified limits. Verify from raw data and recalculate one or more % R using the following equation:

$$\%R = \frac{SSR - SR}{S} \times 100$$

Where:

SSR = spiked sample result
SR = sample result
S = amount of spike

Actions to be taken:

If the spike recovery is >125% and the reported sample results are <IDL, the data is acceptable for use.

If the spike recovery is >125% or <75% and the sample results are <IDL, qualify the data for these samples as estimated (J).

If the spike recovery falls within the range of 30-74% and the sample results are <IDL, qualify the data for these samples as estimated (UJ).

If the spike recovery results fall <30% and the sample results are >IDL, qualify the data for these samples as unusable (R).

If the field blank was used for matrix spike analysis, all other QC data must be carefully checked and professional judgement exercised when evaluating the data.

Laboratory Precision Evaluation

Duplicate analyses are indicators of laboratory precision based on each sample matrix. Samples identified as field blanks cannot be used for duplicate sample analysis.

A control limit of ± 20% (35% for soil) for the Relative Percent Difference (RPD) shall be used for sample values >5X CRDL.

A control limit of ±CRDL (±2X CRDL for soil) shall be used for sample values <5X CRDL, including the case when only one of the duplicate sample values is <5X CRDL.

Check the raw data and recalculate one or more RPD using the following equation to verify that results have been correctly reported on Form VI.

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

Where:

S = First Sample Value (original)
D = Second Sample Value (duplicate)

Verify that the field blank was not used for duplicate analysis.

If duplicate analysis results for a particular analyte fall outside the appropriate control windows, qualify the results for that analyte in all associated samples of the same matrix as estimated (J).

Laboratory Control Sample (LCS)

The laboratory control sample serves as a monitor of the overall performance of all steps in the analysis, including the sample preparation.

All aqueous LCS results must fall within the control limits of 80-120%R, except Sb and Ag which have no control limits.

All solid LCS results must be evaluated on a case by case basis.

Review and verify that results fall within the control limits.

Check the raw data (ICP printout, strip charts, bench sheets) to verify the reported recoveries on Form VII. Recalculate one or more of the recoveries (%R) using the following equation:

$$\text{LCS } \%R = \frac{\text{LCS Found}}{\text{LCS True}} \times 100$$

Where:

LCS Found = concentration (in ug/L for aqueous; mg/kg for solid analyte measured in the analysis of LCS solution

LCS True = concentration (in ug/L for aqueous; mg/kg for solid) of each analyte in the LCS source

Action to be taken:

If the LCS recovery for any analyte falls within the range 50 - 79% or >120%, qualify results >IDL as estimated (J).

If results are <IDL and the LCS recovery is greater than 120%, the data are acceptable

If results are <IDL and the LCS recovery falls within the range of 50-79%, qualify the data for the affected analytes as estimated (UJ).

If LCS recovery results are <50%, qualify the data for these samples as unusable (R).

If the solid LCS recovery for any analyte falls outside the EPA control limits, qualify all sample results >IDL as estimated (J).

If the solid LCS results are higher than the control limits and the sample results are <IDL, the data are acceptable.

If the solid results are lower than the control limits, qualify all sample results <IDL as estimated (UJ).

Standard Additions/Furnace Atomic Absorption Analysis

Duplicate injections and furnace post digestion spikes establish the precision and accuracy of the individual analytical determinations.

For sample concentrations >CRDL, duplicate injections must agree within ±20% Relative Standard Deviation (RSD), or (Coefficient of Variation (CV), otherwise the sample must be rerun once (at least two additional injections).

Spike recovery must be ≥85% and ≤115%

The Furnace Atomic Absorption Scheme must be followed as described in the 7/87 SOW, p. E-15.

Check raw data to verify that duplicate injections agree within ±20% RSD (or CV) for sample concentrations >CRDL.

Review Furnace AA raw data to verify that the Furnace Atomic Absorption Scheme has been followed.

Action to be taken:

If duplicate injections are outside the ±20% RSD (or CV) limits and the sample has not been rerun once as required, qualify the data as estimated (J).

If the rerun sample results do not agree within ±20% RSD (or CV), qualify the data as estimated (J).

If the post digestion spike recovery is ≤40%, qualify results >IDL as estimated (J).

If the post digestion spike recovery is ≥10%, but <40%, qualify results <IDL as estimated (UJ).

If the post digestion spike recovery is <10%, qualify results <IDL unusable (R).

If sample absorbance is <50% of the post digestion spike absorbance then:

a. If the furnace post digestion spike recovery is not within 85-115%, qualify the sample results >IDL as estimated (J).

b. If the furnace post digestion spike recovery is not within 85-115%, qualify the sample results <IDL as estimated (UJ).

If Method of Standard Additions (MSA) is required but has not been done, qualify the data as estimated (J).

If any of the samples run by MSA have not been spiked at the appropriate levels, qualify the data as estimated (J).

If the MSA correlation coefficient is <0.995, qualify the data as estimated (J).

Serial Dilution

The serial dilution determines whether significant physical or chemical interferences exist due to sample matrix.

If the analyte concentration is sufficiently high (concentration in the original sample is minimally a factor of 50 above the IDL), an analysis of a 5-fold dilution must agree within 10% Difference (%D) of the original results.

Check the raw data and recalculate the %D using the following equation to verify that the dilution analysis results agree with results reported on Form IX.

$$\%D = \frac{|I-S|}{I} \times 100$$

Where:

I = Initial Sample Result
S = Serial Dilution Result (Instrument Reading x 5)

check the raw data for evidence of negative interference, i.e., results of the diluted sample are significantly higher than the original sample.

When the criteria are not met, qualify the associated data as estimated (J).

If evidence of negative interference is found, use professional judgment to qualify the data.

The raw data should be examined to verify the correct calculation of sample results reported by the laboratory. Digestion and distillation logs, instrument printouts, strip charts, etc. should be compared to the reported sample results.

1. Examine the raw data for any anomalies (i.e., baseline shifts, negative absorbances, omissions, legibility, etc.).

2. Verify that there are no transcription or reduction errors (e.g., dilutions, percent solids, sample weights) on one or more samples.

3. Verify that results fall within the linear range of the ICP (Form XIII) and within the calibrated range for the non-ICP parameters.

4. Verify that sample results are >5X ICP, if ICP analysis results are used for As, TI, Se, Pb.

Note: When the laboratory provides both ICP and furnace results for an analyte in a sample and the concentration is > ICP IDL, the results can assist in identifying quantitation problems.

Action to be taken:

If there are any discrepancies found, the laboratory may be contacted by the designated representative to obtain additional information that could resolve any differences. If a discrepancy remains unresolved, the reviewer may determine qualification of the data is warranted.

QUALITY ASSURANCE REVIEW
INORGANIC DATA PACKAGE

5195

Project File: _____ Sampling Date: _____

Case Number: _____ Receipt Date: _____

SDG Number: _____ Number of Samples: _____

The above data package has been reviewed and the quality assurance and performance data summarized. The general criteria used to determine the performance were based on an examination of:

* Holding times
* Calibration Verification
* Field and lab blank
* Interference QC Results
* Matrix Spike %R Results
* Laboratory Precision Results
* Field precision Evaluation
* Lab Control Sample Results
* Detection Limit Results
* Standard addition results
* Serial Dilution Results
* CRDL Results

Overall Comments: _____

_____

_____

_____

_____

_____

_____

_____

Definition of Qualifiers:

JB - Approximate data due to blank contamination
J - Approximate data due to other quality control criteria
R - Reject due to quality control review
ND - Non-detected element

Reviewed by: _____ Date: _____

Concurrence by: _____ Date: _____

-5195

I HOLDING TIMES Date Samples Collected _____

Date samples received: _____ Date analyzed (Hg): _____

Date samples analyzed (CN): _____

Date samples analyzed (all others) by: _____

Action: If samples are analyzed for mercury (28 days), cyanide (14 days) or any other element (6 months) from dated collection, in excess of the holding times, approximate results for that element. If mercury or cyanide are held for more than one month beyond the required analysis date, reject the results for non-detects results of samples exceeding holding times and flag positive results as estimated (J).

Remarks: _____

_____

Preservation metals, ph <2 _____ Cyanide, ph >12 _____

IIA INITIAL AND CONTINUING CALIBRATION VERIFICATION

_____ Calibrations were performed every ten samples.

_____ Calibrations were within +/- 10 % (Metals) +/-15% (CN), or +/-20% (HG) for ICV and CCU

_____ Calibrations were not performed every ten samples for
(AA) ____ (ICP) ____ (CVAA) ____ (GFAA) ____ (CN) ____

_____ Calibrations were not within specified limits for
(AA) ____ (ICP) ____ (CVAA) ____ (GFAA) ____ (CN) ____

The correlation coefficient must be $\geq$0.995 for :

AA standard curve ____ Hg standard curve ____ Cyanide standard curve ____

_____ Verify that the midrange CN standard was distilled

_____ Verify calculations of ICV and CCV (one per type of analysis; ICP, AP, etc.

Action windows for ICV and CCV

	Accept	Approximate	Reject
Mercury	80-120 for +/ND ≥ 121 for ND	65-79 for +/ND 121-135 for +	<65 or >135 for +/ND
Cyanide	85-115 for +/ND ≥ 116 for ND	70-84 for +/ND 116-130 for +	<75 or >130 for +/ND
all others	90-110 for +/ND ≥ 111 for ND	75-89 for +/ND 111-125 for +	<75 or >125 for +/ND

Note: results <IDL are acceptable (positive bias)
ND = non-detected element
+ = positive result

IIB INITIAL AND CONTINUING CALIBRATION VERIFICATION

CRA/CRI Check Samples

M	Analyte	True Value (ug/L)	Percent Recovery
P	Antimony	120	
F	Arsenic	10	
P	Beryllium	10	
P	Cadmium	10	
P	Chromium	20	
P	Cobalt	100	
P	Copper	50	
F	Lead	5	
P	Manganese	30	
P	Nickel	80	
F	Selenium	5	
P	Silver	20	
F	Thallium	10	
P	Vanadium	100	
P	Zinc	40	

Remarks: _____

5195

III. BLANK ANALYSIS RESULTS

L	ICB	CCB1	CCB2	CCB3	CCB4	CCB5	Prep B1	Action
Al								
Sb								
As								
Ba								
Be								
Cd								
Ca								
Cr								
Co								
C								
Fe								
Pb								
Mg								
Mn								
Hg								
Ni								
K								
Se								
Ag								
Na								
Tl								

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EL	ICB	CCB1	CCB2	CCB3	CCB4	CCB5	Prep B1	Action
V								
Zn								
CN								
Mo								
*								

-5195

* = other

Note: Contamination detected above IDLs should be evaluated and qualified.

Action levels are determined by multiplying the highest concentration determined in any field or laboratory blank by five. The action level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor.

All results less than 5 times the action level should be considered highly suspect and reported as "JB". No action should be taken on the blank itself.

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IV ICAP INTERFERENCE CHECK SAMPLE

The ICAP interference check sample analysis is performed to verify the contract laboratories interelement and background correction factors.

_____ Interference QC samples were run before sample analysis and at the end of the analysis run (or every eight hours, whichever is more frequent).

_____ Interference QC samples were within the specified limits of +/- 20 percent.

_____ Interference QC samples were run but did not meet recovery criteria for: _____

_____ Are these results >IDL for analytes which are not present in the ICS solution?

In general, the sample data can be accepted without qualification if the concentrations of A1, Ca, Fe, and Mg are less than 50% of the ICS concentrations.

_____ Are these results >10mg/L of other than ICS analytes present.

Note: The 20% contract limit is based on the true value for EPA standards, and on the mean value (run at least five times) for non-EPA standards.

Remarks: _____

-5195

V. MATRIX SPIKE RESULTS

Sample Number: _____

_____ recalculations of %R from raw data were verified on one or more analytes

Element	SSR	SR	S	%R	Action
Aluminum					
Antimony					
Arsenic					
Barium					
Beryllium					
Cadmium					
Chromium					
Cobalt					
Copper					
Iron					
Lead					
Manganese					
Mercury					
Nickel					
Potassium					
Selenium					
Silver					
Thallium					
Vanadium					
Zinc					
Cyanide					
Molybdenum					
Other					

Calculation: $\%R = \frac{SSR-SR}{S} \times 100$

Accept	Approximate	Reject
SSR (75-125%)	SSR(+) & SSR<30%[1]	SSR(ND) & SSR<30%[2]
	SR(+,ND) & SSR(30-74%)[3]	
	SR(+) & SSR>125%[4]	

If the sample concentration exceeds the spike concentration by a factor of 4 or more, no action is taken.

NOTE: S = Amount of spike; SSR = spiked sample result;
SR = Sample result; %R = percent recovery; + = positive result;
ND = non-detected element.

1 - Sample results could be biased low.
2 - Possible false negative; analytical deficiencies.
3 - Detection limit may be biased low.
4 - False positive possible.

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VI. LABORATORY PRECISION EVALUATION

Sample #: _____ Duplicate Sample #: _____

Element	CRDL	Sample	Duplicate	RPD	Action
Aluminum	200				
Antimony	60				
Arsenic	10				
Barium	200				
Beryllium	5				
Cadmium	5				
Calcium	5000				
Chromium	10				
Cobalt	50				
Copper	25				
Iron	100				
Lead	5				
Magnesium	5000				
Manganese	15				
Mercury	0.2				
Nickel	40				
Potassium	5000				
Selenium	5				
Silver	10				
Sodium	5000				
Thallium	10				
Vanadium	50				
Zinc	20				
Cyanide	10				
Molybdenum	N/A				
Other	N/A				

Duplicate actions should be applied to all other samples of the same matrix type.

Actions: For samples which have an RPD of >20% (35% for soils) shall be qualified as estimated (J) for each element affected. If sample results are less than 5x the CRDL, then action limits are +/- CRDL. For sample results less than the CRDL, the RPD is not calculated.

Calculation: $RPD = \frac{|A-B|}{(A+B)/2} \times 100$

NOTE: CRDL - Contract Required Detection Limit
RPD - Relative Percent Difference
A - Sample Result
B - Duplicate Result

III LABORATORY CONTROL SAMPLE

_____ Laboratory Control analysis was performed.

_____ Laboratory Control analysis was within specified limits.

_____ Laboratory Control analysis was not performed for the following: _____

_____ Laboratory Control analysis was outside specified limits for the following: _____

Actions:	Accept	Approximate	Reject
% Recovery	80-120% for +,ND >120% for ND	50-79 for +,ND >120% for + <50% for +	<50% for ND

Note: an aqueous LCS is not required for mercury.

IX DETECTION LIMIT RESULTS

_____ Instrument detection limit results were present and found to be less than the CRDL for those elements.

_____ Detection limits were not included in the data package.

_____ Detection limits were present, but the criteria was not met for the following elements: _____

Action:

Adjust sample detection limits for elements not meeting contractual criteria listed above. Elements detected below the adjusted detection limit should be rejected (R'd).

Calculating detection limits for soil samples:
PQL (mg/kg) =

$$\frac{\text{IDL (ug/L)}}{\text{\%Solids}} \times \frac{\text{Volume diluted to (mL)}}{\text{wet weight digested (g)}} \times \frac{1\text{L}}{1000\text{mL}} \times \frac{1000\text{g}}{1\text{kg}} \times \frac{1\text{mg}}{1000\text{ug}}$$

X STANDARD ADDITION/FURNACE ATOMIC ABSORPTION ANALYSIS

_____ Duplicate injections were performed for all samples and analytical spikes.

_____ Duplicate injections agreed within 20%.

_____ Duplicate injections were not performed for the following:

_____

_____ Duplicate injections did not agree within 20% for the following:

_____

_____ Spike recoveries were within 85-115% for all samples.

_____ Spike recoveries were outside 85-115% but greater than 40% and sample abs <50% of spike abs for the following (flagged W):

_____

_____ Spike recoveries were less than 40% for sample and less than 40% for dilution for the following (flagged E):

_____

_____ Spike recoveries were outside 85-115% but greater than 40% and sample abs >50% of spike abs for the following (quantitated by MSA):

_____

Action:	Spike Recov. 85-115%	Spike Recov. <85 or >115%	Spike Recov. <10%
Sample conc. >50% of spike value	Accept	use MSA	Reject

If the spike recovery is less than 40% and the laboratory has not reanalyzed the sample on dilution, approximate (J) the data for that sample.

_____ Method of standard additions was not performed as required for the following samples: _____

_____

_____ MSA was used to quantitate analytical results when contractually required.

_____ Correlation > .995 for samples: _____

_____ Correlation < .995 for samples: _____
(J Data)

I SERIAL DILUTION RESULTS/ICP ANALYSIS

Serial dilution analysis enables the reviewer to evaluate whether significant physical or chemical interferences exist due to sample matrix for samples analyzed by ICP. Sample results for elements analyzed and quantitated by Furnace Atomic Absorption should not be evaluated.

_____ Serial dilutions were performed for each matrix and results of the diluted analysis agreed within ten percent of the original undiluted analysis.

_____ Serial dilutions were not performed for the following:

_____

_____ Serial dilutions were performed, but analytical results did not agree within 10% for analyte concentrations greater than 10 x the IDL after dilution.

Element	IDL	IDL x 10	Sample	Ser. Dil	Action
Aluminum	___	___	___	___	___
Antimony	___	___	___	___	___
Barium	___	___	___	___	___
Beryllium	___	___	___	___	___
Cadmium	___	___	___	___	___
Calcium	___	___	___	___	___
Chromium	___	___	___	___	___
Cobalt	___	___	___	___	___
Copper	___	___	___	___	___
Iron	___	___	___	___	___
Magnesium	___	___	___	___	___
Manganese	___	___	___	___	___
Nickel	___	___	___	___	___
Sodium	___	___	___	___	___
Vanadium	___	___	___	___	___
Zinc	___	___	___	___	___
Molybdenum	___	___	___	___	___
Other	___	___	___	___	___

Actions: All data for samples of the same matrix for that element should be approximated (J'd) when the serial dilution results do not meet contractual requirements.

APPENDIX

A. Editorial Corrections

The package for Project File _____ was reviewed for editorial accuracy in accordance with NQA-1 guidelines. Included in this review is a check for completeness, accuracy, proper xeroxing, initials and dates for line-throughs, absence of traceovers, absence of white-out, and complete filling out of all blocks on a given form.

_____ The package has been found to be complete with respect to editorial accuracy.

_____ The package has been found to be in need of the following editorial corrections:

Page /Form #	Problem

APPENDIX A-III
NON-CLP LABORATORY DATA

NON-CLP LABORATORY DATA (QA Level III)

The purpose of this instruction is to provide an organized method to review non-CLP chemical data from the laboratory. Those areas reviewed include blanks, spikes, and duplicates. The laboratory verifies and validates the analytical data as outlined in the QAPP. Quality Assurance performance data are reviewed and summarized by entering the data on the review lists. Due to analytical problems, i.e., matrix interferences, reports may not meet QC requirements. Therefore, the data need to be evaluated and assigned qualifiers if needed. In cases where data is unclear, response from the laboratory will be requested.

BLANKS

Blanks are screened by reviewing results above detection limits.

Action levels are determined by multiplying the highest concentration determined in any field or laboratory blank by five. The action level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor.

All results less than 5 times the action level should be considered highly suspect and reported as a "JB" - approximate data (value) due to blanks contamination. No action should be taken on the blank itself.

MATRIX SPIKES

Matrix spikes are screened by reviewing spike recoveries and assigning accepted, approximate or rejected as outlined below.

If the sample concentration exceeds the spike concentration by a factor of four or more, no action is taken.

Accept	Approximate	Reject
SSR (75-125%)	SSR(+) & SSR<30%[1]	SSR(ND)&SSR<30%[2]
	SR(+,ND) & SSR(30-74%)[3]	
	SR(+) & SSR>125%[4]	

NOTE: S = amount of spike; SSR = spiked sample result;
SR = sample result; %R = percent recovery; + = positive result; ND = non-detected element
1 - Sample results could be biased low
2 - Possible false negative; analytical deficiencies
3 - Detection limit may be biased low
4 - False positive possible

DUPLICATE ANALYSIS

Duplicate analyses are compared by calculating relative percent difference (RPD) of each set. Duplicate actions should be applied to all other samples of the same matrix type.

Actions: For samples which have an RPD of >20% (35% for soils) shall be qualified as estimated (J). If sample results are less than 5x the CRDL< then action limits are +/- CRDL. For sample results less than the CRDL, the RPD is not calculated.

Calculations: $RPD = \frac{|A-B|}{(A+B)/2} \times 100$

NOTE:
CRDL - Contract Required Detection Limit
RPD - Relative Percent Difference
A - Sample Result
B - Duplicate Result

BLIND DUPLICATE ANALYSIS

The blind duplicate samples will be identified and RPDs calculated per duplicate analysis above.

The reviewer shall use professional judgement when assigning qualifiers to data and document the evaluation on the checklist.

Non CLP
Review Checklist

Project File: _____ Sampling date: _____
Matrix: _____ Receipt date: _____

Overall Comments:

The above data package has been reviewed and the quality assurance and performance data summarized the general criteria used to determine the performance we have based on as examination of:

* Holding times
* Field and lab blank
* Interference QC results
* Matrix spikes
* Laboratory precision results
* Detection limits

Definitions of Qualifiers:

JB - Approximate data due to blank contamination
J - Approximate data due to other quality control criteria
R - Reject due to quality control review
ND - Non-detected element
+ - Positive element identification

Reviewed by: _____ Date: _____

Concurrence by: _____ Date: _____

Quality Assurance Review
Inorganic Data Package

I. HOLDING TIMES

Date samples received	_____	Holding times
Date samples analyzed (Hg):	_____	28 days
Date samples analyzed (CN):	_____	14 days
Date samples analyzed other metals	_____	6 months
Date samples analyzed Cr + 6	_____	24 hours
Date samples analyzed (TON) (Ammonia)	_____	28 days
Date samples analyzed (Cl, F, SO_4)	_____	28 days
Date samples analyzed NO_3 with preservative	_____	28 days
Date samples analyzed TOC	_____	28 days
Date samples analyzed TOX	_____	14 days
Date samples analyzed PO_4	_____	28 days
Date samples analyzed Sulfide	_____	7 days
Date samples analyzed Phenol	_____	28 days

II. BLANK ANALYSIS RESULTS

	Blank	Blank
EL		
Al		
Sb		
As		
Ba		
Be		
Cd		
Ca		
Cr		
Cu		
Fe		
Pb		
Mg		
Mn		
Hg		
Ni		
K		
Se		

II. BLANK ANALYSIS RESULTS

	Blank	Blank
Ag		
Na		
T1		
V		
EL		
Zn		
CN		
Mo		
Cr+6		
TKN		
Ammonia		
F		
C1		
SO_4		
NO_3		
PO_4		
TOC		

II. BLANK ANALYSIS RESULTS

	Blank	Blank
TOX		
Sulfide		
Phenol		

Note: Contamination detected above IDLS should be evaluated and qualified

Action levels are determined by multiplying the highest concentration determined in any field or laboratory blank by five. The action level for samples which have been concentrated or diluted should be multiplied by the concentration/dilution factor.

All results less than 5 times the action level should be considered highly suspect and reported as "JB". No action should be taken on the blank itself.

VI. LABORATORY PRECISION EVALUATION

Sample #: _____ Duplicate Sample #: _____

Element	CRDL ug/L	Sample	Duplicate	RPD	Action
Aluminum	200				
Antimony	60				
Arsenic	10				
Barium	200				
Beryllium	5				
Cadmium	5				
Calcium	5000				
Chromium	10				
Cobalt	50				
Copper	25				
Iron	100				
Lead	5				
Magnesium	5000				
Manganese					
Mercury	0.2				
Nickel	40				
Potassium	5000				
Selenium	5				
Silver	10				
Sodium	5000				
Thallium	10				
Vanadium	50				
Zinc	20				
Cyanide	10				
Molybdenum	N/A				
Other	N/A				
Cr+6					
TKN					
Ammonia					
Fluoride					
Cl					
SO_4					
NO_3					
PO_4					
TOC					
TOX					
Sulfide					
Phenol					

Duplicate actions should be applied to all other samples of the same matrix type.

Actions: For samples which have an RPD of >20% (35% for soils) shall be qualified as estimated (J) for each element affected. If sample results are less than 5x the CRDL, then action limits are +/- CRDL. For sample results less than the CRDL, the RPD is not calculated.

Calculation: $RPD = \frac{|A-B|}{(A+B)/2} \times 100$

NOTE: CRDL - Contract Required Detection Limit
RPD - Relative Percent Difference
A - Sample Result
B - Duplicate Result

Quality Assurance Review
Inorganic Data Package

IV. MATRIX SPIKE RESULTS

Sample Number: _____

Element	SSR	SSRD	SR	S	%R	%RD	RPD	Action
Aluminum								
Antimony								
Arsenic								
Barium								
Beryllium								
Cadmium								
Calcium								
Chromium								
Cobalt								
Copper								
Iron								
Lead								
Magnesium								
Manganese								
Mercury								
Nickel								
Potassium								
Selenium								
Silver								
Sodium								
Thallium								
Vanadium								
Zinc								
Cyanide								
Molybdenum								
Other								
Cr+6								
TKN								
Ammonia								
Fluoride								
Cl								
SO_4								
NO_3								
PO_4								
TOC								
TOX								
Sulfide								
Phenol								

Calculation: $\%R = \frac{SSR-SR}{S} \times 100$

Accept	Approximate	Reject
SSR (75-125%)	SSR(+) & SSR<30%[1] SR(+,ND) & SSR(30-74%)[3] SR(+) & SSR>125%[4]	SSR(ND) & SSR<30%[2]

If the sample concentration exceeds the spike concentration by a factor of 4 or more, no action is taken.

NOTE: S = Amount of spike; SSR = spiked sample results; SSRD = spiked sample result duplicate

SR = Sample result; %R = percent recovery; + = positive result; ND = non-detected element.

RPD - Relative Percent Difference
A - Sample Result
B - Duplicate Result

1 - Sample results could be biased low.
2 - Possible false negative; analytical deficiencies.
3 - Detection limit may be biased low.
4 - False positives possible.

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RADIOLOGICAL LABORATORY ANALYSIS QUALITY CONTROL (QA Level V)

The radiological analysis laboratory QC will provide that the required analysis, QC sample checks, and verification of the results are performed and that the acceptability of the results is known and verifiable. Any deficiencies in the testing program will be identified so proper corrective action can be taken. A more detailed discussion of radiological QC requirements is included in the IT/RSL Radioanalytical Methodology and Procedures Manual and the IT/RSL QA Manual.

DUPLICATE SAMPLE ANALYSIS

One duplicate sample will be run for every 10 to 20 samples. The results of these analyses will be used to determine the percent relative standard deviation (percent RSD), which will be recorded on radiological analysis quality control forms (e.g., control charts) for the parameters being tested. If the results of the percent relative standard deviation are excessive (i.e., outside the control limits) for the materials analyzed and method used, the samples will be reanalyzed.

MATRIX SPIKE ANALYSIS

One sample out of every 10 to 20 will be spiked prior to analysis with the parameters of interest to determine the percent bias. The percent bias will be recorded on radiological analysis QC forms (e.g., control charts). If the results of the percent bias determinations fall outside appropriate values (i.e., control limits) for the material analyzed and method used, the samples will be reanalyzed and the valves recorded.

METHOD AND FIELD BLANK ANALYSES

At least one method blank for each group of samples will be analyzed for the pertinent radiological parameters. The method blanks will consist of a distilled or de-ionized water sample. Field blanks will be analyzed to monitor for possible sample contamination during storage and shipment. Field blanks will be prepared by filling two sample containers with distilled water and shipping the blanks to the lab with the sample bottles. The field blanks accompany the sample bottles through collection and shipment to the laboratory and are stored with the samples. If the field blanks indicate possible contamination of the samples, the laboratory manager and site manager will be notified immediately and, depending upon the nature and extent of the contamination, the sample results may be corrected for the field blank concentration or the sources resampled. Results of method and field blank analyses will be filed with the corresponding sample analytical data.
Radiological measurements (i.e., surface and subsurface soil, sediment, surface and ground water, and radiation survey measurements) which have not undergone complete validation should use the following criteria.

I. Radiation Survey Measurements

The procedure and checklists shown in this document should be used to validate data that has not previously been validated.

II. Soil/Sediment Measurements

A. Review separately the analytical data from each radiological parameter for all samples.

1. For each parameter with results listed as "less than the detection limit" verify that the following detection limits are listed.

Radiological Laboratory Detection Limits Rinsate.

Parameter	Lab Detection Limits (pCi/g)	Rinsate Limits (pCi/l)
Uranium, total	1 *ug/g*	1 *ug/l*
Np-237	0.6	30.0
Tc-99	0.9	5.0
Sr-90	0.5	1.0
Pu-239, 240	0.6	1.0
Pu-238	0.6	1.0
Th-232	0.6	1.0
Th-230	0.6	1.0
Th-230	0.6	1.0
U-238	0.6	1.0
U-235, 236	0.6	1.0
U-234	0.6	1.0
Ra-228	0.5	3.0
Ra-226	0.3	1.0
Ru-106	1.0	150.0
CS-137	0.2	20.0

(RI/FS, FMPC, Volume V: QAPP, Rev. 3, Section 4, p. 19)

2. For each sample and each parameter, determine whether results are greater than the laboratory detection limit for that parameter.

3. If laboratory detection limits are exceeded, the location of the soil sample is investigated by reviewing the field sample logs and other site records to determine, if possible, the source of the activity.

4. For every reading above the detection limit, verify that there is a two sigma (95%) uncertainty listed. Verify that the uncertainty does not exceed the parameter reading.

5. Anomalies are investigated by reviewing field logs and other site records to determine if the source of the anomaly is apparent.

B. Review the consistency of total uranium data

1. Calculate the mass concentration of uranium in each sample using the formula:

U-238(pCi/g) x 3 + U-235(pCi/g) x 0.5 = μg/g

This equation is used to estimate the mass concentration. The factors, 3 and 0.5, are the reciprocals to the specific activities for ^{238}U and ^{235}U, respectively.

Specific Activity = Lambda x N,

Lambda = In2/Radioactive Halflife, and
N = Number of Atoms per gram of Radioactive Material

Lambda (^{238}U) = In2/(4.5 x 10^9 yrs x 3.15 x 10^7 sec/yr) = 4.89 x 10^{-15} sec^{-1}

$$N\ (^{238}U) = \frac{6.02 \times 10^{23}\ \text{atoms/g-mole} \times 10^{12}\ \text{pCi/Ci}}{238\ \text{g/g-mole} \times 3.7 \times 10^{10}\ \text{dps/Ci} \times 10^{6}\ \mu\text{g/g}} = 0.33\ \text{pCu}/\mu\text{g}$$

The reciprocal being 1/0.33, or 3 μg/pCi. The same calculation can be performed for ^{235}U substituting in the radiological halflife of 7.1 x 10^6 yrs and the atomic mass of 235 g/g-mole. The answer in this case being 0.47 μg/pCi.

The second formula is simply the ratio of the ^{238}U specific activity to the ^{235}U specific activity multiplied by 100. The same calculations as those used above were used. The specific activity for ^{238}U is 0.33 pCi/μg while that for ^{235}U is 2.15 pCi/μg (2.15 pCi/μg). The ratio times 100 is 15.6.

2. Compare this calculated value with the reported "total uranium" values (μg/g) by calculating the ratio of the two values.

3. Any ratio outside of the range of 0.8 - 1.2 is considered an outlier and the laboratory data sheets for that sample are to be reviewed for errors.

4. Anomalies are investigated by reviewing field logs and other site records to determine if the source of the anomaly is apparent.

C. Review the consistency of isotopic uranium data

1. Calculate the percent enrichment (by mass) of U-235 for each sample using the formula:

$$\frac{\text{U-235 (pCi/g)}}{\text{U-238 (pCi/g}} \times 15.56 = \_\_\_\%$$

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2. Any percent enrichment outside of the range of 0.2 - 1.3% is considered an outlier and the laboratory data sheets for that sample are to be reviewed for errors.

3. Calculate the ratio of U-234 (pCi/g) to U-238 (pCi/g) for each sample.

4. Any ratio outside the range 0.4 to 1.3 is considered an outlier and the laboratory data sheets for the sample are to be reviewed for errors.

5. Anomalies are investigated by reviewing field logs and other site records to determine if the source of the anomaly is apparent.

D. Review maps and plots of total uranium in soil samples.

1. Soil concentrations of total uranium should be within the background range of 0.5 to 5 pCi/g if the location is distant from known areas of elevated concentrations (sewage treatment plant, NE corner of plant).

   The range of total uranium values was determined by soil samples taken distant to the FMPC site. A range of 0.76 to 2.2 pCi/g for ^{238}U in soil was presented by T. E. Myrick, et al, for 12 samples taken in the state of Ohio which is line with the estimate used in the Data Validation Plan. Concentration outside of the range were considered anomalous, investigated, and unresolved items noted in a memorandum to the Data Validation Technical Representative, (Myrick, T. E., et al, "Determination of Concentrations of selected Radionuclides in Surface Soils in the U.S.", Health Physics, Vol. 45, No. 3, pp. 631-42.)

2. Measured concentration near known areas of elevated concentrations should increase with decreasing distance from the area.

3. Anomalies are investigated by reviewing field logs and other site records to determine if the source of the anomaly is apparent.

4. Any unresolved anomalies are noted in a memorandum to the DV Technical Rep.

E. Review maps and plots of other parameters in soil samples

1. Anomalies are investigated by reviewing field logs and other site records to determine if the source of the anomaly is apparent.

III. Surface and GroundWater Measurements

The criteria used above in Section II. Soil/Sediment Measurements, Parts A - C, should be used in addition to the following to validate surface and groundwater sample data.

A. Review maps and plots of surface water measurements

1. Surface water concentrations of total uranium should be within the background range of 1 to 2 pCi/ℓ if the location is distant from known areas of elevated concentration.

The "Hydrogeologic Study of FMPC Discharge to the Great Miami River" (IT Corporation, August 1, 1988) documents a total uranium range of 1.0 to 1.8 pCi/liter. Recent Fernald Environmental Monitoring Reports have presented varying concentrations found at location W5 (Paddys Run, north of the railroad tracks entering the site) which are in the 1.0 to 2.0 pCi/liter range.

2. Anomalies are investigated by reviewing field logs and other site records to determine if the source of the anomaly is apparent.

B. Review maps and plots of ground water measurements

1. Ground water concentrations of total uranium should be within the background range of 1 to 2 pCi/ℓ if the location is distant from known areas of elevated concentration.

2. Anomalies are investigated by reviewing field logs and other site records to determine if the source of the anomaly is apparent. It is important to utilize information from different depth wells to validate that results are noted elsewhere in the area if a positive result is observed.

IV. Review of Radiochemical Blanks, Replicates and Spikes

A. Blanks analyzed with each set of samples?

B. Do the blanks exhibit high background?

C. Was the high background investigated?

D. Replicates run at least every 20 samples?

E. Does the relative standard deviation exceed control limits liquids)?

F. Does the mean relative standard deviation exceed control limits (for inorganic solids)?

G. Spikes are run at least every 20 samples?

H. Were percent bias results documented on control charts?

I. Does the percent bias result exceed control limits?

SPECIFIC VALIDATION CHECKLIST	RADIOCHEMICAL CHECKLIST FOR BLANKS, SPIKES, AND DUPLICATES	
PROJECT:	DATE:	PAGE __ OF __
SAMPLE/I.D.:		

CHECKLIST ITEMS	U-234/238	Pu-239	Np-237	Th-232	Tc-99	Sr-90	U-TOT	Ra 226/228
ARE BLANKS RUN EVERY 20 SAMPLES?								
BLANK SAMPLE FORM #'S								
BLANK BACKGROUND COUNT RATE								
ARE HI BKGROUNDS DOCUMENTED/ INVESTIGATED?								
ARE SPIKES RUN EVERY 20 SAMPLES?								
SPIKE SAMPLE FORM #'S SPIKE NORMALIZED DEV'S								
ARE NORMALIZED DEVIATIONS WITHIN CONTROL LIMITS? (-3<X<+3)								
ARE DUPLICATES RUN EVERY 20 SAMPLES?								
RESULTS: IF DUP#=SAM#								
ARE NORMALIZED RANGES WITHIN CONTROL LIMITS (O<X<+4) -FOR LIQUIDS?								
-FOR INORGANIC SOLIDS?								

NOTES:		COMMENTS:
NA - NOT APPLICABLE - - QC INFO NOT FOUND # - QC INFO FOUND	#(XX) - QC INFO FOUND, BUT WAS AFTER XX SAMPLES (I.E. MORE THAN 20)	

REVIEWED BY:	DATE:	CONCURRENCE BY:	DATE:

Data Validation Procedures for Biology Data

The procedures for Biology Sampling in Section 9.1.8 of the Draft Validation, QAPP Addendum, cover the biological sampling conducted in 1987 and 1988.

1.0 Macroinvertebrate Surveys of Paddy's Run and the Great Miami River, Task 3.05.01

A. Refer to the Specific Validation Checklist for Macroinvertebrate Surveys.

B. Each sample and sampling event should be properly recorded in the field log, along with physicochemical data recorded in the field at the time of sampling.

C. The following document requires review:

* Field Log (bound notebook, specific to Fernald, kept by field personnel).

D. The Plan of Work for Macroinvertebrate Surveys, in the Project Files Task 3.5, provides background information for macroinvertebrate surveys.

E. Macroinvertebrates collected from Paddy's Run and the Great Miami River are identified using the following references and keys:

* Mason, W.T., 1973, An Introduction to the Identification of Chironomid Larvae, Analytical Quality Control Laboratory, NERC/EPA, Cincinnati, Ohio.

* Merritt, R.W. and K.W. Cummins (eds.), 1984, An Introduction to the Aquatic Insects of North America, 2nd ed., Kendall/Hunt Publishing Company, Dubuque, Iowa.

* Parrish, F.K., 1975, Keys to Water Quality Indicative Organisms of the Southeastern United States, 2nd ed., Office of Research and Development, USEPA, Cincinnati, Ohio.

* Pennak, R.W., 1978, Freshwater Invertebrates of the United States, 2nd. ed., Ronald Press Company, New York New York.

* Ward, H.B. and G.C. Whipple (eds.), 1959, Freshwater Biology, 2nd ed., John Wiley and Sons, New York, New York.

F. Organisms are classified into pollution tolerance classes according to the following references:

* Conn, C.C., 1973, Biological Survey of the Great Miami River, The Miami Conservancy District.

* Merritt, R.W. and K.W. Cummins (eds.), 1984, An Introduction to the Aquatic Insects of North America, 2nd ed., Kendall/Hunt Publishing Company, Dubuque, Iowa.

* Weber, C.I., 1973, Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, EPA/670/4-73/001, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.

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G. Surber samplers, used to collect organisms from Paddy's Run, are used in accordance with American Society for Testing and Materials (ASTM) practice, described in the following reference:

* Cairns, J. and K.L. Dickson (eds.), 1973, Biological Methods for the Assessment of Water Quality, ASTM Special Technical Publication 528, American Society for Testing and Materials, Philadelphia, Pennsylvania.

H. Statistical analyses of data are performed according to the following references:

* Green, R.H., 1979, Sampling Design and Statistical Methods for Environmental Biologists, John Wiley and Sons, New York, New York.

* Ludwig, J.A. and J.F. Reynolds, 1988, Statistical Ecology, John Wiley and Sons, New York, New York.

* Zar, J.H., 1974, Biostatistical Analysis, Prentice Hall, Inc., Englewood Cliffs, New Jersey.

I. Dissolved oxygen, temperature, pH, conductivity, and oxidation reduction potential of the water at macroinvertebrate sampling stations are recorded with a Hydrolab Surveyor II water quality analyzer, calibrated according to the manufacturer's instructions.

J. The Specific Validation Checklist should contain the following items:

* Samples from field properly logged into analytical laboratory, checking ID against field log.

* Tables of physicochemical data for reports verified against field log.

* For QA checks of organism IDs and numbers, organism IDs match and counts match within 10%.

* Report checklist shows verification of calculations of indices and statistics used in reports.

K. The Technical Review of the Macroinvertebrate Survey Report, which will be deposited in the Project File Task 3.5, should also be consulted to ensure that all technical comments have been properly dispositioned.

2.0 Acute and Chronic Toxicity Testing of FMPC Effluent, Task 3.05.02

A. Refer to the Specific Validation Checklist for Acute and Chronic Toxicity Testing.

B. The following documents require review:

* C-C (Use General Validation Checklist for this document.)

* FADL or field log.

C. The Plan of Work for Acute and Chronic Testing, in the Project Files Task 3.5, provides background information for acute and chronic toxicity testing. Testing requirements are contained in the following documents:

Acute Testing

USEPA, 1985, Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Third Edition, EPA/600/4-85/013, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.

Chronic Testing

USEPA, 1989, Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Second Edition, EPA/600/4-89/001, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.

Items on the Specific Validation Checklist are adapted from these documents.

D. The specific tests conducted on FMPC effluent are listed below. Recommended test conditions are stated in the referenced table.

Acute Toxicity Tests

1. *Daphnia pulex* (Water Flea) 48 Hour Survival Test (USEPA, 1985, Table 5)

2. *Pimephales promelas* (Fathead Minnow) 96 Hour Survival Test (USEPA, 1985, Table 7)

Chronic Toxicity Tests

1. *Selanastrum capricornutum* (Algal) Growth Test (USEPA, 1989, Section 13, Table 3)

2. *Ceriodaphnia dubia* (Cladoceran) Survival and Reproduction Test (USEPA, 1989, Section 12, Table 3)

3. *Pimephales promelas* (Fathead Minnow) Larval Survival and Growth Test (USEPA, 1989, Section 10, Table 1)

E. Items to be listed on the Specific Validation Checklist are as follows (this list is proposed to replace the current Specific Validation Checklist):

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* Provide space to indicate kind of test being validated, e.g. "Acute Test, Daphnia". The "SAMPLE/I.D." block on the proposed Specific Validation Checklist might be an appropriate location for this information.
* Test conducted in general accordance with USEPA guidance (1985, 1989).

* Temperature within ± 2 C of test temperature

* Two or more concentrations exhibit a trend deviation?

* Holding times for effluent and acclimation water less than 72 hours

* Any unexplained discrepancies in mortality between replicate treatments?
* Any unexplained discrepancies in physicochemical data between replicate treatments?

F. The Technical Review of the Acute and Chronic Toxicity Testing Report, which will be deposited in the Project File Task 3.5, should also be consulted to ensure that all technical comments have been properly dispositioned.

3.0 Wetlands Delineation, Task 3.05.03

A. The Plan of Work for Wetlands Delineation, in the Project File Task 3.5, provides background information for wetlands delineation.

B. Requirements for valid wetlands delineation are contained in the following document:

* Federal Interagency Committee for Wetland Delineation, 1989, Federal Manual for Identifying and Delineating Jurisdictional Wetlands, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C. Cooperative technical publication. 76 pp. plus appendices.

C. The Technical Review of the Wetlands Delineation Report, which will be deposited in the Project File Task 3.5, should also be consulted to ensure that all technical comments have been properly dispositioned.

4.0 Bioaccumulation Study, Task 3.05.04

A. Refer to the Specific Validation Checklist for the bioaccumulation study.

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B. Each sample should appear in the C-C, RFA, and FADL (or field log). Make certain each form is correctly filled out by using General Validation Checklists for these forms. Alternately, if numerous discrepancies exist, make a copy of the document and circle the discrepancies with a red pen. Note this fact on the checklist and attach the copy.

C. The Plan of Work for the Bioaccumulation Study, in the Project Files Task 3.5, provides background information for the bioaccumulation study. Section 7.1 of QAPP contains requirements for C-C and RFA. NOTE: there are General Validation Checklists for each of these forms.

D. The RFA should indicate the type of analysis the sample should undergo. Packaging requirements for samples are contained in section 6.3.4 of the Sampling Plan, and should correspond to the type of analysis requested on the RFA.

E. The Specific Validation Checklist should contain the following items:

* Location of fish cages and time and date of placement recorded in bound notebook.

* Fish healthy at time of placement in cages.

* Fish all procured from same supplier, at one time.

* Tables of physicochemical data from field, used for reports, verified against field log.

F. The Technical Review of the Bioaccumulation Report, which will be deposited in the Project File Task 3.5, should also be consulted to ensure that all technical comments have been properly dispositioned.

5.0 Soils and Sediment Toxicity Testing, Task 3.05.05

A. Refer to the Specific Validation Checklists for Soils and Sediment Toxicity Testing and for Surface Soil Sampling.

B. Soils and sediment sample collection and radiological analyses should follow data validation procedures outlined in the QAPP Addendum, Section 9.1.8, Surface Soil Sampling.

C. Background information on soil and sediment toxicity testing is provided in the Plan of Work for soils and sediment toxicity testing, in the Project Files Task 3.5. Testing requirements are contained in the following documents:

* USEPA, 1985, Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Third Edition, EPA/600/4-85/013, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.

* USEPA, 1989, Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Second Edition, EPA/600/4-89/001, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.

* Nebecker, A., 1984, "Biological Methods for Determining Toxicity of Contaminated Freshwater Sediments to Invertebrates", Environmental Toxicology and Chemistry, Vol. 1, pp. 617-630.

Items on the Specific Validation Checklist are adapted from these documents.

D. The following documents require review:

* C-C (Use General Validation Checklist for this document.)

* FADL or field log.

E. The specific tests conducted on soils and sediments are listed below.

1. Pimephales promelas (Fathead Minnow) 96 Hour Static Acute Whole Sediment Bioassay

2. Chironomus tentans (Chironomid) 10-Day Acute Whole Sediment Bioassay

3. Daphnia magna (Water Flea) 48 Hour Static Nonrenewal Sediment Bioassay

F. Items to be listed on the Specific Validation Checklist are as follows (adapted from Acute and Chronic Toxicity Testing Specific Validation Checklist):

* Provide space to indicate kind of test being validated, e.g. "Daphnia magna". The "SAMPLE/I.D." block on the proposed Specific Validation Checklist might be an appropriate location for this information.

* Test conducted in general accordance with guidance in the documents cited above. Other guidance consulted will be referenced in the Soil and Sediment Toxicity Testing Report.

* Temperature within $\pm$ 2 C of test temperature

* Two or more concentrations exhibit a trend deviation?

* Holding times for sediments less than 30 days at 4 C.

* Any unexplained discrepancies in mortality between replicate treatments?

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* Any unexplained discrepancies in physicochemical data between replicate treatments?

G. The Technical Review of the Soils and Sediment Toxicity Testing Report, which will be deposited in the Project File Task 3.5, should also be consulted to ensure that all technical comments have been properly dispositioned.

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SPECIFIC VALIDATION CHECKLIST				TITLE: BIOLOGICAL RESOURCES SAMPLING ECOLOGICAL FIELD SURVEY COLLECTION LOG	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:				EPA/600/4-85/014--EPA/600/4-85/013	
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
PROJECT NAME AND NUMBER					
COLLECTORS NAME,DATE AND TIME					
STATION NAME AND NUMBER					
LOCATION OF SAMPLE COLLECTION					
WEATHER CONDITION & AIR TEMP					
SAMPLE NUMBER					
SAMPLE TYPE					
COLLECTION METHOD AND SAMPLER					
DEPTH & COLLECTION DIMENSIONS					
SAMPLE PRESERVATIVES					
LOCATION SKETCH					
HABITAT TYPE					
HABITAT WIDTH/DEPTH/TURBIDITY					
HABITAT PERCENT SHADING & FLOW VELOCITY					
HABITAT COVER, SUBSTRATE, GRADIENT, BANKS					
GENERAL DESCRIPTION OF LAND USE					
DESCRIPTION-POSSIBLE POLLUTION					
DESCRIPTION-FLOODPLAIN					
DESCRIPTION-MACROPHYTES					
DESCRIPTION-CONDITIONS/COMMENTS					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

SPECIFIC VALIDATION CHECKLIST				TITLE: BIOLOGICAL RESOURCES ACUTE AND CHRONIC	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:				EPA/600/4-85/014--EPA/600/4-85/013	
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
DILUTION WATER OBTAINED FROM AN UPSTREAM SOURCE					
SAMPLE PRESERVED ON ICE					
SAMPLE ANALYZED WITHIN 72 HOURS					
INSTRUMENTS TO MEASURE DO, pH, CONDUCTIVITY, ALKALINITY AND HARDNESS CALIBRATED					
WATER TEMPERATURE MAINTAINED BETWEEN TEST RANGE					
pH KEPT BETWEEN 6.0 - 9.0					
DO AND pH CHECKED DAILY					
DO EXCEED 40% (4 MG/L) SATURATION					
CONTROL SURVIVAL EXCEED 80%					
TEST ORGANISM DISEASE FREE					
ORGANISMS AT APPROPRIATE AGE					
REFERENCE TOXICANT CHECKED MONTHLY					
LC 50 FOR REFERENCE TOXICANT WITHIN EXPECTED RANGE					
FOOD QUALITY CHECKED					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

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GEOTECHNICAL OF INTERNAL QUALITY CONTROL CHECKS (QA Level II)

Internal quality control checks, (e.g., QC samples) are not applicable to geotechnical testing. This is due to the inability of obtaining samples with known characteristics. Blanks and spikes are also not applicable to geotechnical testing.

QC measures to insure accuracy and precision of test results include the following: 5195

100% verification on all numerical results - all raw data entries, transcriptions and calculations entered by lab technicians are checked, recalculated and verified by the geotechnical laboratory manager.

Data validation through test reasonableness - summaries of all test results for individual reports are reviewed by the geotechnical laboratory manager to determine the overall reasonableness of data and to determine the presence of any data that may be considered outliers.

Routine instrument calibration - all instruments, gauges, and equipment used in testing are calibrated on a timely routine basis. All instrument calibration follows ASTM or manufacturer's guidelines.

Maintenance of all past calibration records - records and certification documents of all instruments, gauges, and equipment are updated routinely and maintained in the geotechnical analytical instruments; in some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. The quality depends on the use of suitable calibration standards, reference materials, sample preparation equipment, and the training of the operator. Results are available in real-time or several hours.

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The following QA/QC measures are the mainstay of Geotechnical Services:

A. Procurement and control of instrumentation and supplies required for laboratory operation

B. Sample receipt, chain-of-custody completion, and sample storage

C. Calibration of testing equipment

D. Geotechnical tests in accordance with prescribed, industry-standard test methods

E. Data processing, validation, and reporting

F. Control and maintenance of laboratory records

G. Identify and resolve nonconformances requiring corrective action

H. Audits to verify laboratory performance and the reporting of audit results to management

The reviewer shall verify that those items on the check list have been accomplished.

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Geotechnical Testing Procedures

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Soil Sampling	*ASTM D420
Preserving and Transporting Samples	ASTM D4220
Preparation of Soil Samples	ASTM D421/D2217
Water Content	ASTM D2216
Particle Size Distribution	ASTM D422
Atterberg Limits	ASTM D4318
Bulk Density	ASTM D4531
Specific Gravity	ASTM D854
Permeability	ASTM D2434
Saturated Hydraulic Conductivity	ASTM D2434
Porosity	ASTM D2434
pH	**MOSA 12-2.6

*ASTM - American Society for Testing and Materials
**MOSA - Methods of Soil Analysis Part 2

Test Method	Sample Size	Reporting Unit
ASTM D420	NOT APPLICABLE	NOT APPLICABLE
ASTM D4220	NOT APPLICABLE	NOT APPLICABLE
ASTM D421/D2217	NOT APPLICABLE	NOT APPLICABLE
ASTM D2216	25 g	% WATER-OVEN DRY
BASIS		
ASTM D422	100 g	% PER DIAMETER
CLASS		
ASTM D4318	250 g	% WATER LIQUID
LIMIT		
		% WATER PLASTIC
LIMIT		
		PLASTICITY INDEX
USCS		CLASSIFICATION
ASTM D4531	100 g (UNDISTURBED)	g/cm^3
ASTM D854	50 g	g/cm^3
ASTM D2434	500 g	COEFFICIENT OF PERMEABILITY (cm/sec)

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SPECIFIC VALIDATION CHECKLIST				TITLE: GEOTECHNICAL	
PROJECT:				DATE:	PAGE __ OF __
SAMPLE/I.D.:					
CHECKLIST ITEMS	YES	NO	N.A.	REMARKS/COMMENTS	
IS CHAIN-OF-CUSTODY COMPLETE?					
IS REQUEST FOR ANALYSIS COMPLETE?					
WAS HYDROMETER CALIBRATED?					
IS CALIBRATION DONE ON EQUIPMENT WHICH REQUIRES DAILY CALIBRATION?					
ARE THERMOMETERS NBS TRACEABLE?					
ARE SIEVES CERTIFIED TO ASTM.11.87?					
ARE CALIPERS CALIBRATED?					
ARE PYCNOMETERS CALIBRATED?					
ARE QA CHECKS PERFORMED ON DATA (I.E. CALCULATIONS,TRANSCRIPTION ERRORS)					
REVIEWED BY: DATE:				CONCURRENCE BY: DATE:	

APPENDIX B
DATA VALIDATION TEAM FORMS

-5195

No. _____

FMPC RI/FS DATA VALIDATION DEFICIENCY REPORT

Date _____

Task:

Field Data Form:

Lab Project Number:

Sample Numbers:

Problem Description:

Problem Significance/Impact:

430

Data Validation Team Recommendation:

DVT Leader/Tech Rep _____ Date _____

QA Officer _____ Date _____

Dep Dir Technical/Tech Manager _____ Date _____

Project Director _____ Date _____

IP940.kg2

*Completed Checklist Attached

FMPC RI/FS DATA VALIDATION DEFICIENCY REPORTS LOG

5195

No./Date	Field Data Form/ Lab Project No.	Task	Sample Nos.

432

DATA VALIDATION
TEAM MEMBER BASIC ORIENTATION/TRAINING

Name	General Field Techniques Briefing	Work Plan Vol. I, Sec. 4	QAPP, Sec. 10	ASI Data Validation White Paper	DVP	WMCO Videotape "ERA Cleanup"

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