STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

IN THE MATTER OF REMEDIAL ACTION BY:	)	
	)	ENFORCEMENT ORDER
CAMERON-YAKIMA, INCORPORATED	)	No. DE 94TC-C168
1414 SOUTH FIRST STREET	)	
PO BOX 1554	)	
YAKIMA, WASHINGTON 98901	)	

TO: Bob Hansen, President
CAMERON-YAKIMA, INCORPORATED

I.

Jurisdiction

This Order ("Order") is issued pursuant to the authority of the Revised Code of Washington (RCW) 70.105D.050(1).

II.

Findings of Fact

The Department of Ecology (Ecology) makes the following Findings of Fact.

2.1. The Facility, Cameron-Yakima, Inc., (CYI) is located at 1414 South First Street in Yakima, Washington, on Parcel Number 19133042441 (according to Yakima County Assessor's records). CYI has been owned and operated as an activated carbon recycling business since 1944.

CYI is an active Facility that regenerates spent carbon from air, water, and industrial process filtration systems. Management areas include, but are not limited to, multiple hearth furnaces, drum storage, and a decant unit (which was identified in a September 10, 1990 Part A RCRA permit application by CYI as an in-ground spent carbon transfer tank). The CYI Facility operations are regulated under a RCRA interim status permit.

2.2. On June 28, 1988 the Environmental Protection Agency (EPA), via a contractor, completed a preliminary site assessment of CYI. A manifest review showed tetrahydrofurane, xylene, tetrachloroethene (perchlorethylene, PCE), dichloroethene, trichloroethylene (TCE), and dichlorbromopropane adsorbed on the carbon arriving at the Facility. Based on information gathered during a Facility Assessment (RFA), the EPA assigned the Facility a high priority for corrective action.

2.3. On March 29, 1988 the EPA issued a 3013 Order to CYI pursuant to RCRA. The Order stated that inspectors "...discovered that the Facility has been storing outdoors approximately 500 55-gallon drums of charcoal contaminated with Perchloroethylene."

2.4. On August 1 through 3, 1988 CYI consultants, Black and Veatch, Waste Management Incorporated, conducted soil sampling at the CYI Facility as required in the March 29, 1988 3013 Order. Contamination of soil by Perchloroethylene (PCE) was found in concentrations as high as 170 mg/kg (ppm). Additional contaminants found included trichloroethene, methylene chloride, chloroform, toluene, ethylbenzene, xylene, and carbon disulfide.

2.5. Delta Environmental, consultants to CYI, conducted a hydrogeologic assessment in August of 1988 as required under the March 29, 1988 3013 Order. Data from this study showed tetrachlorethene in groundwater as high as 960 ppb in an on-site monitoring well MW-4.

2.6. Ecology & Environment, Inc. (E&E), contractors to EPA, conducted a soil-gas study of a 2-1/2 square mile area in the downtown industrial section of Yakima between June 5, 1989 and July 22, 1989. CYI is located within the area of the study known as the Yakima Railroad Area (YRRA). In its report, E&E stated "...it is believed that Cameron-Yakima, Inc., property is a ...potential source of PCE in groundwater contamination."

2.7. On October 24, 1991, after notice and opportunity for comment, Ecology issued a final determination of Potentially Liable Person (PLP) status under RCW 70.105D.040 for the YRRA to CYI.

2.8. On February 11, 1992 the YRRA PLPs were issued an Order by Ecology (Order No. DE 92TC-C108) which directed them to provide bottled water to those residences in the YRRA on private wells.

2.9 On October 8, 1993 Cameron-Yakima, Inc., provided Ecology with a "Preliminary Site Assessment" prepared by Hart Crowser, dated September 28, 1993. Contamination of soil by PCE was found in concentrations as high as 720 mg/kg (ppm). Additional contaminants found at the Facility included Trichloroethene, 1,2-Dichloroethane, 1,2-Dichloroethene, 1,1,1-Trichloroethane, Ethylbenzene, Toluene, Xylene, Freon

12, Freon 11, Freon 113, Vinyl Chloride, Methylene Chloride, cis-1,2-Dichloroethene, Benzene, Styrene, 1,2,4-Trimethylbenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene. Additionally, it was found that soil moisture levels appear elevated in various locations at the Facility including the barrel washing area and the surface impoundment unit presently undergoing closure.

III.

Ecology Determinations

3.1. CYI is an "owner or operator" as defined in RCW 70.105D.020(6) of a "Facility" as defined in RCW 70.105D.020(3).

3.2 The Facility is known as Cameron-Yakima, Incorporated, and is located at 1414 South First Street in Yakima, Washington 98901, Parcel Number 19133042441.

3.3. The substances found at the Facility as described above are "hazardous substances" as defined in RCW 70.105D.020(5).

3.4. Based on the presence of these hazardous substances at the Facility and all factors known to Ecology, there is a release or threatened release of hazardous substances from the Facility, as defined in RCW 70.105D.020(10).

3.5 CYI is one of the facilities from which there is a release or threatened release of PCE within the YRRA.

3.6. By letter dated October 24, 1991 Ecology notified CYI of its status as a "potentially liable person" under RCW 70.105D.040 after notice and opportunity for comment.

3.7. Pursuant to RCW 70.105D.030(1) and RCW 70.105D.050, Ecology may require PLPs to investigate or conduct other remedial actions with respect to the release or threatened release of hazardous substances, whenever it believes such action to be in the public interest.

3.8. Based on the foregoing facts, Ecology believes the remedial action required by the Order is in the public interest.

IV.

Work to be Performed

Based on the foregoing Facts and Determinations, it is hereby ordered that Cameron-Yakima, Incorporated, take the following remedial actions and that these actions be conducted in accordance with Chapter 173-340 of the Washington Administrative Code (WAC) unless otherwise specifically provided for herein.

4.1. No later than thirty (30) days after issuance of this Enforcement Order, Cameron-Yakima, Inc., shall submit to Ecology for review and approval, a draft Work Plan (Plan) for completion of a Remedial Investigation/Feasibility Study (RI/FS). This draft Plan shall consist of a detailed RI/FS work plan which, at a minimum, shall address the components outlined in Attachment A. Attachment A is incorporated by this reference and is an integral and enforceable part of this Order. The draft Plan will also include a Schedule of Deliverables as outlined in Attachment B. Attachment B is incorporated by this reference and is an integral and enforceable part of this Order.

Twenty (20) days after receipt of Ecology's comments on the draft Plan, Cameron-Yakima, Inc., shall submit a final Plan for approval by Ecology.

No later than thirty (30) days after receipt of Ecology's written approval of the final Plan, Cameron-Yakima, Inc., shall begin the RI/FS work described in the Plan. The RI/FS work shall be completed according to the time frame and schedules described in the approved Plan.

The RI/FS will collect, develop, and evaluate sufficient information regarding the Facility to enable the selection of a cleanup action under WAC 173-340-360. The RI/FS will be implemented to meet the requirements of WAC 173-340-350.

4.2. Samples from the initial round of groundwater and soil sampling conducted for the RI/FS shall be analyzed for all constituents specified in Appendix IX of 40 CFR, Part 264. Parameters for subsequent sampling events shall be selected, subject to Ecology review and approval, based on initial sampling and analysis, and upon the composition of wastes that are, or have been,

managed at CYI. The rationale for selection of all parameters shall be provided.

4.3. Cameron-Yakima, Inc., will develop and submit to Ecology for approval a Quality Assurance/Quality Control (QA/QC) Plan in accordance with the Ecology Guidelines and Specifications for Preparing Quality Assurance Project Plans (May 1991), Attachment C. Attachment C is incorporated by this reference and is an integral and enforceable part of this Order. No sampling associated with this Order may be conducted prior to Ecology approval of the QA/QC Plan.

4.4. Results from sampling shall be provided to Ecology's project coordinator within 14 days of receipt from the laboratory.

4.5. Written progress reports shall be submitted to Ecology with a copy to EPA and RCRA by CYI at least monthly from the date of this Order to completion. CYI shall immediately notify Ecology by telephone of any unexpected delays in the work required as part of this Order.

4.6. In accordance with WAC 173-340-840(5), sampling data shall be submitted according to Attachment D: DATA SUBMITTAL REQUIREMENTS. Attachment D is incorporated by this reference and is an integral and enforceable part of this Order.

4.7. Cameron-Yakima, Inc., shall prepare and submit to Ecology a detailed, written estimate, in current dollars, of the cost of completion of all RI/FS activities required by this Order, including development of work plans, implementation, and satisfactory performance of the RI/FS. The cost estimate must be based on the costs to respondent of hiring a third party to perform all RI/FS activities required by this Order. Respondent shall annually adjust and submit to Ecology the most up-to-date corrective action cost estimate for inflation within thirty (30) days after close of their fiscal year. The original cost estimate will be developed within ninety (90) days of the effective date of this Order. Respondent shall adjust and submit to Ecology the most up-to-date RI/FS cost estimate within thirty (30) days after CYI becomes aware of new information which may increase the cost of satisfactory completion of this Order. Within 120 days of the effective date of this Order, CYI shall establish and shall continuously maintain financial assurance for performance of remaining RI/FS activities at the Facility in at least the amount of the most up-to-date

cost estimate prepared in accordance with this Order. The mechanism(s) for obtaining and demonstrating financial assurance for corrective action must be one of the forms specified in paragraphs (a) through (f) of 40 CFR, section 265.143.

4.8 Deviations from the Scope of Work may only be made with prior Ecology approval.

V.

Terms and Condition of Order

5.1. Definitions

Unless otherwise specified, the definitions set forth in Chapter 70.105D RCW and Chapter 173-340 WAC shall control the meanings of the terms used in this Order.

For purposes of this Order, Ecology is defined as the Toxics Cleanup Program, Central Regional Office, Yakima, Washington.

5.2. Public Notices

RCW 70.105D.030(2)(a) requires that, at a minimum, this Order be subject to concurrent public notice. Ecology shall be responsible for providing such public notice and reserves the right to modify or withdraw any provisions of this Order should public comment disclose facts or considerations which indicate to Ecology that the Order is inadequate or improper in any respect.

5.3 Remedial Action Costs

Cameron-Yakima, Inc., shall pay to Ecology costs incurred by Ecology pursuant to this Order. These costs shall include work performed by Ecology or its contractors at the Facility under Chapter 70.105D RCW both prior to and subsequent to the issuance of this Order for investigations, remedial actions, and Order preparation, oversight and administration. Ecology costs shall include costs of direct activities and support costs of direct activities as defined in WAC 173-340-550(2). Cameron-Yakima, Inc., shall pay the required amount within ninety (90) days of receiving from Ecology an itemized statement of costs that includes a summary of costs incurred, an identification of involved staff, and the amount of time spent by involved staff

members on the project. A general description of work performed will be provided upon request. Itemized statements shall be prepared quarterly. Failure to pay Ecology's costs within ninety (90) days of receipt of an itemized statement of costs will result in interest charges pursuant to WAC 173-340-550(4).

5.4 Designated Project Coordinators

The project coordinator for Ecology is:

Rick Roeder (509) 454-7837
Department of Ecology
Central Regional Office
106 South 6th Avenue
Yakima, Washington 98902-3387

Cameron-Yakima, Inc., shall notify Ecology of its project coordinator within ten (10) calendar days of receiving this Order. The project coordinator(s) shall be responsible for overseeing the implementation of this Order. To the maximum extent possible, communications between Ecology and CYI, and all documents, including reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Order, shall be directed through the project coordinator(s). Should Ecology or CYI change project coordinator(s), written notification shall be provided to Ecology or CYI, at least ten (10) calendar days prior to the change.

5.5. Performance

All work performed pursuant to this Order shall be under the direction and supervision, as necessary, of a professional engineer or hydrogeologist, or similar expert, with appropriate training, experience, and expertise in hazardous waste site investigation and cleanup. Cameron-Yakima, Inc., shall notify Ecology as to the identity of such engineer(s) or hydrogeologist(s), and of any contractors and subcontractors to be used in carrying out the terms of this Order, in advance of their involvement at the Facility. Cameron-Yakima, Inc., shall provide a copy of this Order to all agents, contractors, and subcontractors retained to perform work required by this Order and shall ensure that all work undertaken by such agents, contractors, and subcontractors will be in compliance with this Order.

Except where necessary to abate an emergency situation, or to comply with RCRA requirements, Cameron-Yakima, Inc., shall not perform any remedial actions at the Cameron-Yakima, Inc., Facility outside that required by this Order unless Ecology concurs, in writing, with such additional remedial actions.

WAC 173-340-400(7)(b)(i) requires that "construction" performed on the site must be under the supervision of a professional engineer registered in Washington state.

5.6. Access

Ecology or any Ecology-authorized representative shall have the authority to enter and freely move about all property at the Facility at all reasonable times for the purposes of, inter alia: inspecting records, operation logs, and contracts related to the work being performed pursuant to this Order; reviewing the progress in carrying out the terms of this Order; conducting such tests or collecting samples as Ecology or the project coordinator may deem necessary; using a camera, sound recording, or other documentary type equipment to record work done pursuant to this Order; and verifying the data submitted to Ecology by Cameron-Yakima, Inc. In the course of conducting oversight of this Order under the Model Toxics Control Act, Ecology shall provide reasonable notice before entering property unless an emergency prevents notice. When Ecology is acting under a statute other than the Model Toxics Control Act, Ecology shall provide notice consistent with that statute. Ecology shall allow split or replicate samples to be taken by Cameron-Yakima, Inc., during an inspection unless doing so would interfere with Ecology's sampling. Cameron-Yakima, Inc., shall allow split or replicate samples to be taken by Ecology and shall provide Ecology fourteen (14) days notice before any sampling activity.

5.7. Public Participation

Cameron-Yakima, Inc., shall prepare a public participation plan for the Facility. Said public participation plan shall be coordinated with the public participation plan being developed for the Yakima Railroad Area. Ecology shall maintain the responsibility for public participation at the Facility. Cameron-Yakima, Inc., shall help coordinate and implement public participation for the Facility. Cameron-

Yakima, Inc., shall designate a point of contact for the development and implementation of said public participation plan.

A draft public participation plan shall be submitted to Ecology within sixty (60) days of the date of this Order. A final public participation plan shall be submitted for approval within thirty (30) days of receipt of Ecology comments on the draft.

5.8. Retention of Records

Cameron-Yakima, Inc., shall preserve in a readily retrievable fashion, during the pendency of this Order and for ten (10) years from the date of completion of the work performed pursuant to this Order, all records, reports, documents, and underlying data in its possession relevant to this Order. Should any portion of the work performed hereunder be undertaken through contractors or agents of Cameron-Yakima, Inc., then Cameron-Yakima, Inc., agrees to include in their contract with such contractors or agents a record retention requirement meeting the terms of this paragraph.

5.9 Dispute Resolution

Cameron-Yakima, Inc., may request Ecology to resolve disputes which may arise during the implementation of this Order. Such request shall be in writing and directed to the signatory, or his/her successor(s), to this Order. Ecology resolution of the dispute shall be binding and final. Cameron-Yakima, Inc., is not relieved of any requirements of this Order during the pendency of the dispute and remains responsible for timely compliance with the terms of the Order unless otherwise provided by Ecology in writing.

5.10 Reservation of Rights/No Settlement

Ecology reserves all rights to issue additional Orders or take any action authorized by law in the event or upon the discovery of a release or threatened release of hazardous substances not addressed by this Order, upon discovery of any factors not known at the time of issuance of this Order, in order to abate an emergency, or under any other circumstances deemed appropriate by Ecology.

Ecology also reserves all rights regarding the injury to, destruction of, or loss of natural resources resulting from

the releases or threatened releases of hazardous substances from the Cameron-Yakima, Inc., Facility.

In the event Ecology determines that conditions at the Facility are creating, or have the potential to create, a danger to the health or welfare of the people at the Facility or in the surrounding area or to the environment, Ecology may order Cameron-Yakima, Inc., to stop further implementation of this Order for such period of time as needed to abate the danger.

5.11 Transference of Property

No voluntary or involuntary conveyance or relinquishment of title, easement, leasehold, or other interest in any portion of the Facility shall be consummated by Cameron-Yakima, Inc., without provision for continued implementation of all requirements of this Order and implementation of any remedial actions found to be necessary as a result of this Order.

Prior to transfer of any legal or equitable interest Cameron-Yakima, Inc., may have in the Facility or any portions thereof, Cameron-Yakima, Inc., shall serve a copy of this Order upon any prospective purchaser, lessee, transferee, assignee, or other successor in such interest. At least thirty (30) days prior to finalization of any transfer, Cameron-Yakima, Inc., shall notify Ecology of the contemplated transfer.

5.12 Compliance with Other Applicable Laws

All actions carried out by Cameron-Yakima, Inc., pursuant to this Order shall be done in accordance with all applicable federal, state, and local requirements.

VI.

Satisfaction Of This Order

The provisions of this Order shall be deemed satisfied upon Cameron-Yakima, Inc's., receipt of written notification from Ecology that Cameron-Yakima, Inc., has completed the remedial activity required by this Order, as amended by any modifications, and that all other provisions of this Order have been complied with.

VII.

Enforcement

7.1. Pursuant to RCW 70.105D.050, this Order may be enforced as follows:

A. The Attorney General may bring an action to enforce this Order in a state or federal court.

B. The Attorney General may seek, by filing an action if necessary, to recover amounts spent by Ecology for investigative and remedial actions and Orders related to the Facility.

C. In the event Cameron-Yakima, Inc., refuses, without sufficient cause, to comply with any term of this Order, Cameron-Yakima, Inc., will be liable for:

(1) up to three times the amount of any costs incurred by the state of Washington as a result of its refusal to comply; and

(2) civil penalties of up to $25,000 per day for each day it refuses to comply.

D. This Order is not appealable to the Washington Pollution Control Hearings Board. This Order may be reviewed only as provided under RCW 70.105D.060.

Effective date of this Order: MAR 31 1994.

Ecology Signature

AWG:RR:vw
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Attachment A

SCOPE OF WORK FOR RI/FS WORK PLANS UNDER CHAPTER 173-340 WAC
DRAFT DOCUMENT March 30, 1994

The Work Plans shall include a plan to conduct a Remedial Investigation and Feasibility Study (as described under WAC 173-340-350). A Remedial Investigation/Feasibility Study (RI/FS) defines the extent of the problems at the site and evaluates alternative cleanup actions. The Department of Ecology (Ecology) will use the completed RI/FS to develop a Cleanup Action Plan. Deviations from the Scope of Work may only be made with prior Ecology approval. Information shall be presented in sufficient detail to fulfill the objectives of the RI as determined by Ecology. The minimum components of the RI/FS are detailed below:

I. REMEDIAL INVESTIGATION

The purpose of the Remedial Investigation is to determine the nature and extent of releases of hazardous substances (as defined by RCW 70.105D.020(5)) from the Facility (as defined in RCW 70.105D.020(3)), and to gather all necessary data to support the Feasibility Study. The Potentially Liable Party(s) (PLP, as defined under RCW 70.105D.020(8)) shall furnish all personnel, materials, and services necessary for, or incidental to, performing the Remedial Investigation at the Facility.

The Remedial Investigation (RI) will consist of the following six tasks:

RI Task I: Description of Current Conditions (Facility History)

The PLP shall submit for Ecology approval a Facility History providing the background information pertinent to the Facility, contamination, and emergency or interim measures as set forth below. The data gathered during any previous investigations or inspections and other relevant data shall be included.

A: Facility Background

The Facility History shall summarize the regional location, pertinent boundary features, general Facility physiography, hydrogeology, and historical use of the Facility. The Facility History shall include:

1. Maps (as specified by WAC 173-340-840(4)) depicting the following:

   a. General geographic location;

   b. Property lines, with the owners of all property which abuts the facility clearly indicated;

   c. Topography and surface drainage (with a contour interval of one foot or less and a scale of 1 inch = 50 feet, unless otherwise approved by Ecology) depicting all waterways, wetlands, floodplains, water features, drainage patterns, and surface water containment areas located at the Facility.

   d. All above ground and underground tanks, buildings, utilities, paved areas, easements, rights-of-way, sumps, trenches, vaults, storm water retention equipment, and other features;

   e. All past and present known or suspected hazardous substance treatment, storage or disposal areas;

f. All past or present product and waste underground tanks and piping, both underground and surfacial;

g. A series of all aerial photographs that may be obtained from public sources (provide actual photos).

h. Surrounding land uses (residential, commercial, agricultural, recreational); and

i. The location of all groundwater supply and monitoring wells within a one mile radius. These wells shall be clearly labeled and ground and top of casing elevations and construction details included. Sources of well location and construction information shall include state and local environmental and public health agencies, supplemented with oral interviews of property owners to identify unreported or undocumented wells. Information from well surveys conducted by other Yakima Railroad Area PLPs may be used if within the one mile radius.

j. A listing of all waste generators from whom CYI has received manifested wastes for treatment at the Facility. This will include identification of the generators, the waste sent to the CYI Facility, and hazardous constituents present in the waste.

All maps shall be of sufficient detail and accuracy to locate and report all current and future work performed at the site;

2. A history and description of ownership and operation, waste generation, treatment, storage and disposal activities at the Facility, including interviews with former employees and local residents;

3. Dates or periods of past product and waste spills, identification of the materials spilled, the amount spilled, the location where spilled, and a description of the response actions conducted including any inspection reports or technical reports generated as a result of the response; including reports required under the Uniform Fire Code.

4. A history and description of physical changes at the Facility including backfilling, movement of buildings, off-loading locations, and locational changes of any waste management operations.

B: Nature and Extent of Contamination

The Facility History shall describe the existing information on the nature and extent of contamination.

1. The Facility History shall summarize all possible source areas of contamination. This, at a minimum, should include all known or suspected waste disposal areas, spill areas, solid waste management units, and other suspected source areas of contamination. For each area, the Facility History shall identify the following:

a. Location of area (which shall be depicted on a Facility map);

b. Quantities of hazardous substances;

c. Hazardous substances, to the extent known;

d. Identification of areas where additional information is necessary; and

2. The Facility History shall include an assessment and description of the existing degree and extent of contamination. This should include:

a. Available monitoring data and qualitative information on locations and levels of contamination at the Facility;

b. All potential migration pathways including information on geology, hydrogeology, pedology, physiography, hydrology, water quality, meteorology, air quality; and

c. The potential impact(s) on human health and the environment, including demography, groundwater and surface water use, and land use.

C: Implementation of Interim or Emergency Measures

The Facility History shall document interim or emergency measures which were or are being undertaken at the Facility. This shall include:

1. Objectives of the interim or emergency measures: how the measure is mitigating a potential threat to human health and the environment and/or is consistent with and integrated into any long term solution at the Facility;

2. Design, construction, operation, and maintenance requirements;

3. Schedules for design, construction and monitoring; and

4. Schedule for progress reports.

RI Task II: Pre-investigation Screening of Cleanup Action Alternatives Report

Prior to starting the Facility Investigation, the PLP shall submit to Ecology, for review and approval, a screening of cleanup action alternatives report that identifies the potential cleanup action technologies that may be used on-Facility or off-Facility, including remediation, treatment, containment, and/or disposal of contamination. All criteria used to screen the potential cleanup alternatives must be stated in this report. This report shall also identify any field data that must be collected in the RI/FS to facilitate the evaluation and selection of the final Cleanup Action or Actions.

The screening of cleanup action alternatives report allows the PLP to support subsequent decisions to direct RI/FS data gathering efforts and Facility specific studies onto those cleanup alternatives likely to be used at the Facility. The report will help direct expenditures of resources away from unlikely cleanup alternatives. This screening will be included in the RI/FS Work Plan submitted to Ecology for review.

RI Task III: Facility Investigation Report

The PLP shall conduct those investigations necessary to completely characterize the Facility and actual or potential contaminant migration pathways (Environmental Setting and Pathway Characterization); define the source of contamination (Source Characterization); define the degree and extent of contamination (Contaminant Characterization); identify actual or potential receptors (Receptor Identification); and an assessment of risks posed to receptors by the Facility (Risk Assessment). The results of these investigations shall be reported to Ecology in the Facility Investigation Report.

The investigations should result in data consistent with the Quality Assurance/Quality Control Plan and of sufficient technical quality to support the development and evaluation of the cleanup action alternative or alternatives during the Feasibility Study. All sampling and analysis shall be conducted in accordance with the Sampling and Analysis Plan (WAC 173-340-820). All sampling locations shall be documented in a log and identified on a detailed site map, which shall be presented in an Appendix to the Facility Investigation Report.

A: Environmental Setting and Pathway Characterization

The PLP shall collect information to supplement and verify existing information on the environmental setting and potential contaminant migration pathways at the Facility. The PLP shall completely characterize the following:

1. Hydrogeology

The PLP shall conduct a program to evaluate hydrogeologic conditions at the Facility. This program shall provide the following information:

a. A description of the regional and Facility specific geologic and hydrogeologic characteristics affecting groundwater flow beneath the Facility, including:

i) Regional and Facility specific stratigraphy;

ii) Structural geology;

iii) Depositional history;

iv) Identification and characterization of areas and amounts of recharge and discharge;

v) Regional and Facility specific groundwater flow patterns; and

vi) Characterization of seasonal variations in the groundwater flow regime.

b. An analysis of any topographic features that might influence the groundwater flow system.

c. Based on field data, tests, and cores, a representative and accurate classification and description of the hydrogeologic units which may be part of the migration pathways at the Facility (including saturated and unsaturated units), including:

i) Hydraulic conductivity, porosity, effective porosity, pore water velocity, and Darcy velocity;

ii) Lithology, grain size, sorting, degree of cementation;

iii) An interpretation of the degree of interconnections between saturated zones; and

iv) The contaminant solute attenuation capacity and mechanisms affecting contaminant transport.

d. Based on field studies and cores, structural geology and hydrogeological cross sections and fence diagrams showing the extent (depth, thickness, lateral extent) of hydrogeological units which may be part of the migration pathways identifying:

i) Sand and gravel layers in unconsolidated deposits;

ii) Zones of fracturing or channeling in consolidated or unconsolidated deposits;

iii) Zones of higher permeability or lower permeability that might direct and restrict the flow of contaminants;

iv) The uppermost aquifer: geologic formation or group of formations that are capable of yielding a significant amount of groundwater to wells and springs; and

v) Water bearing zones above the first confining layer that may serve as a pathway for contaminant migration including perched zones of saturation.

e. Based on data obtained from groundwater monitoring wells and/or piezometers installed upgradient and downgradient from the potential contaminant sources, a representative description of water level or fluid pressure monitoring including:

i) Water level contour and/or potentiometric maps (displayed legibly, superimposed on Facility maps);

ii) Hydrologic cross sections showing vertical gradients;

iii) The flow system including the vertical and horizontal components of flow; and

iv) Any temporal changes in hydraulic gradients.

f. A description of man-made influences that may affect the hydrogeology of the site (schedules and volumes of production for local water supply wells, pipelines, drains, ditches, septic tanks, utility trenches, asphalt seals, etc.).

2. Soils

The PLP shall conduct a program to characterize the soil and rock units above the water table in the vicinity of the Facility. Such characterization shall include, but not be limited to, the following information:

a. SCS soil classification;
b. Surface soil distribution;
c. Hydraulic conductivity (saturated and unsaturated);
d. Bulk density;
e. Porosity;
f. Soil sorptive capacity;
g. Soil organic content;
h. Soil pH;
i. Particle size distribution;
j. Moisture content, specific capacity, infiltration rate;
k. Soil stratification effect on unsaturated flow; and
l. Mineral content.
m. Cation exchange capacity

3. Surface Water and Sediment

The PLP shall conduct a program to characterize the surface water bodies in the vicinity of the Facility. Such characterization shall include but not be limited to the following activities and information:

a. Description of the water bodies including:

   i) For streams and rivers: location, elevation, flow, velocity, depth, width, seasonal fluctuations, and flooding tendencies (i.e., 10, 50, 100 and 500 year flood events); and

   ii) Storm water drainage patterns and collection processing system at the Facility.

b. Description of the chemistry of the natural surface water and sediments. This includes determining the pH, total dissolved solids, total suspended solids, BOD, COD, alkalinity, conductivity, dissolved oxygen profiles, nutrients, total organic carbon, specific contaminant concentrations, etc.

c. Description of the sediment characteristics including:

   i) Deposition area;

   ii) Thickness profile;

   iii) Physical and chemical parameters (e.g., grain size, density, organic content, pH, contaminant concentration, etc.).

4. Air

The PLP shall provide information characterizing the climate and meteorology and potential air migration pathways within a one mile radius of the Facility. Such information shall include but not be limited to:

a. General meteorological data including: annual and monthly rainfall averages, monthly temperature averages, wind speed and direction, relative humidity and dew point, pressure variations, evaporation rates, development of inversions, and climatic extremes that have occurred in the vicinity of the Facility (including frequency of occurrence);

b. A description of topographic and man-made features which affect air flow and emission patterns;

c. Modeling which assesses the impact of current air emissions, as measured by source testing and from engineering calculations, from the Facility on ambient air quality and which assesses the potential for deposition of airborne contaminants in the vicinity of the Facility.

B: Source Characterization

The PLP shall collect analytical data to completely characterize and designate the wastes and areas where wastes have been placed, collected, discharged or removed including: type; quantity; physical form; disposition; and Facility characteristics affecting release. This shall include quantification of the following specific characteristics at each source area:

1. Disposal area characteristics including: location, design features, operating practices, period of operation, age of area, and general physical conditions. Additionally, integrity tests of all waste management piping, tanks, containment units, etc., must be provided for use in identifying potential source areas.

2. Waste characteristics

a. Type, quantity and chemical composition of wastes placed in the area, including degradation and reaction by products.

b. Physical and chemical characteristics of the waste.

c. Migration and dispersal characteristics of the waste including: sorption, biodegradability, hydrolysis rates and chemical transformations.

C: Contamination Characterization

The PLP shall collect analytical data on background conditions and contamination in groundwater, soils, surface water, sediment, and subsurface gas in the vicinity of the Facility. This data shall be sufficient to define the extent, origin, direction, and rate of movement of contaminants. Data shall include time and location of sampling, media sampled, concentrations found, conditions during sampling, and the identity of the individuals performing the sampling and analysis. The PLP shall address the following types of contamination at the Facility:

1. Groundwater contamination including: the horizontal and vertical extent of groundwater contamination, direction of hazardous substance (contaminant) movement, velocity of contaminant movement, horizontal and vertical concentration of the indicator parameters of all possible hazardous and dangerous waste constituents, evaluation of factors affecting contaminant movement, and extrapolation of future contaminant movement.

2. Soil contamination including: vertical and horizontal extent of contamination, contaminant concentrations, velocity and direction of contaminant movement, and a description of the contaminant and soil chemical properties and interaction.

3. Surface water and sediment contamination including: the horizontal and vertical extent of contamination, direction of contaminant movement, velocity of contaminant movement, horizontal and vertical concentration contaminants, evaluation of factors affecting contaminant movement, description of the chemistry of the contaminant and surface water or sediment properties and interaction, and extrapolation of future contaminant movement.

4. Subsurface gas contamination including: vertical and horizontal extent of contamination, gas concentrations, gas composition, physical and chemical description of the gases.

5. Emissions to the air from any thermal treatment unit, such as a multi-hearth furnace or rotary kiln, as measured by source testing and supplemented with engineering calculations. Source testing shall include, but not be limited to, primary and afterburner temperatures, testing for stack gas velocity, volumetric flow rate, oxygen concentration, carbon dioxide concentration, moisture, particulate emissions, opacity, and carbon monoxide concentrations. Source testing shall be conducted according to methods 1-5, and 9 contained in Title 40 Code of Federal Regulations Part 60 Appendix A, most recent version, or according to alternate methods as approved by Ecology in the final RI Work Plan. In addition to the Method 5 particulate determination, procedures for "back-half" analysis of condensible matter as described in the document "Particulate Source Test Procedures", current edition, issued by the Puget Sound Air Pollution Control Agency shall be employed. Particulate matter shall then be analyzed for the priority pollutant metals (antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc) plus hexavalent chromium utilizing procedures to be proposed by CYI in the RI Work Plan. Such testing shall be conducted prior to installation of any additional air quality control equipment not in place on the date of issuance of this Order. Source testing and engineering calculations will be based on worse case conditions for loading and operations of the thermal units.

   Ecology will determine upon completion of above source testing and engineering calculations if additional source testing is required.

D: Potential Receptor Identification

The PLP shall collect data describing the human populations and environmental systems that are susceptible to contaminant exposure from the Facility. The following characteristics shall be identified:

1. Local uses and possible future uses of groundwater within one mile of the Facility.

2. Local uses and possible future uses of surface waters within three miles of the Facility.

3. Human use of or access to the Facility and adjacent lands including: recreation, hunting, residential, commercial, zoning, and relationship between population locations and prevailing wind directions.

4. A description of the biota in surface water bodies adjacent to the Facility.

5. A description of any endangered or threatened species near the Facility.

The PLP shall prepare a Sampling and Analysis Plan (in accordance with WAC 173-340-820) for use during all Facility characterization studies. The Sampling and Analysis Plan shall be prepared for all sampling activities which are part of investigation and remedial actions unless otherwise directed by Ecology and except for emergencies. The level of detail required in the Sampling and Analysis Plan may vary with the scope and purpose of the sampling activity. Sampling and Analysis Plans prepared under this Order shall be submitted to Ecology for review and approval and shall include:

A. A sampling plan including:

1. Objectives;

2. Schedules and task assignments;

3. Access;

4. Quality Assurance Project Plan (see: *Guidelines and Specifications for Preparing Quality Assurance Project Plans, May, 1991, Washington Department of Ecology, Environmental Investigations and Laboratory Services Program, Quality Assurance Section, P.O. Box 488, Manchester, WA, 98353*), including:

a. Field quality assurance/quality control (QA/QC) methods:

(1) Standard operating procedure for field sampling methods (reference SOP and describe briefly);
(2) Field documentation methods;
(3) Frequency of QA/QC samples:
(a) duplicates;
(b) rinsate;
(c) blank.
(4) Field instrument calibration;

b. Chain of custody procedures;

c. Decontamination procedures, including:

(1) entry and exit controls;
(2) disposal of wastes from sampling effort; and
(3) equipment and personnel decontamination.

d. Laboratory QA/QC program:

(1) laboratory identification and accreditation;
(2) sample custody;
(3) analytical turn-around time;
(4) calibration procedures and frequency;
(5) data reduction, validation, and reporting;
(6) internal quality control checks;
(7) performance system and audits; and
(8) specific procedures for routine assessment of data precision, accuracy and completeness.

5. Samples, including:

a. Sampling methods;

b. Locations and ID numbers (located legibly on a Facility map);

c. Order of sample collection;

d. Sample media and objectives;

(1) samples to determine nature and extent of contamination; and
(2) samples to develop possible remedial actions.

e. QA/QC samples;

f. Shipping and handling arrangements;

g. Split sampling opportunity; and

h. Analytical parameters, including:

(1) justifications for choice of analyses;
(2) laboratory and analytical method identification, including detection limits;
(3) sample containers preservation and holding times; and
(4) laboratory-generated QA/QC samples.

6. List of supplies and equipment; and

7. Monitoring well construction and development standards (references for this include WAC 173-160, the RCRA Ground Water Monitoring Technical Enforcement Guidance Document).

The PLP shall prepare a Facility Safety and Health Plan, for undertaking RI/FS activities and Cleanup Actions under WAC 173-340. The Safety and Health Plan shall be submitted for Ecology's review, comment and approval as part of the RI/FS Work Plan. The Safety and Health Plan must be consistent with Chapter 49.17 RCW and regulations promulgated pursuant thereto. At a minimum the plan must include the following:

1. Level of protection;

2. Hazard evaluation;

3. Waste characteristics;

4. Special Facility considerations; and

5. Emergency information.

Task IV: Remedial Investigation Report

The PLP shall prepare a Remedial Investigation Report, consistent with WAC 173-340-840, that presents an analysis and summary of all Task II and Task III Facility investigations and their results. The objective of this task shall be to ensure that the investigation data are sufficient in quality and quantity to describe the nature and extent of contamination, potential threat to human health and the environment and to support a Feasibility Study.

A: Data Analysis

The PLP shall analyze all Facility investigation data outlined in Task III and prepare a report on the type and extent of contamination at the Facility including sources and migration pathways. This shall include but not be limited to:

1. Nature of the contamination;

2. Extent of contamination, including volume of material needing remediation;

3. The pathways by which contamination reached or can reach the media;

4. Known or potential hazards to public health, welfare, and the environment, including physical hazards; and

5. Recommendations for further study, if necessary.

B. Protection Standards

The PLP shall provide Facility and hazardous substance information to support development and selection of cleanup standards for all hazardous substances found at the Facility.

The PLP shall provide a comparison of ambient air concentrations projected by modeling for all contaminants detected in source testing and predicted by engineering calculations with national and state ambient air quality standards and acceptable source impact levels.

C. Appendices to the report will be prepared by the PLP containing full documentation of investigative activities and analytical results. In addition to the requirements of WAC 173-340-840(6) this shall include:

1. General field observations, including:

   a. Groundwater characterization, including potentiometric maps and data related to all hydraulic testing;

   b. Location of nearby wells and well log information;

   c. Soil conditions including locations, descriptions, and photographs of test pits;

   d. Surface water characterization; and

   e. Well driller and hydrogeologist logs and observations.

2. Changes in sample collections from the sampling plan, including:

   a. Opportunity samples; and

   b. Other changes.

3. Sample location map, legibly superimposed on a Facility map, including:

   a. Sample media; and

   b. Sample numbers.

4. Table of principal facts related to sampling and analysis results;

5. Maps, legibly superimposed on the Facility map, identifying contaminant concentrations, including field sampling results. One Facility map shall include the longitude and latitude, for five known points at the Facility;

6. Quality assurance, data validation, which includes detailed evaluation of data according to approved QAPP;

7. Full data package as appendix including QA/QC information and field logs with date, time and activity information. Actual handwritten field notes and boring logs will be provided by the PLP to ecology upon written request by Ecology.

8. Analysis of data in relation to possible cleanup action alternatives and recommendations of cleanup action alternatives to be investigated; and

RI Task V: Treatability Investigations (Bench or Pilot Scale Studies)

The PLP shall conduct bench and/or pilot scale studies to determine the applicability of a Cleanup Action technology or technologies to the Facility conditions. This shall include: development of a testing plan identifying the type(s) and goal(s) of the study(ies), the procedures to be used for data management and interpretation, evaluation of the test results with respect to site specific conditions, and preparation of a report summarizing the testing program and its results.

RI Task VI: Reporting

A Remedial Investigation Report shall be prepared at the completion of the remedial investigation. Additionally, Ecology may require reports to be submitted following discrete elements of the remedial investigation. Reports prepared under this section and under an Order or Decree shall be submitted to Ecology for review and approval. These reports shall include:

A. Monthly reports summarizing sampling activities and analytical results. The PLP shall attach to the monthly reports the results of significant phases of the Remedial Investigation that were completed since the previous monthly report (i.e., report on soils when the soils study is complete); and

B. Consistency with WAC 173-340-840.

II. FEASIBILITY STUDY

The PLP will conduct a Feasibility Study and will prepare a Feasibility Study Report. The PLP shall furnish all personnel, materials, and services necessary for, or incidental to, performing the Feasibility Study of the Facility.

The feasibility study will serve to evaluate the feasibility and effectiveness of implementing alternative cleanup actions (as required by WAC 173-340-360). It shall include:

A. Detailed identification of contamination to be remediated and physical hazards to be removed;

B. Identification of cleanup action alternatives that will protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route, shall be required. The number and types of alternatives to be evaluated shall take into account the characteristics and complexity of the Facility. A phased approach for evaluation of alternatives may be required for certain facilities, including an initial screening of alternatives to reduce the number of potential remedies for the final detailed evaluation. The final evaluation of cleanup action alternatives that pass the initial screening shall be evaluated for compliance with the requirements in WAC 173-340-360. Specifically each alternative must be assessed for its' ability to:

1. Adequately protect public health, welfare, safety and the environment;

2. Reduce the toxicity, mobility, and volume through treatment;

3. Eliminate or remove all physical hazards;

4. Meet all federal and state laws and rules designated to be applicable or relevant and appropriate by Ecology; and

5. Be a permanent remedial action for the site.

C. A requirement to conduct additional sampling and/or laboratory testing necessary to evaluate remedial alternatives;

D. An evaluation of alternatives based on cost, technical feasibility, environmental effects, and effectiveness in accomplishing the five requirements specified above [II.B(1-5)];

E. Recommendation of a preferred Cleanup Action Plan for Ecology approval;

F. Schedule for implementation of a preferred cleanup action plan.

A Feasibility Study Report shall be prepared at the completion of the Feasibility Study. Additionally, Ecology may require reports to be submitted following discrete elements of the Feasibility Study. Reports prepared under this section and under an Order or Decree shall be submitted to Ecology for review and approval.

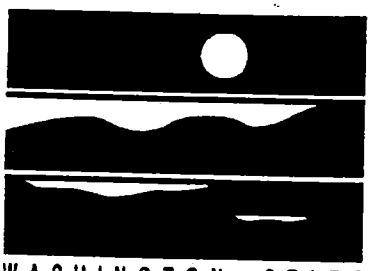
Attachment B:

Schedule of Deliverables

1)	Draft Public Participation Plan	60 days after date of this Order
2)	Final Public Participation Plan.....	30 days after receipt of Ecology comments
3)	Draft RI Work Plan for Ecology Review...	30 days after date of this Order
4)	Commence Implementation of Work Plan.....	30 days after Ecology's written approval of Work Plan
5)	Draft RI/FS Report.....	15 months after implementation commences
6)	Final RI/FS Report.....	3 months from receipt of Ecology's comments on draft RI/FS

Attachment C

QA/QC Guidance



Guidelines and Specifications for Preparing Quality Assurance Project Plans

Washington State Department of Ecology
Environmental Investigations and Laboratory Services Program
Quality Assurance Section
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May 1991
91-16

ABSTRACT

A quality assurance (QA) project plan should be prepared for each Ecology project which generates environmental data. A QA project plan describes the objectives of a project and the procedures to be followed to ensure that the data generated will serve those objectives. The plan serves to focus the planning process and to promote communication among the staff responsible for implementing the project.

These guidelines describe the elements to be considered for inclusion in a QA project plan and provide guidance in developing those elements. Several appendices provide specific information on analytical and quality control procedures to facilitate the planning process.

CONTENTS

1.0 INTRODUCTION

The Quality Assurance Program Plan for the Department of Ecology consists of a Quality Assurance Management Plan and a Quality Assurance Facility Plan.

The Quality Assurance Management Plan, which is presently being revised, describes a comprehensive quality assurance (QA) program for Ecology which includes the preparation of QA project plans for projects which generate environmental data.[1] The management plan also describes the responsibilities of Ecology staff for implementing the QA program.

The Quality Assurance Facility Plan contains the basic policy on quality assurance and quality control (QC) for the Manchester Environmental Laboratory, a facility operated jointly by Ecology and the U.S. Environmental Protection Agency (EPA) Region 10.[2]

2.0 DEFINITION, PURPOSE AND SCOPE

2.1 Definition

A QA Project Plan describes the objectives of a project and the procedures to be followed to ensure that the data generated will serve those objectives. Appendix A contains definitions of special terms used in this document.

2.2 Purpose

The QA project plan serves three important purposes. First, preparation of the plan helps the project manager focus on the factors affecting data quality during the planning stage of the project. Second, the completed plan facilitates communication among field, laboratory and management staff as the project progresses. Finally, the plan provides a record of the project and/or the starting point for a final report.

2.3 Scope

A QA project plan (or a combined work/QA project plan) should be prepared for any project which involves the collection of physical, chemical or biological data. The size and complexity of the project plan will depend on the nature of the project.

3.0 PROJECT PLAN PREPARATION

3.1 Elements of a QA Project Plan

Quality assurance project plans prepared to meet the requirements of the EPA must include the 16 elements described in the EPA's guidelines[3]. The information below will be helpful in meeting EPA requirements.

For Ecology projects, each of the following elements should be considered for inclusion in the QA project plan. The number of elements has been reduced from 16 in the EPA document to 14. Sample Custody has been included under Sampling Procedures and Calibration under Analytical Procedures.

1) Title Page
2) Table of Contents
3) Project Description
4) Project Organization and Responsibility
5) Data Quality Objectives
6) Sampling Procedures
7) Analytical Procedures
8) Data Reduction, Review and Reporting
9) Quality Control Procedures
10) Performance and Systems Audits
11) Preventive Maintenance
12) Data Assessment Procedures
13) Corrective Action
14) Quality Assurance Reports

Section 5.0 describes the content of each of the above elements in detail.

After considering each of these elements, the project manager may decide to omit some of them for a particular project. Factors which influence these decisions include the scope and complexity of the project, the number of staff involved and their level of experience, and past problems which might be avoided by clearly stating project requirements in the plan. Criteria to help the project manager make these decisions are provided in Section 5.0.

The following eight elements cover the basic information necessary to plan and carry out even the simplest Ecology project. These should be included in each project plan.

- Title Page
- Project Description
- Project Organization and Responsibility
- Data Quality Objectives
- Sampling Procedures
- Analytical procedures
- Quality Control Procedures
- Data Assessment Procedures

Many project managers routinely prepare project work plans. These often include many of the QA elements along with other administrative information. If the project manager prefers this approach, combined work/quality assurance project plans may be prepared. The table of contents should include the location of each of the quality assurance elements covered in the plan.

3.2 Responsibilities

Ecology staff with direct responsibility for projects which generate environmental data (project managers) are responsible for the preparation of the QA project plan. Assistance with the preparation of project plans is available from the QA Section.

Ecology staff with direct responsibility for administering grants or contracts involving projects which generate environmental data (project administrators) are responsible for ensuring that QA project plans are prepared by the grantees or contractors. Assistance with the development of QA requirements for inclusion in grants and contracts is also available from the QA Section.

4.0 PLAN REVIEW, APPROVAL AND DISTRIBUTION

The QA Section will review project plans at the request of the project manager. The reviewer will check the project plan for errors or omissions and provide comments and suggestions for improvement. The QA Section will consult with the Manchester Laboratory in the review process. The project manager should make any necessary changes to the plan based on the review.

The project manager's immediate supervisor should then check the plan and sign the title page, indicating approval to proceed with the project. Data collection should not begin until the plan has been approved, except when emergency response is required.

Copies of the project plan should be distributed to everyone responsible for its implementation.

5.0 PROJECT PLAN CONTENT

The following sections provide specific information on each of the 14 elements of a QA project plan.

5.1 Title Page

In addition to the project title and the organization conducting the project, include any other information which may be useful in identifying the plan such as the date or the document, grant, or contract number. At the bottom of the page, provide space for the approval signature(s).

5.2 Table of Contents

The use of a table of contents is optional. Include a table of contents when the plan is large enough to need one. The table will direct the reader to the project plan elements and to tables, figures and appendices in the plan. A distribution list may be added after the table of contents.

5.3 Project Description

In this element, provide a clear and complete description of the objectives of the project which the data must support. The rest of the plan should flow from this element. All of the procedures described in the subsequent elements should relate directly to the information in the project description.

The following topics should be included:

Historical Information

Provide a brief history of the situation with emphasis on the sources and fate of known or suspected contaminants. Include information from previous studies of this or similar sites.

Project Objectives

A clear and complete description of the specific problem(s) which the project will address is essential to the successful selection of sampling, analytical and QC procedures. Describe the proposed use of the data, any relevant regulatory criteria, and any other data to which those from this project will be compared.

Site

Describe the site, watershed, groundwater area, etc. covered by the project and include maps or drawings showing key features and the proposed sampling locations. The description and map or drawing should be sufficiently detailed to allow a person unfamiliar with the location to understand the correlation between the objectives of the project and the proposed sampling and analysis plan. Also describe any known or anticipated problems with the site, such as limited accessibility or the likely presence of dangerous levels of hazardous substances, which may require modifications to otherwise routine procedures.

Design

Describe the design of the sampling network in terms of the project objectives. Explain how the proposed sampling frequency and locations relate to the expected temporal and spatial variability of the parameters of interest. If possible, estimate the range of the results for each parameter.

Schedule

Include dates for sampling activities, for arrival of samples at the laboratory, for delivery of analytical results, and for the final project report. Also describe any limitations imposed on the schedule by factors such as weather, seasonal practices, availability of equipment, etc.

5.4 Project Organization

Identify all individuals and organizations with responsibility for supervision or implementation of the project and describe their responsibilities. Include names, addresses and phone numbers of all key personnel. For complex projects, an organization chart may be helpful.

5.5 Data Quality Objectives

All environmental data are only estimates of the true values of the parameters measured. These estimates are affected by variability in the medium being sampled and by random and systematic errors introduced by the sampling and measurement processes.

Data quality objectives (DQOs) are qualitative or quantitative statements of the precision (a measure of random error), bias (a measure of systematic error), representativeness, completeness and comparability necessary for the data to serve the objectives of the project.

During the planning process, the project manager must first determine the level of quality needed for the data. Prepare a table listing each parameter of interest along with the required precision and bias. It would be very helpful to include in this table the expected range of results, the required detection limit, and any applicable criteria to which the results will be compared. This table provides the basis for subsequent selection of sampling, analytical and quality control procedures.

Precision

Precision is a measure of the scatter in the data due to random error. The basic concepts of the statistical treatment of random error are described in the introductory chapter of Standard Methods for the Examination of Water and Wastewater[23]. For most environmental measurements, the major sources of random error are the sampling and analytical procedures. Microbiological and biotoxicity measurements have unique sources of random error which are discussed elsewhere[42-44].

Precision is often stated in term of the percent relative standard deviation (RSD). At 10% RSD, there is a 68% probability that a result is within 10% of the mean of all possible results and a 95% probability that a result is within 20% of that mean. Stated another way, at 10% RSD, there is about a 5% chance that a single result will differ from the mean of all possible results by more than 20%.

If the objective of the project is simply to determine whether a substance is present at a concentration of about 100 ppm (i.e. accuracy is not critical), then an RSD of 40% at 100 ppm and a detection limit of 20 ppm will do. At 100 ppm, there is a 95% chance that the measurement result will be between 20 and 180 ppm and the project manager will be able to conclude from the result that the substance is present.

However, if the objective of the project is to determine whether a criterion limiting the substance to 100 ppm has been exceeded, the project manager may require an RSD of 5% at 100 ppm. Then, at a concentration of 110 ppm, the probability of a result of less than 100 ppm (a false negative) will be less than 2.5%. The other 2.5% of the results will be over 120 ppm.

Finally, suppose the objective of the project is to monitor a long-term trend and the project manager needs to be able to document a 5% change in the parameter of interest. In this case, an RSD of 1 - 2% will be required.

Bias

Bias is a measure of the difference between the result for a parameter and the true value due to systematic errors. Potential sources of systematic errors include:

- Sample collection
- Physical/chemical instability of samples
- Interference effects
- Inability to measure all forms of a determinand
- Calibration of the measurement system
- Contamination

Since random error affects the determination of systematic error, it is very difficult to obtain a precise estimate of bias. Therefore, instead of attempting to correct results for bias, efforts should be directed toward selecting unbiased procedures.

Careful adherence to established procedures for collection, preservation, transportation and storage of samples will eliminate most sources of bias.

The project manager should decide how much analytical bias can be tolerated in the results. For most Ecology projects, bias of 10% would be acceptable. If larger bias would not affect the usefulness of the data, that should be stated, as it may facilitate the selection of an analytical method for some analytes, particularly organics. If the available analytical methods do not meet the requirements for bias, laboratory staff should be consulted regarding alternatives.

For some Ecology projects, the analytical methods are established by regulatory or programmatic requirements. In these cases, the analytical precision and bias achievable by the routine application of these methods will be acceptable and this should be stated under data quality objectives.

Representativeness

Representativeness is achieved by selecting sampling locations, methods and times so that the data describe the site conditions which the project seeks to evaluate. Information on the design of representative sampling plans is available in several of the references listed at the end of this document[34-41]. Many EILS staff are experts in sampling environmental media and may be consulted for advice.

Describe in the data quality objectives any requirements or considerations regarding the representativeness of the data. For example, indicate any weather or time constraints which might affect the collection of representative samples. Also, indicate any inherent bias in the sampling design.

Completeness

Completeness refers to the amount of useable data produced in the project. With good planning, all samples should be successfully collected, transported and analyzed and all data should be reported.

Rather than trying to quantify completeness, mention in the data quality objectives any situations which might hinder the collection of all the samples or the timely reporting of all the results and discuss alternatives which might be used to compensate for the possible loss of data. For example, if accessibility to a sampling site is questionable, alternative sites should be selected in advance. Also, duplicates of critical samples might be collected.

Comparability

Comparability refers to the ability to compare the data from the project to other data. Comparability is ensured by selection of standardized procedures and by clearly stating any non-standard requirements. Describe in the data quality objectives the critical characteristics of the existing data. Then select procedures which will ensure that the project data will match those characteristics. For example, if the results are to be incorporated into a data base, that fact should be stated here and the required format should be specified under Data Reduction, Review and Reporting.

5.6 Sampling Procedures

Describe the procedures to be used to collect, preserve, transport and store the samples.

SOPs - Attach or reference SOPs for sampling which will be followed in the project. The SOPs must be up to date and readily available to the staff who will use them. Provide a detailed description of any non-standard procedures to be used in the project.

Sampling schedule - Include a table listing the number and type of samples and the proposed date and time of collection.

Field notebooks - List the information to be recorded in the field notebook.

Containers, sample size, preservation, holding times - Include a table with this information or attach a copy of the back of the Manchester Laboratory Request For Analysis form with the relevant information highlighted. Also include a list of the total number of each type of container needed for the project.

Requirements for containers, sample size, preservation and holding times are listed in Appendix B.

Sample Identification - Describe exactly how the samples are to be labeled and the sample identification scheme to be used.

Sample custody - When the data may be needed for legal purposes, formal chain-of-custody procedures, such as those described in the Ecology Laboratory Users Manual[4], must be used. Describe or reference any such procedures.

5.7 Analytical Procedures

Select a measurement or analytical method for each parameter which will meet the data quality objectives. List the source and method number or attach SOPs describing any specialized methods or modifications to established methods. Approved methods will be used whenever required by federal, state or agency regulations.

The project manager should check the detection limits or lower reporting limits of the methods. The method selected should measure a parameter at a level 5 to 10 times below the lowest significant level.

Appendix C lists most of the analytical methods available through the Manchester Laboratory. Appendix D gives some precision and bias information on many of these methods based on intra- and interlaboratory studies conducted by the EPA. In addition, the laboratory may be able to provide more recent data on precision and results from previous projects are an excellent resource for this information. The project manager should contact the laboratory to resolve any questions related to methods at this stage of planning.

5.8 Data Reduction, Review and Reporting

Data reduction is the process of converting raw data to final results. Data Review involves checking the data for errors or omissions. This can range from a peer review of bench sheets up to a formal review of the entire data package by an independent contractor. Reporting addresses the format in which the data is delivered to the project manager.

These functions are usually performed by the laboratory according to an SOP which may be referenced in the QA project plan. For the Manchester Environmental Laboratory, these procedures are described in the Quality Assurance Manual.[5] If the routine laboratory procedures are acceptable and there are no field measurements in the project, this element may be omitted.

Otherwise, describe the procedures to be used for the reduction, review and reporting of data collected in the field and any special requirements for the data from the laboratory.

5.9 Quality Control Procedures

Quality control procedures provide the means of controlling the precision and bias of the results. Careful adherence to established procedures for sample collection, preservation and storage will minimize errors due to sampling and sample instability. Analytical and measurement systems must be in statistical control, which means that errors have been reduced to acceptable levels and then documented. QC sample results enable the project manager to assess the accuracy of the data.

Field QC Procedures

List the QC samples to be collected and their purpose in relation to the data quality objectives. Appendix E describes several types of field QC samples and their use in defining data quality.

The analysis of replicate samples provides an estimate of the total precision of the results. That estimate improves with the number of replicates. If the requirement for total precision is very stringent, several replicate samples will have to be collected and analyzed.

The results of the analysis of field blanks will indicate problems with contamination introduced in the field. Field blanks should only be used when there is reason to expect a problem with contamination.

Some of the reference materials available from the National Institute of Standards and Technology (NIST), EPA, etc. are suitable for submission to the laboratory as field check standards. It may be appropriate to send these to the laboratory in advance of the samples to demonstrate analytical capability.

The use of field spikes to detect bias due to sample instability is not recommended due to the logistical difficulties of transporting and handling a concentrated solution of a contaminant in the field. If there is reason to believe that sample handling, preservation or storage practices are contributing significant bias to the results, a separate study should be carried out to evaluate the problem.

Laboratory QC Procedures

Laboratory QC samples are used to control and document the quality of analytical results. Appendix E lists the types of QC samples used in the laboratory. Requirements for the use of quality control samples are included in most published analytical methods. Routine QC practices are described in the Manchester Laboratory Quality Assurance Manual and the QC samples analyzed at Manchester Laboratory are listed in Appendix F.

The random or blind selection of QC samples is not desirable. The project manager may tell the laboratory which samples to use for laboratory QC. For example, duplicate non-detect results provide no useful information. Identify samples for which positive results are expected for use as lab duplicates.

The QC procedures used at the Manchester Laboratory will be satisfactory for most Ecology projects. The QA Section can assist the project manager in selecting laboratory QC procedures for special situations.

State in the project plan that the routine laboratory QC procedures are acceptable or list any additional requirements.

5.10 Performance and Systems Audits

Audits are conducted to determine whether procedures are being followed or to detect problems so that corrective action can be initiated. For large, long-term or repetitive projects, it may be necessary to specify that audits be performed periodically. The project manager should determine whether audits of field procedures are appropriate for the project and, if so, describe them in the project plan.

In a performance audit, performance evaluation (PE) samples are analyzed for the purpose of evaluating the performance of the measurement or analytical procedures. PE samples are reference standards which are obtained from an outside source and submitted blind for analysis.

Systems audits are conducted to determine if the requirements described in the project plan are being properly carried out. A systems audit may cover the entire project or any portion thereof.

The Manchester Environmental Laboratory and most commercial laboratories routinely participate in performance and systems audits of their routine procedures. Results of these audits can be obtained from the laboratory.

All contract laboratories performing water quality analyses for Ecology projects must be accredited by the QA Section. The accreditation process includes performance and systems audits. Two of the references describe the requirements for some systems audits and accreditation programs.[12,13]

5.11 Preventive Maintenance

The project plan should include the following:

- preventive maintenance procedures for field sampling and measurement equipment (Reference to an SOP or equipment manual may be adequate if these documents are readily available to the field staff.)
- a schedule of preventive maintenance activities
- a list of critical spare parts and tools that should be on hand to minimize equipment downtime.

The laboratory is responsible for preventive maintenance of its equipment. The project manager need not address lab preventive maintenance in the project plan unless there is reason to expect a problem.

For small projects preventive maintenance could be included under Sampling Procedures.

5.12 Data Assessment Procedures

When the results of the measurements have been assembled, the project manager must determine whether the data quality objectives have been achieved. In this element, describe the procedures that will be used to make that determination.

The data review from the laboratory should document that the analytical data quality objectives have been achieved. For most projects, data assessment will include the evaluation of field QC results.

Precision

State here the method for calculating precision based on replicate results and the criteria for dealing with excessive variability. For example, a result might be rejected if its confidence interval included the limit of detection.

For many projects, a single pair of duplicate samples are collected and analyzed for a given parameter. An estimate of precision based on duplicate results is not a very good estimate and can only be used to make a qualitative judgement concerning the total random error affecting the results. If the analytical precision met the data quality objectives, a large standard deviation for the duplicate results suggests that the medium sampled was not homogeneous or that there was a problem with sample instability prior to analysis.

Bias

Field blanks should be analyzed and the results reported as if they were ordinary samples. If field blank results are positive, then a decision will have to be made as to their effect on the sample results. Criteria for that decision should be stated here. For example, the criteria might be that results for samples associated with a positive field blank will be rejected when they are less than five times the blank result.

Completeness

If it is likely that a significant number of the results may be qualified by the laboratory, describe here the criteria for the use of qualified data. If it is likely that data may not be collected due circumstances related to weather or industrial process schedules, describe the procedure for determining whether enough data has been produced to consider the project successfully completed.

Calculations for assessing data quality are described in Appendix G.

For on-going projects, the project manager will have the opportunity to take action to resolve problems with inadequate data. Indicate here any requirements for timely assessment of initial results for the purpose of modifying subsequent phases of the project.

5.13 Corrective Action

Quality control procedures may indicate problems with data quality during the course of the project. The project manager should try to anticipate these problems and describe here the procedures to be followed to correct or compensate for them in the event that they occur.

Laboratory QC procedures should include criteria for initiating corrective action based on QC results. The Manchester Environmental Laboratory QA Manual includes SOPs for the preparation and use of control charts which indicate when analytical procedures are out of control. The project manager should require contract laboratories to specify their criteria for initiating corrective action.

This is an optional element which should be used when the scope of the project warrants it. For small projects, any corrective actions could be described under Sampling Procedures, Analytical Procedures or Quality Control Procedures.

5.14 Quality Assurance Reports

The final report for each project should include a QA section which summarizes data quality information.

Project plans for large or repetitive projects should provide a mechanism for periodic reporting to management on the performance of measurement systems and on data quality. As a minimum, these reports should include:

- Assessment of data accuracy and completeness
- Results of performance and/or systems audits
- Significant QA problems and recommended solutions

The project manager should list the reports required for the project and identify those responsible for preparing them.

6.0 STANDARD OPERATING PROCEDURES

A Standard Operating Procedure (SOP) is a document which describes in detail the way in which a routine procedure is to be carried out. The level of detail will be sufficient to enable the staff with responsibility for the procedure to carry it out in a way that will produce consistent results.

Many field and laboratory activities can be described in SOPs. When SOPs are applicable and available, they may be incorporated into the QA project plan as an attachment.

Some examples of activities which might be described in SOPs include:

- Sampling site selection
- Modified sampling and analytical procedures
- Use of field instruments
- Routine preventive maintenance
- Field QC procedures
- Field documentation and sample custody procedures
- Data assessment procedures
- Safety procedures

7.0 SUMMARY

A QA project plan should be prepared in advance for every project conducted by or for Ecology that generates environmental data. All 14 elements described above should be considered for inclusion in the plan. The project manager determines the level of detail in the plan based on the requirements of the project and the policy of the program administering it. The QA Section will provide assistance in the preparation of project plans and will review them at the request of the project manager.

8.0 REFERENCES

General Topics

1. Department of Ecology Quality Assurance Management Plan, State of Washington, April, 1983.

2. Manchester Laboratory Quality Assurance Facility Plan, State of Washington, Department of Ecology, October 1988.

3. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, EPA-QAMS-005/80, December 1980.

4. Laboratory Users Manual, State of Washington, Department of Ecology, Revised August 1988.

5. Quality Assurance Manual, Manchester Environmental Laboratory, State of Washington, Department of Ecology, June 1988.

6. Kendra, W. (ed.), Technical Methods for Assessing the Quality of Aquatic Environments in Washington State: a Handbook of the Surface Water Investigations Section, State of Washington, Department of Ecology, 1990.

7. Carey, B., Quality Assurance Interim Guidelines for Water Quality Sampling and Analysis: Groundwater Management Areas Program, State of Washington, Department of Ecology, 1986.

8. Quality Assurance Guidelines for IERL-CI Project Officers, EPA-600/9-79-046, December 1979.

9. NEIC Policies and Procedures Manual, Office of Enforcement, EPA-330-9-78-001, May 1978.

10. Juran, J. M. (ed), Quality Control Handbook, Second Edition, McGraw Hill, New York, 1962.

11. Juran, J. M. and F. M. Gryna, Quality Planning and Analysis, McGraw Hill, New York, 1970.

12. Procedure for the Evaluation of Environmental Monitoring Laboratories, EPA 600/4-78-017, March 1978.

13. Manual for the Interim Certification of Laboratories Involved in Analyzing Public Drinking Water Supplies - Criteria and Procedures, EPA 600/8-78-008, August 1978.

Air Quality

14. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I - Principles, EPA-600/9-76-005, March 1976.

15. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II - Ambient Air Specific Methods, EPA-600/4-77-027a, May 1977.

16. Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III - Stationary Source Specific Methods, EPA-600/4-77-027b, August 1977.

17. Systems Audit Criteria and Procedures for Ambient Air Monitoring Programs,

18. Techniques to Evaluate Laboratory Capability to Conduct Stack Testing,

19. Performance Audit Procedures for Ambient Air Monitoring Programs,

20. Appendix A - Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS), Federal Register, Vol. 44, No. 92, pp. 27574-81, May 10, 1979.

21. Appendix B - Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring, Federal Register, Vol. 44, No. 92, pp. 27582-84, May 1979.

22. Appendix E - Quality Assurance Requirements for Continuous Emission Monitoring Systems (CEMS), To be submitted as a proposed regulation to amend 40 CFR 60.

Water Quality

23. Clesceri, L. S., A. E. Greenberg and R. R. Trussell, Ed., Standard Methods for the Examination of Water and Wastewater, 17th Ed, APHA, AWWA, WPCF, 1989.

24. Handbook for Analytical Quality Control in Water and Wastewater Laboratories, EPA-600/4/79-019, March 1979.

25. NPDES Compliance, Sampling and Inspection Manual, U. S. EPA, Office of Water, Enforcement and Permits, Compliance Branch, May 1988.

26. Cheeseman, R. V. and A. L. Wilson, Manual on Analytical Quality Control for the Water Industry, Water Research Centre Technical Report TR 66, January 1978.

27. Hunt, D. T. E. and A. L. Wilson, The Chemical Analysis of Water, The Royal Society of Chemistry, 2nd Ed., 1986.

APPENDIX A

GLOSSARY OF TERMS

AUDIT:

A systematic review of the operation of all or a portion of a project. Audits may be of two basic types:

(1) performance audits in which quantitative data on samples of known composition are used to asses the capability of a measurement system

(2) systems audits in which project activities are evaluated in terms of adherence to the project plan.

DATA ASSESSMENT:

The process of evaluating the quality control data produced in the project to determine whether the data quality objectives have been met.

DATA QUALITY:

The characteristics of data that determine its ability to satisfy a stated purpose. The data quality indicators used in this document are:

Precision - the random variability among repetitive measurements of the same parameter.

Bias - the difference between the analytical result and a reference or true value due to systematic error.

Completeness - a measure of the amount of useable data obtained from a project compared to the amount expected.

Representativeness - deals with how well the data reflect the true value of the parameter of interest in the medium sampled. Problems with representativeness might be due to parameter variability at the sampling point due to process or environmental conditions.

Comparability - deals with the ability to compare the data from the project with existing or future data.

DATA REVIEW:

A systematic process for checking measurement data to assure that the data are complete and consistent and that they meet QC criteria. Data review may range from peer or supervisory screening of raw data reports to a full scale review of the data package according to established guidelines by an independent contractor.

DUPLICATES:

Two identical samples or subsamples used to estimate random error in measurement processes.

ENVIRONMENTAL DATA:

Data produced by field and laboratory procedures involving:

the measurement of chemical, physical, or biological parameters in the environment

the determination of the presence or absence of priority pollutants in waste streams

health and ecological effect studies

study or measurement of pollutant transport and fate.

QUALITY ASSURANCE:

An integrated program for assuring the reliability of monitoring and measurement data. A system for integrating the quality planning, quality assessment, and quality improvement efforts to meet user requirements.

QUALITY ASSURANCE PROGRAM PLAN:

A statement of management policies, objectives, principles, and general procedures designed to ensure the production of data of known and adequate quality.

QUALITY ASSURANCE PROJECT PLAN:

A statement of detailed procedures by which data of known and adequate quality is produced for a specific project. (An agency or laboratory would have only one QA program plan, but would have a QA project plan for each of its projects.)

QUALITY CONTROL:

The routine application of statistically-based procedures to evaluate and control the accuracy of measurement or analytical data.

REPLICATES:

Two or more identical samples or subsamples used to estimate random error in measurement processes. Duplicates are two replicates.

SPIKES:

Subsamples to which a known amount of an analyte has been added.

APPENDIX B

CONTAINERS, PRESERVATION AND HOLDING TIMES

Parameter	Container	Sample Size(mL)	Preservation	Holding Time
Acidity	Poly or Glass	100	Cool, 4°C	14 Days
Alkalinity	Poly or Glass	100	Cool, 4°C	14 Days
BOD_5	Poly or Glass	2000	Cool, 4°C	48 Hours
COD	Poly or Glass	100	Cool, 4°C, H_2SO_4 to pH < 2	28 Days
Chloride	Poly or Glass	100	None	28 Days
Color	1-L Cubetainer	100	Cool, 4°C	48 Hours
Conductivity	Poly	1000	Cool, 4°C	28 Days
Cyanide	Poly or Glass	500	Cool, 4°C, 0.6 g ascorbic acid	14 Days
Fluoride	Polyethylene	100	None	28 Days
Hardness	Poly or Glass	100	HNO_3 or H_2SO_4 to pH < 2	6 Months
Ammonia N	Poly	125	Cool, 4°C, H_2SO_4 to pH < 2	28 Days
Kjeldahl N	Poly	125	Cool, 4°C, H_2SO_4 to pH < 2	28 Days
NO_3^--NO_2^- N	Brown Poly	125	Cool, 4°C, H_2SO_4 to pH < 2	28 Days
Metals	Poly	250	HNO_3 to pH < 2[1]	6 Months
Cr^{+6}	Poly or Glass	250	Cool, 4°C	24 Hours
Hg	Poly	250	HNO_3 to pH < 2	28 Days
Oil & Grease	Glass	500	Cool, 4°C, H_2SO_4 to pH < 2[2]	28 Days
TOC	Amber Glass	50	Cool, 4°C, Store in dark, HCl or H_2SO_4 to pH < 2	28 Days
PO_4^{-3} P	Brown Poly	125	Filter immediately, Cool, 4°C	48 Hours

CONTAINERS, PRESERVATION AND HOLDING TIMES (Continued)

Parameter	Container	Sample Size(mL)	Preservation	Holding Time
Total P	Poly	125	Cool, 4°C, H_2SO_4 to pH < 2	28 Days
Solids	Poly or Glass	500	Cool, 4°C	7 Days
Sulfate	Poly or Glass	100	Cool, 4°C	28 Days
Turbidity	Poly or Glass	100	Cool, 4°C	48 Hours
Coliform	Sterile Glass	250	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 Hours(3)
Volatile Organics	Glass, Teflon lined septum	40	Cool, 4°C, 0.008% $Na_2S_2O_3$, HCl to pH 2	14 Days
Phenolics	Glass, Teflon lined lid	500	Cool, 4°C, H_2SO_4 to pH < 2	28 Days
BNAs	Glass, Teflon lined lid	2000	Cool, 4°C, 0.008% $Na_2S_2O_3$	7 Days to extraction, then 40 Days
Pesticides & PCBs	Glass, Teflon lined lid	200	Cool, 4°C	7 Days to extraction, then 40 Days
Chlorophyll	Brown Poly	1000	Cool, 4°C	
TOX	Amber Glass, Teflon lined lid	500	Cool, 4°C, HNO_3 to pH 2, 5 mg Na_2SO_3/L	14 Days

(1) Samples for total metals analysis can be acidified at the lab if they arrive within 24 hours of collection and have been maintained at 4°C from the time of collection. Be sure not to acidify samples for <u>dissolved metals</u> analysis prior to filtration.

(2) Samples for oil and grease analysis can be acidified at the lab if they arrive "within a few hours" of collection and have been maintained at 4°C from the time of collection.

(3) The Manchester Lab Users Manual lists a holding time of 30 hours. EPA is allowing 30 hours as a practical matter.

Soil and sediment samples should be collected in 8 Oz. wide-mouth glass jars with Teflon lid liners. The jar should be nearly full and samples should be cooled to 4°C during transportation and storage.

APPENDIX C
ANALYTICAL PROCEDURES
available through the Manchester Laboratory

GENERAL CHEMISTRY

Parameter	Method	Reference EPA / SM-17	Lower Reporting Limit
Acidity	Potentiometric titration to pH 8.3 with NaOH	305.1/2310 B	1 mg/L
Alkalinity	Potentiometric titration to pH 4.5 with H_2SO_4	310.1/2320	1 mg/L
BOD 5	D.O. depletion, after 5 days @ 20°C	405.1/5210 B	3 mg O_2/L
COD	Titrimetric	410.1/5220 D	4 mg/L
Chloride	Ion Chromatography	300.0/4110 B	0.1 mg/L
Chlorophyll		/10200 H	
Color	Spectrophotometric	110.1/2120 C	3 units
Conductivity	Wheatstone bridge	120.1/2510	1 µmho/cm @ 25 °C
Cyanide	Automated Colorimetric(1)	335.2/4500-CN E	0.002 mg/L
Fluoride	Automated complexone	340.3/4500-F E	0.01 mg/L
Hardness	EDTA Titrimetric	130.2/2340 C	1 mg/L
Total Kjeldahl Nitrogen	Automated H_2SO_4 Digestion, colorimetric phenate	351.1	0.01 mg/L
Tot. Persulfate Nitrogen	353.2		
Ammonia N*	Colorimetric, automated phenate	350.1/4500-NH_3 H	0.01 mg/L
Nitrate-Nitrite* and Nitrite*	Colorimetric, automated Cd reduction	353.2/4500-NO_3 F	0.01 mg/L
Oil & Grease	Extraction, gravimetric	413.1/5520 B	1 mg/L
TOC	Persulfate/UV Ox. - FID	415.2/5310 C	0.1 mg/L
pH		150.1	

ANALYTICAL PROCEDURES
GENERAL CHEMISTRY(Continued)

Parameter	Method	Reference EPA/SM-17	Lower Reporting Limit
Ortho Phosphate*	Automated ascorbic acid	365.3	0.01 mg/L
Total Phosphate*			
(* These five determinations constitute the "Nutrients (5)" procedure.)			
Phenolics	Automated colorimetric	EPA 420.2	2 µg/L
TS**	Gravimetric, 103-105 °C	160.3/2540 B	1 mg/L
TSS**	Filter, Grav. 103-105 °C	160.2/2540 D	1 mg/L
TNVS**, TNVSS**	Gravimetric, 550 °C	160.4/2540 E	1 mg/L
(** These four determinations constitute the "Solids(4)" procedure.)			
TVS	Grav., 550 °C, by diff.	160.4	1 mg/L
TDS	Gravimetric, 180 °C	160.1/2540 C	1 mg/L
SS	Gravimetric	160.5/2540 F	1 mg/L
Sulfate	Ion Chromatography	300.0/4110 B	0.1 mg/L
Turbidity	Nephelometric	180.1/2130	1 NTU

(1) Method 335.2 has been modified by automating the colorimetric detn.

References - EPA = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 (Rev. March, 1983).
SM-17 = Standard Methods for the Examination of Water and Wastewater, 17th Ed. (1989).

Lower Reporting Limit (LRL) - the level below which the result is reported as "not detected at the lower reporting limit."

BOD_5 = 5-Day Biochemical Oxygen Demand
TOC = Total Organic Carbon
COD = Chemical Oxygen Demand
TS = Total Solids
TSS = Total Suspended Solids
TNVS = Total Nonvolatile Solids
TNVSS = Total Nonvolatile Suspended Solids
TDS = Total Dissolved Solids
SS = Settleable Solids
NTU = Nephelometric Turbidity Unit

ANALYTICAL PROCEDURES
METALS

Parameter	Method	Method Number EPA/SW846	Practical Quant. Limit Water(µg/L)	Soil(mg/Kg)
Al	ICP-AES	200.7/6010	70	7
Sb (PP)	ICP-AES	200.7/6010	150	15
	GFAA	204.2/7041	10	1
As (PP,TCLP)	ICP-AES	200.7/6010	150	15
	GFAA	206.2/7060	5	0.5
Ba (TCLP)	ICP-AES	200.7/6010	5	0.5
Be (PP)	ICP-AES	200.7/6010	5	0.5
	GFAA	210.2/7091	NA	NA
B	ICP-AES	200.7/6010	50	5
Cd (PP,6,TCLP)	ICP-AES	200.7/6010	15	1.5
	GFAA	213.27131	0.5	0.05
Ca	ICP-AES	200.7/6010	10	1.0
	AA	215.1/7140	1	
Cr (PP,6,TCLP)	ICP-AES	200.7/6010	15	1.5
	GFAA	218.2/7191	1.0	0.1
Hexavalent Cr	GFAA	218.5/7195	1.0	0.1
	Colorimetric	/7196		
Co	ICP-AES	200.7/6010	15	1.5
	GFAA	219.2/7201	NA	NA
Cu (PP,6)	ICP-AES	200.7/6010	10	1.0
	GFAA	220.2	NA	NA
Fe	ICP-AES	200.7/6010	20	2.0
Pb (PP,6,TCLP)	ICP-AES	200.7/6010	100	10
	GFAA	239.2/7421	5	0.5
Mg	ICP-AES	200.7/6010	10	0.5
Mn	ICP-AES	200.7/6010	10	1.0
Hg (PP,TCLP)	CVAA	245.1/7470	0.5	
	CVAA	245.5/7471		0.05

ANALYTICAL PROCEDURES
METALS (Continued)

Parameter	Method	Method Number EPA/SW846	Practical Quant. Limit Water(µg/L)	Soil(mg/Kg)
Mo	ICP-AES	200.7/6010	20	2.0
Ni (PP,6)	ICP-AES	200.7/6010	70	7
	GFAA	249.2	5	0.5
K	ICP-AES	200.7/6010	1,000	100
	AA	258.1/7610	40	4
Se (PP,TCLP)	ICP-AES	200.7/6010	300	30
	GFAA	270.2/7740	5	0.5
SiO_2	ICP-AES	200.7	70	7
Ag (PP,TCLP)	ICP-AES	200.7/6010	10	1.0
	GFAA	272.2/7740	1	0.1
Na	ICP-AES	200.7/6010	70	7
	AA	273.1/7770	1	
Sr	ICP-AES	200.7	10	10
Tl (PP)	ICP-AES	200.7/6010	300	30
	GFAA	279.2/7841	10	1.0
Sn	ICP-AES	200.7	NA	NA
Ti	AA	283.1	NA	NA
V	ICP-AES	200.7/6010	10	1.0
	GFAA	/7911	NA	NA
Zn (PP,6)	ICP-AES	200.7/6010	20	2.0

NA = Information not immediately available. Check with the laboratory.

If analysis of "dissolved metals" is required, the sample must be filtered and acidified in the field (See Manchester Laboratory User's Manual).

Liquid samples are digested by SW-846 Methods 3005, 3010, 3015, 3020 or 3050; soil and sediment samples by Methods 3050 or 3051; and tissue samples by a modification of Method 3051.

Practical Quantitation Limits (PQL) are the concentrations below which results are qualified as estimated (J). They are about 5 times the instrument detection limit and the relative standard deviation at the PQL should be ≤10%.

ANALYTICAL PROCEDURES
METALS (Continued)

(PP) - priority pollutant metal.

(6) - Included in Manchester Lab "Metals 6" procedure.

(TCLP) - The leachate from the Toxicity Characteristic Leaching Procedure, SW846 Method 1311, is analyzed for this metal.

AA = flame atomic absorption spectrometry.

GFAA = graphite furnace atomic absorption spectrometry.

CVAA = cold vapor atomic absorption spectrometry.

ICP-AES = Inductively-coupled plasma atomic emission spectroscopy.

The full text of Method 200.7, "Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," is given in Appendix C of 40 CFR 136.

ANALYTICAL PROCEDURES
VOLATILE ORGANIC COMPOUNDS

Water and wastewater samples are analyzed for the following compounds by EPA Method No. 624 and soil and sediment samples by a modification of SW846 Method No. 8240 (GC/MS):

Bromodichloromethane
Bromoform
Carbon tetrachloride(T)
Chloroethane
Chloromethane
1,2-, 1,3-dichlorobenzene
1,1-dichloroethylene(T)
1,2-dichloropropane
Ethylbenzene
1,1,2,2-tetrachloroethane
Toluene
Trichloroethylene(T)
Vinyl Chloride(T)
Benzene(T)
Bromomethane
Chlorobenzene(T)
Chloroform(T)
Dibromochloromethane
1,1-, 1,2-dichloroethane(T)
trans-1,2-dichloroethylene
cis-, trans-1,3-dichloropropylene
Methylene chloride (Dichloromethane)
Tetrachloroethylene(T)
1,1,1-, 1,1,2-trichloroethane
Trichlorofluoromethane

Reporting limits of 1 - 10 µg/L are generally achieved for the above compounds in water samples. Reporting limits of 5 - 10 µg/Kg are generally achieved in soil samples. There are many potential interferences in wastewater, soil and sediment samples which can elevate the reporting limits substantially. If you have concerns about a particular type of sample, contact the laboratory.

(T) - The leachate from the Toxicity Characteristic Leaching Procedure (TCLP) is analyzed for this compound.

ANALYTICAL PROCEDURES
SEMI-VOLATILE ORGANIC COMPOUNDS
(Base/Neutral Acid (BNA) Extractables)

Water and wastewater samples are analyzed for the following compounds by a modification of EPA Method No. 625 and soil and sediment samples by a modification of SW846 Method No. 8270 (GC/MS). EPA Method 1625, isotope dilution GC/MS, is also available.

Acenaphthene
Anthracene
Benzo(a)anthracene
Benzo(b), Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Bis(2-chloroethoxy)methane
Bis(2-ethylhexyl)phthalate
4-bromophenylphenylether
2-chlorophenol
Chrysene
1,2-, 1,3-, 1,4-dichlorobenzene
2,4-dichlorophenol
2,4-dimethylphenol
1,2-diphenylhydrazine
Di-n-octylphthalate
Fluoranthene
Hexachlorobenzene(T)
Hexachlorocyclopentadiene
Indeno(1,2,3-c,d)pyrene
Naphthalene
N-nitrosodimethylamine
N-nitrosodiphenylamine
Phenol
1,2,4-trichlorobenzene
Acenaphthylene
Benzoic acid
Benzo(a)pyrene
2-, 4-methylphenol(T)
Benzylbutylphthalate
Bis(2-chloroethyl)ether
Bis(2-chloroisopropyl)ether
2-chloronaphthalene
4-chlorophenylphenylether
Dibenzo(a,h)anthracene
3,3'-dichlorobenzidine
Diethylphthalate
Dimethylphthalate
Di-n-butylphthalate
2,4-, 2,6-dinitrotoluene
Fluorene
Hexachlorobutadiene(T)
Hexachloroethane(T)
Isophorone
Nitrobenzene(T)
N-nitrosodi-n-propylamine
Phenanthrene
Pyrene

Reporting limits of 10 - 50 µg/L are generally achieved for the above compounds in 1 liter water samples. Special low-level analysis with reporting limits of 5 -25 µg/L is available at the Manchester Laboratory. Reporting limits of 50 - 100 µg/Kg are generally achieved in soil samples. There are many potential interferences in wastewater, soil and sediment samples which can elevate the reporting limits substantially. If you have concerns about a particular type of sample, contact the Manchester Laboratory.

4-chloro-3-methylphenol
2-, 4-nitrophenol
2,4,6-trichlorophenol(T)
2,4-dinitrophenol
Pentachlorophenol(T)
4,6-dinitro-2-methylphenol

Reporting limits of about 50 - 250 µg/L are generally achieved for these phenols in 1 liter water samples.

(T) = The leachate from the Toxicity Characteristic Leaching Procedure (TCLP) is analyzed for this compound.

ANALYTICAL PROCEDURES
ORGANOCHLORINE PESTICIDES AND PCBS

Water and wastewater samples are analyzed for the following compounds by a modification of EPA Method No. 608 and soil and sediment samples by a modification of SW846 Method No. 8080 (GC/ECD):

Pesticides	PCBs
Aldrin	Arochlor-1016
alpha-, beta-, delta-BHC	Arochlor-1221
gamma-BHC (Lindane)(T)	Arochlor-1232
Chlordane(T)	Arochlor-1242
4,4'-DDD	Arochlor-1248
4,4'-DDE	Arochlor-1254
4,4'-DDT	Arochlor-1260
Dieldrin	
Endosulfan I, II, sulfate	
Endrin(T)	
Endrin aldehyde	
Endrin ketone	
Heptachlor(T)	
Heptachlor epoxide	
Methoxychlor	
Toxaphene(T)	

(T) = The leachate from the TCLP is analyzed for this compound.

Reporting limits are in the range of 0.05 to 0.5 µg/L in water samples and about 40 µg/Kg in soil and sediment samples. There are many potential interferences in wastewater, soil and sediment samples which can elevate the reporting limits substantially. If you have concerns about a particular type of sample, contact the Manchester Laboratory.

ORGANOPHOSPHOROUS PESTICIDES

Water and wastewater samples are analyzed for the following compounds by EPA Method 614 and soil and sediment samples by SW846 Method 8140 (GC/FPD or NPD):

Mevinphos	Phorate
Dimethoate	Diazinon
Methyl parathion	Ethyl parathion
Malithion	Ethion
Carbophenothion	Azinphos (methyl or ethyl)
Dichlorvos	Dioxathion
Ronnel	Fenthion
Phosphamidon	Folex
DEF	Phencapton
Monocrotophos	EPN
Imidan	Coumaphos
Disulfoton	

The detection limits for this procedure vary significantly with the sample matrix. The limits for water samples generally range form 0.05 to 0.5 µg/L.

ANALYTICAL PROCEDURES
OTHER ORGANICS ANALYSES

Parameter	Method	Reference	Lower Reporting Limit
Polynuclear Aromatic Hydrocarbons (PAH)	HPLC/UV GC/FID	EPA 610/SW846 8310 SW846 8100	0.25 µg/L
PAH	HW Designation	WDOE 83-13	
TOX	Charcoal trap, pyrolisis, microcoulometric titration	SW846 9020	5 µg/L
Resin/Fatty acids	GC/MS	NCASI RAFA-85.01	
Guiacols/ Catechols/ Phenols		NCASI CP-86.01	
Halogenated Hydrocarbons	Ion Chromatography	WDOE 83-13	100 ppb Cl^-
Chlorophenoxy Herbicides	GC/EC or GC/HD	EPA 615 SW846 8150	Check with Lab
Hydrocarbon ID	GC Pattern Matching	MEL Internal SOP	Qual. Only
Tri-butyl tin		NOAA Method	
Total Petroleum Hydrocarbons (TPH)	GC/FID	EPA 418.1 (Mod) SW846 8015 (Mod)	
% Lipids		MEL Internal SOP	
VOA Air Toxics		EPA TO-16	

ANALYTICAL PROCEDURES
BIOLOGICAL TESTS

Parameter	Method	Reference
Fecal Coliform	Membrane Filter	SM17 9222 D
	Most Probable Number	SM17 9221 C.1
Total Coliform	Membrane Filter	SM17 9222 B
	Most Probable Number	
Enterococci	Membrane Filter	
	Most Probable Number	
Fecal Streptococcus	Membrane Filter	
	Most Probable Number	
% Klebsiella		
Bacterial ID		
Iron Bacteria	Wet Mount Identification	
Sulfur Bacteria	Wet Mount Identification	

ANALYTICAL PROCEDURES
BIOASSAY PROCEDURES

Species	Reference
HW Designation Salmonid	
Acute Tests	
Salmonid	DOE 80-12
Daphnia magna	EPA/600/D-87/080
Microtox	Microtox Manual - for water samples Puget Sound Protocols and Guidelines (5/86) - for sediments/sludge
Hyallela	Nebeker, et al, 1984
Rhepoxynius abronius	ASTM STP 854(1985)
Daphnia sp.	
Echinoderm Sperm Cell	
Bivalve Larvae	
Chronic Tests	
Daphnia sp.	
Ceriodaphnia	
Fathead minnow*	EPA/600/4-89/001

Note: Due to the specialized nature of these tests and the long lead times required for preparation of the organisms, Margaret Stinson MUST be contacted several weeks in advance of the date samples will be submitted.

* Manchester Lab contracts this test out to a commercial laboratory.

ANALYTICAL PROCEDURES
MISCELLANEOUS TESTS

Parameter	Method	Reference
BOD5 Inhibited, BOD20 and BOD20 Inhibited		EPA 405.1
Soil pH		SW846 9045
Salinity		SM16 210
% Solids	Gravimetric, 103-105 °C	EPA 160.3
Sediment Grain Size		PSP&G
TOC in Soil		PSP&G
Ignitability		SW846 1010 & 1020
Asbestos		
TCLP	Analyze leachate for 8 metals and 31 organics	SW846 1311

Priority Pollutant/
Hazardous Substance list/
Toxic Compound List Scan
(Includes any or all of: BNA, VOA, PEST/PCB, Metals, Cyanide)

PSP&G = Puget Sound Protocols and Guidelines

APPENDIX D
DATA QUALITY FOR ANALYTICAL PROCEDURES

GENERAL CHEMISTRY

Parameter	Reference	Precision	Bias
Acidity, as $CaCO_3$	EPA 305.1	s = ± 10[a] up to 2000 mg/L	
Alkalinity, as $CaCO_3$	EPA 310.1	s = ± 3[b] @ 122 mg/L	
BOD_5	EPA 405.1	s = ± 0.7[a] @ 2.1 mg/L ± 26[a] @ 175 mg/L	
COD	EPA 410.1 SM-17 5220 B	s = ± 17.76[a] @ 270 mg/L s = ± 13[a] @ 200 mg/L ± 14[a] @ 160 mg/L	-4.7%
Conductivity	EPA 120.1 SM-17 2510 B	s = ± 6[b] @ 536 µmho/cm RSD = 8% @ 147 - 228 µmho/cm	
F^-, Total	EPA 340.3 SM-17 4500-F E	s = ± 0.018[b] @ 0.06 - 1.08 mg/L s = ± 0.03[b] @ 0.40 - 0.82 mg/L	-11% - +2% -2%
Hardness, as $CaCO_3$	EPA 130.2 SM-17 2340 C	s = ± 3[b] @ 194 mg/L RSD = 2.9%[a] @ 610 mg/L	
pH	EPA 150.1	s = ± 0.1[b] @ 7.7	
Kjeldahl N	EPA 351.1	s = ± 0.54[a] @ 1.89 mg/L ± 1.85[a] @ 5.81 mg/L	-25% -22%
NH_3 as N	EPA 350.1	s = ± 0.005[b] @ 0.43 - 1.41 mg/L	-1% - +7%
NO_3^- as N	EPA 352.1	s = ± 0.092[a] @ 0.16 mg/L ± 0.214[a] @ 1.24 mg/L	-7% +3%
NO_3^--NO_2^- as N	EPA 353.2 SM-17 4500-NO_3^-F	s = ± 0.012[a] @ 0.29 mg/L ± 0.176[a] @ 2.48 mg/L s = ± 0.050[b] @ 0.200 - 2.100 mg/L	+6% -3%
NO_2^- as N	SM-17 4500-NO_2^-B	s = ± 0.004[b] @ 0.24 mg/L ± 0.01[b] @ 1.04 mg/L	0 0

DATA QUALITY FOR ANALYTICAL PROCEDURES

GENERAL CHEMISTRY (Continued)

Parameter	Reference	Precision	Bias
TOC	EPA 415.1	s = ± 3.9[a] @ 4.9 mg/L	+15%
		± 8.3[a] @ 107 mg/L	+1%
PO_4^{-3} as P, Total P	EPA 365.1	s = ± 0.019[a] @ 0.04 mg/L	+17%
		± 0.066[a] @ 0.30 mg/L	-13%
	SM-17 4500-P F	s = ± 0.015[b] @ 0.34 mg/L	-4% - -11%
Phenols	EPA 420.2	s = ± 0.5[b] @ 3.8 µg/L	-22%
		± 1.0[b] @ 89 µg/L	-2%
		± 4.2[b] @ 299 µg/L	-2%
TSS	SM-17 2540 D	s = ± 5.2[a] @ 15 mg/L	
		± 24[a] @ 242 mg/L	
		± 13[a] @ 1707 mg/L	
TNVS & TNVSS	EPA 160.4	s = ± 11[a] @ 170 mg/L	
TDS	SM-17 2540 C	s = ± 21[b] @ 293 mg/L	
$SO_4^=$	EPA 300.0	s = ± 0.066[b] @ 1.02 mg/L	+2%
		± 0.71[b] @ 10.0 mg/L	+12%
		± 1.5[b] @ 98.5 mg/L	+4%
	SM-17 4110 B	s = ± 0.03[b] @ 0.52 mg/L	
		± 2.2[b] @ 43.5 mg/L	
Surfactants	EPA 425.1	s = ± 0.048[a] @ 0.49 mg/L	+2%
		± 0.27[a] @ 2.98 mg/L	+1%
	SM-17 5540 C	RSD = 15%[a] @ 0.270 mg/L	10%
Turbidity	EPA 180.1	s = ± 0.6[b] @ 26 NTU	
		± 4.7[b] @ 180 NTU	

References - EPA = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 (Rev. March, 1983).
SM-17 = Standard Methods for the Examination of Water and Wastewater, 17th Ed. (1989).

Notes - a = Interlaboratory precision
b = Intralaboratory or single-analyst precision

BOD_5 = 5-Day Biochemical Oxygen Demand
TOC = Total Organic Carbon
COD = Chemical Oxygen Demand
TSS = Total Suspended Solids
TNVSS = Total Nonvolatile Suspended Solids
$CBOD_5$ = 5-Day Carbonaceous Biochemical Oxygen Demand (Inhibited BOD_5)
TS = Total Solids
TDS = Total Dissolved Solids
NTU = Nephelometric Turbidity Unit
TNVS = Total Nonvolatile Solids
SS = Suspended Solids

DATA QUALITY FOR ANALYTICAL PROCEDURES

METALS

Parameter	Reference	Precision	Bias
Al	EPA 200.7	RSD = 5.6%[a] @ 700 µg/L	-0.6%
		33%[a] @ 60 µg/L	+3%
As	EPA 200.7	RSD = 7.5%[a] @ 200 µg/L	+4%
		23%[a] @ 22 µg/L	-14%
	EPA 206.2	s = ± 0.7[b] @ 20 µg/L	+5%
		± 1.6[b] @ 100 µg/L	+1%
Be	EPA 200.7	RSD = 6.2%[a] @ 750 µg/L	-2%
		9.8%[a] @ 20 µg/L	0
Cd	EPA 200.7	RSD = 12%[a] @ 50 µg/L	-4%
		16%[a] @ 2.5 µg/L	+16%
	EPA 213.2	s = ± 0.10[b] @ 2.5 µg/L	-4%
		± 0.33[b] @ 10.0 µg/L	-2%
Cr	EPA 200.7	RSD = 3.8%[a] @ 150 µg/L	-1%
		18%[a] @ 10 µg/L	0
	EPA 218.2	s = ± 0.1[b] @ 19 µg/L	-3%
		± 0.8[b] @ 77 µg/L	+2%
Co	EPA 200.7	RSD = 10%[a] @ 500 µg/L	+2.5%
		4.1%[a] @ 20 µg/L	0
Cu	EPA 200.7	RSD = 5.1%[a] @ 250 µg/L	-6%
		40%[a] @ 11 µg/L	0
Fe	EPA 200.7	RSD = 3.0%[a] @ 600 µg/L	-1%
		15%[a] @ 20 µg/L	-5%
Pb	EPA 200.7	RSD = 16%[a] @ 250 µg/L	-6%
		32%[a] @ 24 µg/L	+25%
	EPA 239.2	s = ± 1.3[b] @ 25 µg/L	-12%
		± 3.7[b] @ 100 µg/L	-5%
Mn	EPA 200.7	RSD = 2.7%[a] @ 350 µg/L	-1.4%
		6.7%[a] @ 15 µg/L	0
Ni	EPA 200.7	RSD = 5.8%[a] @ 250 µg/L	-2%
		11%[a] @ 30 µg/L	-7%
K	EPA 258.1	s = ± 0.2[b] @ 1.6 mg/L	+3%
		± 0.5[b] @ 6.3 mg/L	+2%

DATA QUALITY FOR ANALYTICAL PROCEDURES

METALS (Continued)

Parameter	Reference	Precision	Bias
Se	EPA 200.7	RSD = 22%[a] @ 40 µg/L	-20%
		42%[a] @ 6 µg/L	+142%
	EPA 270.2	s = ± 0.6[b] @ 5 µg/L	-8%
		± 0.5[b] @ 20 µg/L	0
Ag	EPA 272.2	s = ± 0.4[b] @ 25 µg/L-6%	
		± 0.9[b] @ 75 µg/L+4%	
Zn	EPA 200.7	RSD = 5.6%[a] @ 200 µg/L+0.5%	
		45%[a] @ 16 µg/L	+19%

References - EPA - Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 (Rev. March, 1983).

Notes - a = Interlaboratory precision
b = Intralaboratory or single-analyst precision

DATA QUALITY FOR ANALYTICAL PROCEDURES

ORGANICS ANALYSIS

The analysis of environmental samples for organic compounds by gas chromatography presents unique data quality problems. The information in this section must be interpreted very carefully in preparing the data quality objectives for a project.

SEMI-VOLATILE ORGANIC COMPOUNDS

An interlaboratory study reported in EPA Method No. 625 in which spiked samples of wastewater (5 - 2400 µg/L) were analyzed by several laboratories gave the following results:

The average percent recoveries for the following compounds were in the range of 70% to 93% with a mean of 79%:

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzylbutylphthalate
Bis(2-chloroisopropyl)ether
Bis(2-chloroethoxy)methane
Bis(2-chloroethyl)ether
Bis(2-ethylhexyl)phthalate
4-Bromophenylphenyl ether
2-Chloronaphthalene
Chrysene
Dibenzo(a,h)anthracene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-butylphthalate
Di-n-octylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Indeno(1,2,3-c,d)pyrene
Isophorone
Naphthalene
Nitrobenzene
N-nitrosodi-n-propylamine
N-nitrosodiphenylamine
Phenanthrene
Pyrene
4-Chloro-3-methylphenol
2-Nitrophenol
2-Chlorophenol
2,4-Dichlorophenol
2,4,6-Trichlorophenol
4,6-Dinitro-2-methylphenol

The average percent recoveries for the following compounds were in the range of 35% to 69% with a mean of 53%:

Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzidine
Benzo(g,h,i)perylene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Diethylphthalate
Dimethylphthalate
Hexachlorobutadiene
Pentachlorophenol
Hexachloroethane
2,4-Dimethylphenol
4-Nitrophenol
1,2,4-Trichlorobenzene
Phenol

The remaining compounds and their average recoveries were 3,3'-dichlorobenzidine (143%), 2,4-dinitrophenol (108%) and Hexachlorocyclopentadiene (12%).

DATA QUALITY FOR ANALYTICAL PROCEDURES

ORGANICS ANALYSIS (Continued)

The relative standard deviations of the results in this study ranged from 12% to 74% with a mean of 32% (excluding 3,3'-Dichlorobenzidine @ 145%).

The EPA published an interlaboratory study of Method 625 (EPA-600/S4-84-053) with the following results for spiked water samples:

The average recoveries at 100 µg/L ranged from 21% to 113% with a mean of 74%. Half of the values were between 59% and 87%.

The relative standard deviations of the results ranged from 10% to 104% with a median value of 35%. Single-analyst precision ranged from 8% to 72% with a median of 24%

VOLATILE ORGANIC COMPOUNDS

An interlaboratory study is reported in EPA Method No. 624 in which spiked samples of wastewater (10 - 1000 µg/L) were analyzed by several laboratories for the following compounds:

Bromodichloromethane	Benzene
Bromoform	Bromomethane
Carbon tetrachloride	Chlorobenzene
Chloroethane	Chloroform
Chloromethane	Dibromochloromethane
1,1-Dichloroethane	1,2-Dichloroethane
1,1-Dichloroethene	Trans-1,2-dichloroethene
1,2-Dichloropropane	Cis-, Trans-1,3-dichloropropene
Ethylbenzene	Methylene chloride
1,1,2,2-Tetrachloroethane	Tetrachloroethene
Toluene	1,1,1-, 1,1,2-Trichloroethane
Trichloroethene	Trichlorofluoromethane
Vinyl Chloride	2-Chloroethylvinyl ether

The average recoveries for the 28 compounds ranged from 88% to 107% with a mean of 101%. The relative standard deviations ranged from 9% to 31% with a mean of 16%.

The EPA published an interlaboratory study of Method 624 (EPA-600/S4-84-054) with the following results for water samples spiked at 100 µg/L:

The average recoveries ranged from 68% to 123% with a mean of 100%. The relative standard deviations ranged from 13% to 60% with a median of 24%. Single-analyst precision ranged from 11% to 58% with a median of 19%.

Note: These data indicate that the analytical bias of the procedure is virtually zero. However, the collection, transportation and storage of samples for volatiles analysis have the potential to introduce significant bias to the results.

DATA QUALITY FOR ANALYTICAL PROCEDURES
ORGANICS ANALYSIS (Continued)

ORGANOCHLORINE PESTICIDES AND PCBS

An intralaboratory study is reported in EPA Method No. 608 in which spiked samples of wastewater (1 - 200 µg/L) were analyzed by a single laboratory for the following compounds:

Pesticides	PCBs
Aldrin	Arochlor-1016
alpha-, beta-, delta-BHC	Arochlor-1221
gamma-BHC (Lindane)	Arochlor-1232
Chlordane	Arochlor-1242
4,4'-DDD	Arochlor-1248
4,4'-DDE	Arochlor-1254
4,4'-DDT	Arochlor-1260
Dieldrin	
Endosulfan I	
Endosulfan II	
Endosulfan sulfate	
Endrin	
Endrin aldehyde	
Heptachlor	
Heptachlor epoxide	
Toxaphene	

The average recoveries for the 25 compounds ranged from 86% to 99% with a mean of 92%. The relative standard deviations ranged from 1.3% to 5.5% with a mean of 2.8%.

The EPA published an interlaboratory study of Method 608 (EPA-600/S4-84-061) with the following results for water samples:

The average recoveries ranged from 68% to 101%. The relative standard deviations ranged from 12% to 45%. Single-analyst precision ranged from 11% to 33%.

APPENDIX E

QUALITY CONTROL PRACTICES

Quality control data are used to evaluate and control random and systematic errors in measurements. Results for check standards, spikes and blanks provide information on systematic error (bias). Replicate results for check standards, spikes and samples provide information on random error (precision) and replicate results for blanks are used to determine the limit of detection.

Calibration

Calibration of a measurement system is not considered a quality control procedure, although it is critical to the accuracy of the results. Calibration relates the response of the measurement system to the property of the sample being measured and defines the operational range of the system.

Most measurement systems are calibrated with external standards. The response of one or more standards of certified composition is recorded and used to evaluate the response of the samples. For most analytical procedures, calibration is required each day, shift or sample batch. Calibration with a blank and four standards is recommended for most systems.

Some measurement systems (eg. UV-VIS Spectrophotometers) are sufficiently stable that a calibration can serve for a long period of time. This is called fixed calibration. It is recommended that fixed calibrations be based on a blank and at least seven standards. The fixed calibration is not repeated until the results for the check standards indicate the need to do so.

Internal standards are used in some analytical methods, particularly in gas chromatography. One or more standards are added to each sample extract and calibration is based on the ratio of the response of the compound of interest to that of the associated standard.

In the method of standard additions used in metals analysis by Graphite Furnace Atomic Absorption Spectroscopy, standards at several concentrations are added to aliquots of the sample and the resulting calibration curve is used for quantitation.

Sample response must fall within the range of the calibration curve. Thus, it is important that any available information on the expected levels of contaminants be provided along with the samples.

Check Standards

Check standards are prepared independently of the calibration standards and are analyzed along with the samples. Results are reported as percent recovery and are used to verify that the precision of the results is in control and that level of bias due to calibration is acceptable. If the responses of the check standards do not fall within established control limits, the measurement system should be re-calibrated. In some analytical methods, check standard results are used to qualify sample results.

Spikes

A matrix spike is a sample to which a known amount of analyte is added at the start of the procedure. Spike recoveries may indicate bias due to interference from the sample matrix. Since the percent recovery is calculated from the difference between the analytical results for the spiked and unspiked samples, its precision is rather poor. Thus, matrix spike results are not used to correct sample results and should only be used in conjunction with other QC data to qualify them.

The analytical response of the spiked sample must fall within the range of the calibration. The project manager may wish to indicate to the laboratory which samples might be most appropriate for use as matrix spikes and, if necessary, provide additional sample for this purpose.

In some analytical methods all the samples are spiked with surrogate compounds at the start of the procedure. Surrogate compounds produce a response which can be distinguished from that of the analytes of interest and are not expected to be present in the samples. Surrogate recoveries provide an estimate of accuracy for the entire analytical procedure. They are not used to correct sample results but may be used to qualify them.

Blanks

Field blanks may be used to detect contamination from

- Sample containers
- Sampling equipment
- Filtration equipment
- Preservation reagents
- Transportation and/or storage practices
- Other samples

Field blanks should be treated as ordinary samples by the laboratory, including subtraction of the analytical blank response. However, they should be clearly identified as blanks so that they are not selected for use as duplicates or matrix spikes.

The results for field blanks are not used to correct sample results. If a problem with contamination is indicated, its effect on the sample results must be evaluated and some form of corrective action taken.

Field blanks should be used to detect specific problems or to meet legal requirements. They are not necessary for most parameters unless there is reason to expect problems with contamination. The project manager should ensure that every precaution is taken to avoid contamination of the samples in the field.

There is no standard terminology for field blanks. Some common terms and their usual definitions are:

Transport blanks - a sample container (from the same batch used for the samples) is filled with a suitable blank substance, sealed, and transported and stored with the samples. Results indicate contamination from the sample container or from cross-contamination during transport or storage. Transport blanks are used primarily when sampling for volatile analytes.

Transfer blanks - a sample container is filled with a suitable blank substance and appropriate preservatives at the sampling site. Results indicate contamination from the container, from the surroundings where the sample was prepared, from the preservatives used, and/or cross-contamination during transport or storage.

Sampling blanks - a suitable blank substance is exposed to the sampling equipment then placed in a container with appropriate preservatives. Results indicate contamination from the sampling equipment as well as from all the sources mentioned for the transfer blank. Sampling blanks should be collected near the middle of the sampling process or after collecting the samples which are expected to contain the highest levels of the analyte of interest. They are sometimes called rinsate or equipment blanks.

Depending on the analytical method to be used, the laboratory will prepare and analyze one or more blanks.

Method Blanks - A suitable blank substance is prepared along with the samples at the start of the analytical procedure. The analytical responses should be used to blank-correct the sample responses. They may also be used to determine the limit of detection. Method blanks may also be called procedure blanks or preparation blanks.

Replicates

Replicate measurements provide a means of estimating the random error associated with the results. Just as each step in the process offers the potential to contribute to the systematic error (bias), so also each step may introduce random error which affects the precision of the results.

Generally, the most significant sources of random error are the sampling and measurement procedures. The sampling error cannot be measured directly, yet it may be the largest source of error in the results. Sampling error may be estimated from estimates of measurement error and of total error.

Field Replicates -

Field replicates are samples which are collected at the same time and location and are preserved, stored and analyzed under identical conditions. A good estimate of the random error due to sampling can only be made if the results of the field replicates are significantly above method detection levels. Therefore, samples selected for replication should be those expected to produce positive results. It will be helpful to specify that replicate measurements or analyses be made on one or more of the replicate samples.

In most cases, it is not practical to collect and analyze more than duplicate samples. Unfortunately, an estimate of precision based on a single pair of duplicate results is not a very good estimate. If several pairs of duplicate results are available, they may be pooled to provide a better estimate of precision. (See Appendix G.)

Split samples are identical aliquots of a single sample prepared in the field. Replicate split samples can be used to estimate the homogeneity of the sample. They may also be used to compare the results from different laboratories, measurement procedures, etc. If split samples are used to evaluate the performance of a laboratory, they should be accompanied by performance evaluation (PE) samples. In the event that the results for the split samples do not agree, the results for the PE samples will often provide an indication of which laboratory may have a problem.

PE samples are generally acquired from an independent source and are used to check the performance of the laboratory (See 5.9 and 5.10). The response for PE samples should be within the normal working range of the measurement system.

PE samples for many parameters and a variety of matrices are available from NIST, EPA and several commercial sources. Information on sources of PE samples is available from the QA Section.

Laboratory Replicates -

Depending upon the analytical method used, the laboratory may analyze duplicate aliquots of one or more samples. The results for these duplicates may be used to estimate the precision of the sample results (For some matrices such as soil, sub-sampling error may be introduced). The project manager may wish to specify which samples are to be analyzed in duplicate and/or request additional replicate analyses.

In some analytical procedures, the results from replicate blanks, check standards and/or matrix spikes are routinely reported and the results used to qualify the data. In some cases, the historical data for these replicates (i.e. control chart data) will provide good estimates of the analytical precision.

Contract Laboratory Program (CLP)

The EPA established the CLP in order to standardize the requirements for analytical work performed for the EPA by commercial laboratories under the Superfund program. The program has been widely misunderstood and misrepresented. First of all, the CLP is not an accreditation program and provides no indication to anyone but the EPA of the competence of a laboratory (that information is contractually confidential). Second, it applies only to a limited group of analytical methods, specifically volatile and semivolatile organics by GC/MS, pesticides by GC/EC, metals by ICP and GFAA, and mercury and cyanide analyses. CLP requirements apply to no other methods. Third, some of the CLP criteria are very broad and may not be suitable for Ecology projects. Fourth, unless the samples are submitted by EPA, asking for a CLP method from a CLP laboratory in no way obligates that laboratory to meet CLP requirements.

The Ecology project manager must evaluate the CLP QC criteria in the context of the project objectives before incorporating any or all of the criteria into the data quality objectives. Then the laboratory must be consulted to be sure that the criteria can be applied to the procedures selected for the project. Finally, the laboratory must provide a complete description of the application of the criteria to the data, particularly the use of any qualifiers.

Summary

Check standards are used to confirm that analytical precision and calibration bias are in control. If the precision or bias is found to be unacceptable, action is taken to correct the problem and bring the results within the acceptable range. The use of these results to correct sample results for bias is an option for the project manager (See 5.12) but is generally not recommended.

Matrix spike results should be used with caution due to their inherently poor precision.

For the GC/MS methods, the recovery of surrogate spikes may provide the best estimate of the precision for a given batch of samples.

The response for the method blanks should be used to blank-correct the response of the samples for most measurement procedures. Unfortunately, many laboratories do not blank-correct sample results, so the decision to do so is often left to the project manager. Some proscribed methods specifically prohibit blank-correction of results. If not constrained by the selected method, the project manager may wish to specify that the laboratory report blank-corrected results.

The results of replicate measurements may be used to estimate the precision of the method. There may be historical data available to provide estimates of the precision to be expected from the measurement method.

The staff of the QA Section can provide information, references and assistance on the selection of and interpretation of results from QC procedures.

APPENDIX F

QUALITY CONTROL SAMPLES USED AT THE MANCHESTER LABORATORY

Procedure	Check Standards	Duplicates	Spikes	Blanks
Acidity & Alkalinity	1/batch	1/batch	N/A	N/A
BOD_5	1 Sugar, 1 KHP/batch	Every Sample	N/A	Unseeded Dilution H2O
COD	1/batch	1/batch	N/A	2/batch
Chloride	1/batch	1/batch	1/batch	2/batch
Conductivity	1/batch	1/batch	N/A	N/A
Cyanide	1/batch	1/batch	1/batch	1/batch
Fluoride	1/batch	1/batch	1/batch	2/batch
Hardness	1/batch	1/batch	N/A	2/batch
pH	1/batch	1/batch	N/A	N/A
NH_3 N	1Hi, 1Lo/batch	1/batch	1/batch	2/batch
Kjeldahl N	1Hi, 1Lo/batch	1/batch	1/batch	2/batch
NO_3^--NO_2^- N	1Hi, 1Lo/batch	1/batch	1/batch	2/batch
Oil & Grease	1/batch	1/batch	N/A	2/batch
TOC	1/batch	1/batch	N/A	2/batch
PO_4^{-3} P	1Hi, 1Lo/batch	1/batch	1/batch	2/batch
Total P	1Hi, 1Lo/batch	1/batch	1/batch	2/batch
Phenolics	1/batch	1/batch	1/batch	1/batch
Solids	1/Month	1/batch	N/A	2/batch
Sulfate	1/batch	1/batch	1/batch	2/batch
Turbidity	1/month	1/batch	N/A	N/A
Metals	1/10 samples (+ 1 SRM/batch for soil & seds)	As requested or use duplicate spikes	2/batch	2/batch

Note: Batch = 20 or fewer samples

QUALITY CONTROL SAMPLES USED AT THE MANCHESTER LABORATORY
(Continued)

Procedure	Check Standards	Duplicates	Spikes	Blanks
Volatile Organics	4 surrogates in all samples, blanks & spikes	As requested or Duplicate Matrix Spikes	2/batch	Daily
Semi-volatile* Organics	6 surrogates in all samples, blanks & spikes	As requested or Duplicate Matrix Spikes	2/batch	2/batch
Pesticides and PCBs	4 surrogates in all samples, blanks & spikes	As requested or Duplicate Matrix Spikes	2/batch	2/batch
Herbicides	1 Surrogate in all samples, blanks & spikes	As requested or Duplicate Matrix Spikes	2/batch	2/batch
Guaicols, Catechols & Phenolics	2 surrogates in all samples, blanks & spikes	As requested or Duplicate Matrix Spikes	2/batch	2/batch
Resin acids & fatty acids	2 surrogates in all samples, blanks & spikes	As requested or Duplicate Matrix Spikes	2/batch	2/batch

* Semi-volatile Organics include BNA, PAH, Phenolics & any other neutral and base extractables.

Sugar = glucose/glutamic acid standard

KHP = potassium acid phthalate SRM = Standard Reference Material

The surrogates used for volatile organics are 1,2-dichloroethane-d4, 4-bromofluorobenzene, toluene-d8 and 1-bromo-2-fluoroethane.

The surrogates used for semi-volatile organics are 2-fluoropphenol, phenol-d6, nitrobenzene-d5, 2-fluorobiphenyl, pyrene-d10 and terphenyl-d14.

The surrogates used for pesticides/PCBs are hexabromobenzene (HBB), dibromooctafluorobiphenyl (DBOB), dibutylchlorendate (DBC) and octachloronaphthalene.

The surrogate used for Herbicides is 2,4,6-tribromophenol.

The surrogates used for Guaicols, Catechols and Phenolics are 2-ethoxyphenol and resorcinol-d6.

The surrogates used for Resin Acids and Fatty Acids are heptadecanoic acid and ethyl-o-methylpodosorpic acid.

APPENDIX G

STATISTICAL CALCULATIONS

Precision

Precision is the magnitude of the random error in the results and is calculated as the standard deviation. An estimate of standard deviation, s, from n replicate results is given by

$$s=\sqrt{\frac{\sum x_i^2-(\sum x_i)^2/n}{n-1}} \qquad (1)$$

where x_i is the ith result in the set of n results.

The total precision of the results can be estimated from the results for replicate samples. The analytical precision can be estimated from the results of replicate analyses of sample aliquots, check standards or matrix spikes.

If estimates of the total and analytical standard deviations (s_t and s_a, respectively) are available, an estimate of the standard deviation for the sampling procedures, s_s, is given by

$$s_s=\sqrt{s_t^2-s_a^2} \qquad (2)$$

If more than one estimate of the same standard deviation is available, a pooled estimate, s_p, may be calculated from

$$s_p=\sqrt{\frac{\sum \nu_i s_i^2}{\sum \nu_i}} \qquad (3)$$

where ν_i is the number of degrees of freedom (n-1) associated with s_i.

For duplicate results, Equation 1 reduces to

$$s=\frac{D}{\sqrt{2}} \qquad (4)$$

where D is the absolute value of the difference between the two results.

The estimate of the standard deviation improves as n increases. For a better estimate of s, plan to collect and/or analyze three or more replicates or several pairs of duplicates.

For m pairs of duplicate results, a pooled estimate of s is given by

$$s_p = \sqrt{\frac{\sum D^2}{2m}} \qquad (5)$$

Note that pooling the standard deviation is valid only for results which fall within in a range over which the standard deviation does not vary significantly.

Once the standard deviation of the results has been estimated, confidence intervals can be assigned to individual results. The 95% confidence interval for a single result, x, is given by

$$CI = x \pm ts \qquad (6)$$

where t is the value of Students-t statistic and s is an appropriate estimate of the standard deviation.

Data on duplicate results over time for many routine analytical procedures may be available from the laboratory and may provide the best estimate of the analytical precision of the results for the project.

The precision of the measurement must be considered when comparing results to other data or to permit limits or when comparing the results from two laboratories. For example, if the CI for a result includes the regulatory limit, then no decision can be made as to whether the limit was exceeded and an objective of the project may not be achieved. Also, if the CIs for the results from two laboratories overlap, then the two results are not statistically different.

Note that if replicate measurements do not produce usable, positive results for a given determinand, an estimate of precision cannot be calculated for that determinand. Thus, it is important to select samples to be collected and/or analyzed in replicate which are likely to give positive results in order to ensure that the precision of the results can be determined.

Bias

The determination of bias due to sampling procedures requires special studies designed to examine the various sources of error. Studies which have been conducted have led to the recommended procedures for sample collection, preservation, etc. currently in use. Careful adherence to the procedures selected for the project should maintain bias within acceptable limits.

Two potential sources of systematic error (bias) in a measurement are calibration and interferences due to the sample matrix. The results of the analysis of check standards can be used to estimate bias due to calibration error. The results of the analysis of matrix spikes can be used to detect interference effects due to the sample matrix.

An estimate of bias due to calibration is calculated from the difference between the results for check standards and the true concentration. Relative bias is given by

$$B(\%) = \frac{\bar{x} - T}{T} \cdot 100 \qquad (7)$$

where $\bar{x}$ is the mean of the results of replicate analyses (at least 10 to 20) of the check standard and T is the true concentration.

The analyst will monitor the check standard results and recalibrate the instrument if the bias exceeds the laboratory's criteria.

For matrix spikes, the percent recovery (%R) is given by

$$\%R = \frac{x_s - x}{s} \cdot 100 \qquad (8)$$

where x_s is the result for the matrix spike, x is the result for the unspiked sample and s is the concentration of the spike added to the sample.

Bias due to interference is judged to be present when the %R falls outside the control limits established by the laboratory based on historical recovery data. When this occurs, the analytical procedure should be modified to eliminate the interference effects.

Since the %R is a function of the difference between two results, its uncertainty is relatively large and the power of the spike recovery test to quantify bias due to matrix effects is low. For this reason, correction of the sample results based on matrix spike recovery is not recommended.

If laboratory QC results exceed their criteria and no corrective action was taken by the laboratory, the sample results sent to the project manager may be qualified as estimated or unusable. In assessing the data from the project, if excessive bias is indicated by the QC results, the project manager will have to decide if the data can be used or if it should be qualified as being of limited usefulness or rejected as unusable for the purpose of the project.

The staff of the QA Section can assist the project manager in selecting sampling, analysis and QC procedures which will achieve the required level of confidence in the results.

Detection Limits

If the data indicates that an analyte could not be detected at the level the project objectives require, lab staff should be consulted to determine the reason for the problem. Options such as reanalyzing a larger aliquot of the sample may be available. Otherwise, resampling and/or reanalysis by a different procedure may be necessary.

The concentration at which an analyte can be detected depends upon the variability of the blank response. The Criterion of Detection (CD) is defined as 2.33 times the within-batch standard deviation of the blank response. If the blank-corrected sample response exceeds the CD, the probability that the analyte is present is greater than 95%.[25]

The Limit of Detection (LD) is defined as 4.65 times the within-batch standard deviation of the blank response or 2 times the CD. If the true concentration of the analyte exceeds the LD, the probability that the blank-corrected sample response will exceed the CD (i.e. be "detected") is greater than 95%.

The Limit of Quantitation (LQ) is defined as 14.1 times the within-batch standard deviation of the blank response. At the LQ, the relative standard deviation of the result will be about 10%.

The Method Detection Limit (MDL) defined in federal regulations (40CFR136) and the Instrument Detection Limit (IDL) from the CLP Statements of Work are based on the variability of the response of low-level standards rather than on the variability of the blank response. The MDL is three times the standard deviation of the results of eight replicates of a low-level standard and the IDL is three times the standard deviation of the results of three sets of seven replicates of a low-level standard.

The choice of detection limits may affect the reporting and assessment of low-level data. If data from a project is expected to be near the detection limit, the exact procedures for determining the detection limit and reporting the low-level data should be specified in the Quality Control Procedures section of the project plan. QA Section staff can assist the project manager in selecting the method of determining the detection limit best suited to the requirements of the project.

Attachment D

Data Submittal Requirements

January 27, 1993

TO: Persons Collecting Ground Water and Other Data at MTCA Sites

FROM: Carol Fleskes, Program Manager
Toxics Cleanup Program

SUBJECT: Cleanup Information No. 91-1: Ground Water, Soil, Sludge, and Sediment Data (Environmental Data)

Purpose

The purpose of this memorandum is to establish consistency and procedures for organizing, reporting, transmitting, and storing and retrieving surface water, ground water, soil, sludge, and sediment data (environmental data). These procedures will improve Ecology's ability to cleanup contaminated sites by making meaningful data readily available to the public, legislature, management, project managers, and site workers.

Applicability

These procedures apply to all environmental data collection activities required by the Model Toxics Control Act and Regulations. Exceptions may be made for low risk sites as determined by the Ecology project manager.

Background

Currently, very little of the environmental data collected for the state at toxic cleanup sites is available in a readily usable form. With only a few exceptions, these data are submitted to the department in the form of voluminous paper reports. This form precludes the staff from performing rapid, accurate and many times meaningful analysis of spatial and temporal trends of the data. In addition, the evaluation of environmental data cannot always be effective because of missing and/or improper pertinent information.

This procedure establishes appropriate methods to ensure that data submitted to Ecology is encoded, stored, and presented in a magnetic media format (diskette) so that data can be consistently used by our staff. This procedure will reduce data analysis time when compared to using laborious, time consuming hand methods of the past. Today, at most of the larger sites and many of the smaller sites, these data are processed using computers by the PLP's and consultants. This procedure will generally require the data be rearranged and in some cases additional data items collected.

The results of receiving digital data in a consistent manner will allow exchange of environmental date with EPA and between Ecology programs. This format is a super set of that developed by EPA. It is being used by other Ecology Programs.

Standardization of the data will mean that a broad range of computational, statistical, graphical and modeling software will be readily available to summarize and analyze the data. Standardized report will be available for the first time in the program.

Responsibilities

The attached procedures shall be required for all of the environmental data collection activities as follows:

- o Directly by TCP
- o By any contractors or consultants tasked by TCP
- o By "potentially liable parties" acting under terms of a consent decree or order

Implementation of the procedures shall be by incorporation of the appropriate language into contracts, work plans, orders, consent decrees or other appropriate documents by the site project manager or contract officer.

Data shall be entered into the Ecology data base by a data administrator. There is an inter-program team that established new parameters. At this time, Bill Myers at headquarters is acting in this capacity and as the TCP representative to the team.

Depending on the availability of a wide area network, the data would be directly or indirectly available to staff and other data users. At this time, the Site Cleanup Section is developing links from the present data base program to other statistical, graphical and analytical software packages.

Also attached is a model letter which is sent, along with a diskette, to anyone using our format to submit environmental data. These diskettes are also available to staff. To obtain a copy call Bill at the telephone number shown on the letter.

KC:
Attachments

SITE DESCRIPTION AND SAMPLE DATA SUBMITTAL REQUIREMENTS

1. Media

Required data must be submitted on MS-DOS[1](version 5) or compatibly formatted diskettes. The diskettes may be 5 1/4 inch (or 3 1/2 inch) either: double sided, double density; or double sided, high density.

2. Data Formats

The SITE DESCRIPTION FILE, FIELD SAMPLE FILE and the LABORATORY SAMPLE FILE are quote, comma delimited ASCII files used as the standard format for transferring sample data to and from Ecology (LOTUS WK1 files and Ashton Tate DBF files may be substituted for ASCII files). The files will include the fields in the format and order listed (C-Character, N-Numeric, D-date(Character may be substituted in non DBF or WK1 format)).

The following Appendices are attached to standardize information entered into required files (see following appendices):

A. Matrix Codes

B. Sample Source Codes

C. Collection Method Codes

D. Chemical Data Dictionary (Standardizes Spelling, STORET P-codes., etc entered into the SAMPLE ANALYSIS FILE.

E. Laboratory Qualifiers

F. State Plane Zones (N or S)
(NOTE: Copy of RCW 58.20 provided for reference)

G. County Fips Codes

H. Hydrologic Unit Map

3. Submittal

Computer diskettes containing the SITE DESCRIPTION FILE, FIELD SAMPLE FILE and/or the LABORATORY SAMPLE FILE, clearly labeled for Project and Originator shall be submitted in duplicate, along with a backup hard copy of the diskette contents.

[1] Trademark of the Microsoft Corporation

FIELD DEFINITIONS FOR SITE DESCRIPTION FILE

*Wells and Borings must include all Fields except as noted optional. Underlined Fields are required for all stations.

FIELD	TYPE	WIDTH	DEFINITION
REP_DATE	D	10	Reporting date (mm/dd/yyyy).
REP_NAME	C	48	Reporting entity, data submitted by.
PRJ_NAME	C	48	Project, site, or facility name.
STA_TYPE	C	12	Station type (Ground water, Surface wtr, Sediment, Soil, Sludge, Biological or Air).
STA_USE	C	1	Well use (USGS codes) O-observation, W-water withdrawal, X-waste disposal, D-drain, T-test hole, E-geothermal, P-oil/gas, U-unused, R-recharge, Z-destroyed.
WTR_USE	C	1	Water use (USGS codes) W-water quality/level monitoring, D-dewatering, N-industrial, S-stock supply, B-bottling, I-irrigation, Q-aquaculture, U-unused, C-commercial supply, H-domestic supply P-public supply, J-industrial cooling, F-fire protection, Z-other.
DATA_REL	C	1	Data Reliability (USGS codes) C-field checked, L-poor location, U-unchecked.
STA_ID	C	12	Well ID number.
PRI_STA	C	15	Ecology primary station code. To be obtained from Ecology TCP.
SEC_STA1	C	12	Additional station code (previous well numbers, alternate or other well designations).
SEC_STA2	C	12	Additional station code (if any).
SEC_STA3	C	12	Additional station code (if any).
STATE_FIPS	C	2	State FIPS code (WA-53).

SITE DESCRIPTION FILE CONTINUED...

FIELD	TYPE	WIDTH	DEFINITION
COUNTYFIPS	C	3	County FIPS code (use state county code, Appendix F).
STATE_CHAR	C	2	State (WA).
COUNTYCHAR	C	16	County.
OWN_NAME	C	30	Monitoring well owner name.
OWN_DT	D	8	Date of ownership of well (mm/dd/yyyy).
OWN_ADD	C	60	Address of owner.
DRILLER	C	30	Name of Driller.
STA_DESC	C	48	Activity Site, Sample location, or Well location description (for example: "East of Bldg. 2" or "SE corner, intersection 6th & Seneca").
LOC_METHD	C	48	Method of determination of station location coordinates (Note: survey to known horizontal datum is required).
LAT	N	8	Latitude OPTIONAL (degrees-minutes-seconds-tenths).
LONG	N	9	Longitude OPTIONAL (degrees-minutes-seconds-tenths).
STPCO_NORT	N	12	Northerly state plane coordinates REQUIRED (nearest ft).
STPCO_EAST	N	12	Easterly state plane coordinates REQUIRED (nearest ft).
STPCO_ZONE	C	1	State plane coordinates: state plane zone REQUIRED (N or S).
LAND_NET	C	20	Land net location of well (Township, Range, Section, 1/4-1/4 Sec.). Use USGS 1/4-1/4 section alphabetic designator A through R OPTIONAL.

SITE DESCRIPTION FILE CONTINUED...

FIELD	TYPE	WIDTH	DEFINITION
UTM_NORTH	N	9	UTM grid system coordinates: North (meters) OPTIONAL.
UTM_EAST	N	8	UTM grid system coordinates: East (meters) OPTIONAL.
UTM_ZONE	C	2	UTM grid zone.
MAP_NAME	C	24	Name of USGS map and scale covering the sampling location(e.g., Yakima 100K, 1977).
BORE_DEP	N	8	Depth of original hole drilled if applicable (nearest 0.01 ft).
WELL_DEP	N	8	Well depth (nearest 0.01 ft).
WTR_ELEV1	N	8	Water level elevation at time of installation (nearest 0.01 ft).
WLEV_DAT1	D	10	Date of water level elevation measurement (mm/dd/yyyy).
MEAS_ELEV	N	8	Measuring point (reference point) elevation (nearest 0.01 ft).
MEAS_DESC	C	48	Measuring point description.
DATUM	C	48	Measuring point datum (The source of the altitude used to survey in the sampling location altitude i.e. City of Tacoma Sewer Survey 1921).
LEV_COMM	C	240	Comments, depth and water level data.
ALTITUDE	N	8	Approximate land surface elevation XXXXX.XX (ft) at the Station Location.
DEPTOWTR1	N	8	Water depth at time of install. (nearest 0.01 ft).
CONST_DT	D	10	Date of installation (mm/dd/yyyy).
MOREINT	C	1	More than one open interval (Y/N).

SITE DESCRIPTION FILE CONTINUED...

FIELD	TYPE	WIDTH	DEFINITION
UP_DEPTH	N	8	Depth to top of open interval (ft below measuring point).
LOW_DEPTH	N	8	Depth to bottom of open interval (ft below measuring point).
CONST_COMM	C	240	Comments, construction details.
MTD_CON	C	1	Method of construction (USGS WATSTORE codes) A-air rotary, B-bored/augured, C-cable tool, D-dug, H-hydraulic rotary, J-jetted, P-air percussion, T-trenching, V-driven, W-drive wash, R-reverse rotary, X-mud rotary, Z-other.
FILT_LEN	N	5	Length of filter pack (nearest 0.01 ft).
FILT_MAT	C	48	Type of filter pack material and size of material (e.g., Sand 200 mesh).
DIA_BOR	N	8	Boring diameter (in).
DIA_CAS	N	8	Casing diameter (in).
CAS_MAT	C	1	Casing material (USGS WATSTORE codes) B-brick, C-concrete, D-copper, F-teflon/fluorocarbon, G-galvanized iron, I-wrought iron, M-other metal, P-pvc/plastics, R-rock/stone, S-steel, T-tile, W-wood, U-coated steel, Z-other.
DIA_OPN	N	6	Diameter of open interval (in).
LEN_OPN	N	6	Length of open interval (nearest 0.01 ft).
TYP_OPN	C	1	Type of open interval (USGS WATSTORE codes) P-perforated/slotted screen, L-louvered/shuttered screen, S-screen (unknown type), F-fracture, R-wire wound, M-mesh, T-sand point, W-walled, X-open hole, Z-other.

SITE DESCRIPTION FILE CONTINUED...

FIELD	TYPE	WIDTH	DEFINITION
TYP_OMT	C	1	Material type, open interval (USGS WATSTORE codes) R-stainless steel, F-teflon/fluorocarbon, G-galvanized iron, P-pvc/plastic, B-brass/bronze, W-wrought iron, S-steel, T-tile, C-concrete, M-other metal, Z-other.
INT_COMM	C	240	Comments, open interval.
LOG_AVAIL	C	1	Well log data available? (Y/N).
TYP_LOG	C	10	Type of well log (USGS WATSTORE codes) A-time, B-collar, C-caliper, D-driller, E-electric, F-fluid conduction, G-geologist, H-magnetic, I-induction, J-gamma ray, K-dip meter, L-lateral log, M-microlog, N-neutron, O-microlateral log, P-photo/video, Q-radioactive, S-sonic, T-temperature, U-gamma gamma, V-fluid velocity, X-core, Z-other.
LOG_DOC	C	240	Log data source documents (e.g. Remedial Investigation Report).
OTHER_DOC	C	240	Other data source documents.
LOG_LOC	C	60	Location of well log (e.g. Ecology Southwest Regional Office).
AQUI_TEST	C	1	Aquifer testing performed (Y/N).
PUMP_DATA	C	240	Pump data such as: Type, Manufacturer, Horsepower, and depth set .
ANDAT_AVAL	C	1	Analytical or Statistical data available (Y/N).
PROGRAM	C	9	Ecology program (TCP, WQFA, WQ, other).
GEN_COMM	C	240	General comments.
HUCODE	C	8	See US Geological Survey Hydrologic Unit Map 1974-Washington.
AGN_USE	C	1	Agency use (USGS codes) A-Active, I-inactive, O-inventory only.

*** END OF SITE DESCRIPTION FILE ***

FIELD DEFINITIONS FOR FIELD SAMPLE FILE

*All Fields Required

FIELD	TYPE	WIDTH	DEFINITION
PRI_STA	C	15	Ecology Monitoring Well No. will be assigned by Ecology TCP Program.
STA_ID	C	12	Site well ID no. or other designation.
X_LOCATION	C	12	Surveyed coordinates reported in the State Plane Coordinates (to the nearest foot).
Y_LOCATION	C	12	
STPLNZONE	C	1	N - North; S - South.
LO_DAT_U	C	5	Year of Reference datum either 1929 or 1983 and which system L Lat Long or S for State Plane Coordinate System.
LOC_DATUM	C	48	Reference datum from Map or survey e.g., 1983 North American Datum (see Appendix F, RCW 58.20)
DEPT_WATER	N	8	Depth to water (in 0.01 ft) at time of sampling.
UP_DEPTH	N	7	Depth (nearest 0.01 ft) to the top of the interval sampled (e.g. Top of well screen or core interval).
LOW_DEPTH	N	7	Depth (nearest 0.01 ft) to the bottom of the interval sampled (e.g. Bottom of well screen or core interval).
WTR_ELEV	N	8	Water level elevation (in 0.01 ft) at the time of sampling.
AGENCY	C	8	Agency requesting sampling data.
SAMPLE_DAT	D	8	Date of well sampling (mm/dd/yyyy).
SAMP_TIME	C	4	Time of well sampling in military time.
SAMPLE_ID	C	8	Sample ID code or no.

FIELD SAMPLE FILE CONTINUED:

FIELD	TYPE	WIDTH	DEFINITION
FILTERED Yes(Y) or	L	1	Was the sample field filtered? No(N)
ANALYSIS_MTHOD	C	15	EPA Analysis method descriptions (i.e EPA Method 601).
MEAS_ELEV	N	8	Surveyed elevation of the measuring point used to determine water level depths and elevations. (nearest 0.01 ft).
MEAS_DESC	C	48	Description of the well measuring point used (e.g., top of casing, file mark on casing, etc.).
DATUM	C	48	Vertical datum used to reference elevations (e.g., MSL and source/date of information).
MATRIX	C	2	Type of sample; water, sediment, soil, other (from Appendix A).
SOURCE_COD	C	2	Physical environment sampled (from Appendix B).
COLLECTMET	C	2	Collection method code (from Appendix C).
FIELD_PH	N	5	The pH value taken at time of sampling (e.g. 11.67)
FIELD_COND	N	7	The conductivity value in umhos.
FIELD_TEMP in	N	5	The field temperature of the sample degrees celsius.
PURGE_METH	C	1	Purging method: B = Bail, P= Pump
PURGE_VOL	C	2	Number of boring volumes removed prior to sampling (liquid).
PRJ_NAME	C	48	Project, site, or facility name.

*** END OF FIELD SAMPLE FILE ***

FIELD DEFINITIONS FOR LABORATORY SAMPLE FILE

*All Fields Required

FIELD	TYPE	WIDTH	DEFINITION
PRI_STA	C	15	Ecology Monitoring Well No. will be assigned by Ecology TCP Program.
STA_ID	C	12	Site well ID no. or other designation.
SAMPLE_DAT	D	8	Date of well sampling (mm/dd/yyyy).
ANALYZ_DAT	D	8	Date the sample was analyzed (mm/dd/yyyy).
SAMPLE_ID	C	8	Sample ID code or no.
LAB_NAME	C	10	Laboratory performing analysis.
LABSAMP_ID	C	10	Sample number assigned by the laboratory.
CONSTITUEN	C	30	Chemical constituent names as defined in Ecology's Chemical Dictionary (see attached Appendix D)
CAS_ID	C	12	Chemical Abstract Systems ID (see Appendix D).
P_CODE	C	5	STORET Parameter Code (see Appendix D).
RESULT	N	12	Detected chemical concentration result.
UNITS	C	10	Units of measurement (e.g., µg/Kg).
QUAL	C	4	Contract Laboratory Program chemical data qualifiers (such as U, J, R, UJ, etc.). Non-Contract Lab Program qualifiers, such as less-than signs ("<") orasterisks, are not acceptable (see Appendix E).
QA_QUAL	C	4	Qualifier associated with QA Review of Lab report (See Appendix E).
LIMIT	C	10	Lab instrument detection limit.

LABORATORY SAMPLE FILE CONTINUED:

FIELD	TYPE	WIDTH	DEFINITION
DILUTION	N	6	Amount the sample was reduced and diluted to accommodate analysis (i.e. 10X,20X).
FILTERED	L	1	Was the sample lab filtered? Yes(Y) or No(N)
ANALYSIS_MTHOD	C	15	EPA Analysis method descriptions (i.e EPA Method 601).
MATRIX	C	2	Type of sample; water, sediment, soil, other (from Appendix A).
PRJ_NAME	C	48	Project, site, or facility name.

*** END OF LABORATORY SAMPLE FILE ***

APPENDIX A: MATRIX CODES

10	Water-Total
11	Water-Dissolved
40	Sediment/Soil
45	Semi-Solid/Sludge
70	Sediment for EP Toxicity
80	Oil/Solvent
00	Other

APPENDIX B: SAMPLE SOURCE CODES AND DESCRIPTIONS

00	Unspecified source
01	Unknown liquid media (drum/tank)
02	Unknown liquid media (spill area)
03	Unknown liquid media (waste pond)
10	Water (general)
12	Ambient stream/river
13	Lake/reservoir
14	Estuary/ocean
15	Spring/seepage
16	Rain
17	Surface runoff/pond (general)
18	Irrigation canal/return flow
20	Well (general)
21	Well (industrial/agricultural)
22	Well (drinking water supply)
23	Well (test/observation/monitoring)
24	Drinking water intake
25	Drinking water (at tap)
30	Effluent wastewater (general)
31	Municipal effluent
32	Municipal inplant waters
33	Sewage runoff/leachate
34	Industrial effluent
35	Industrial inplant waters
36	Industrial surface runoff/pond
37	Industrial waste pond
38	Landfill runoff/pond/leachate
40	Sediment (general)
42	Bottom sediment of deposit
44	Sludge (general)
45	Sludge (waste pond)
46	Sludge (drum/tank)
48	Soil (general)
49	Soil (spill/contaminated area)
50	Bore hole material

Sample Source Codes and Descriptions
(continued)

60	Air (general)
61	Ambient air
62	Source of effluent air
63	Industrial or workroom air
64	Hi-vol filter
70	Tissue (general)
71	Fish tissue
72	Shellfish tissue
73	Bird tissue
74	Mammal tissue
75	Macroinvertebrate
76	Algae
77	Periphyton
78	Plant/vegetation
80	Oil/solvent (general)
81	Oil (transformer/capacitor)
82	Oil/solvent (drum/tank)
83	Oil/solvent (spill area)
84	Oil/solvent (waste pond)
90	Commercial product formulation
95	Well drill water
96	Well drill mud
97	Well sealing material
98	Gravel pack material

APPENDIX C: COLLECTION METHOD CODES

00	Unknown
10	Hand grab
11	Plastic bucket
12	Stainless steel bucket
13	Brass kemmerer
14	PVC kemmerer
15	D.O. dunker
16	DH 48/DH 49 Integrating sampler
17	Van Dorn bottle
18	Glass dip tube
19	Other
20	Automatic sampler (general)
21	ISCO auto sampler
22	Manning auto sampler
23	Hydrostar or similar pump
24	Submersible pump (electric)
25	Well point sampler (pump)
26	Stainless steel bailer (hand)
27	PVC bailer
28	Teflon bailer
29	Peristaltic pump
30	Dredge (unspecified)
31	Dredge (Peterson)
32	Dredge (Van Dorn)
33	Dredge (Van Veen)
34	Core
35	Freeze core
36	Bladder Pump
40	Macroinvertebrate (unspecified)
41	Picked by hand
42	Kick net
43	Surber
44	Modified Hess type sampler
45	Rock basket
46	Hester Dendy sampler
50	Fish (unspecified)
51	Fish (shocking)
52	Fish (netting)
53	Fish (hook & line)
54	Fish (poison)
60	Periphyton (unspecified)
61	Rock scraping
62	Glass slides

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
1,1,1,2-Tetrachloroethane	527.00	77562	630206	µg/L
1,1,1-Trichloroethane	1.00	34506	71556	µg/L
1,1,2,2-Tetrachloroethane	2.00	34516	79345	µg/L
1,1,2,2-Tetrachloroethene	75.05	34475	127184	µg/L
1,1,2-Trichloro2,2,1trifluoroethane	3.00	77652	76131	µg/L
1,1,2-Trichloroethane	4.00	34511	79005	µg/L
1,1-Dichloroethane	5.00	34496	75343	µg/L
1,1-Dichloroethene	6.00	34501	75354	µg/L
1,1-Dichloroethylene	6.01	34501	75354	µg/L
1,1-Dichloropropene	546.00	77168	563586	µg/L
1,2,3-Trichlorobenzene	534.00	77613	87616	µg/L
1,2,3-Trichloropropane	441.00	81610	96184	µg/L
1,2,3-Trinitrobenzene	85.00	73275	99354	µg/Kg
1,2,4-Trichlorobenzene	7.00	34551	120821	µg/L
1,2,4-Trimethylbenzene	536.00	77222	95636	µg/L
1,2,4-Trinitrobenzene	100.00			
1,2-Dibromoethane (EDB)	8.00	77651	106934	µg/L
1,2-Dichlorobenzene	9.00	34536	95501	µg/L
1,2-Dichloroethane	10.00	34531	107062	µg/L
1,2-Dichloromethane	68.01	34423	75092	µg/L
1,2-Dichloropropane	11.00	34541	78875	µg/L
1,2-Diethoxyethane	482.00	81527	629141	µg/L
1,2-Diethylbenzene	548.00	77340	135013	µg/L
1,2-Dimethylbenzene	77.02	77135	95476	µg/L
1,2-Dimethylhydrazine	582.00	73562	540738	µg/L
1,2-Diphenylhydrazine	84.00	34346	122667	µg/L
1,3,5-Trimethylbenzene	541.00	77226	108678	µg/L
1,3,5-Trinitrobenzene	156.00	73275	99354	µg/Kg
1,3-Dichlorobenzene	12.00	34566	541731	µg/L
1,3-Dichloropropene	544.00	34561	542756	µg/L
1,3-Diethylbenzene	549.00	77348	141935	µg/L
1,3-Dimethylbenzene	67.01	77134	108383	µg/L
1,4-Dichlorobenzene	13.00	34571	106467	µg/L
1,4-Diethylbenzene	550.00	77345	105055	µg/L
1,4-Dimethylbenzene	475.03	77133	106423	µg/L
1,4-Dioxane	583.00	82388	123911	mg/L
1-Methylethyl ester carbamic acid	574.00	73615	615532	µg/L
1-Methylnapthalene	211.00	77418	90120	µg/L
2 Methoxy-5-nitroaniline	584.00	73622	99558	µg/L
2 Methylaniline	585.00	77142	95534	µg/L
2 Methylaniline hydrochloride	586.00	73649	636215	µg/L
2,2,4-Trimethylpentane	545.00		5408401	
2,2-Dichloropropane	547.00	77170	594207	µg/L
2,3,4,6-Tetrachloropheno	1553.00	77767	4901513	µg/L
2,3,6-Trichloro benzeneacetic acid	575.00	85347		
2,3,7,8-TCDD	87.02	34675	1746016	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
2,3,7,8-Tetrachlorodibenzo-p-dioxin	87.00	34675	1746016	µg/L
2,3-Dichloropropylene	88.00	77166	78886	µg/L
2,4,5-T Methyl Ester	89.00	39740	93765	µg/L
2,4,5-TB	554.00	82650	93801	µg/Kg
2,4,5-TP (Silvex)	91.00	39760	93721	µg/L
2,4,5-TP Methyl Ester	90.00			
2,4,5-Trichlorophenol	14.00	77687	95954	µg/L
2,4,5-Trichlorophenoxyacetic acid	319.00	39740	93765	µg/L
2,4,6-Trichlorophenol	15.00	34621	88062	µg/L
2,4,6-Trimethyl-1-1,3,5-Trioxane	92.00	77322	123637	µg/L
2,4-D	93.00	39730	94757	µg/L
2,4-D Methyl Ester	93.01	39730	94757	µg/L
2,4-DB (Water, Total)	555.00	38745	94826	µg/L
2,4-Dichlorophenol	16.00	34601	120832	µg/L
2,4-Dichlorophenoxy butyric acid	235.00		94826	µg/L
2,4-Dimethylphenol	17.00	34606	105679	µg/L
2,4-Dinitrophenol	18.00	34616	51285	µg/L
2,4-Dinitrotoluene	19.00	34611	121142	µg/L
2,4-Toluenediamine	587.00	78888	95807	µg/L
2,5-Dinitrotoluene	94.00	77637	619158	µg/L
2,6-Dinitrotoluene	20.00	34626	606202	µg/L
2-Butanone	376.03	81595	78933	µg/L
2-Chloroethyl vinyl ether	22.00	34576	110758	µg/L
2-Chloronaphthalene	23.00	34581	91587	µg/L
2-Chlorophenol	24.00	34586	95578	µg/L
2-Chlorotoluene	535.00	38680	95498	µg/L
2-Cyclohexene-1-one	488.00	930697		
2-Ethyl hexanoic acid	196.00	82114	149575	µg/L
2-Hexanone	25.00	77103	591786	µg/L
2-Methyl-2H-benzotriazole	576.00	85813	29385431	µg/L
2-Methyl-4,6-dinitrophenol	96.00	34657	534521	µg/L
2-Methyl-4-chlorophenoxyacetic acid	367.02	39151	94746	µg/L
2-Methyl-4-pentanone	95.00	78133	108101	µg/L
2-Methyl-p-cresol	17.01	34606	105679	µg/L
2-Methylnaphthalene	26.00	77416	91576	µg/L
2-Methylphenol	27.00	77152	95487	µg/L
2-Nitroaniline	28.00	30195	88744	µg/L
2-Nitrophenol	29.00	34591	88755	µg/L
2-Pentanone	97.00	77060	107879	µg/L
2-chloro-1-hydroxybenzene	24.02	34586	95978	µg/L
3,3'-Dichlorobenzidine	98.00	34631	91941	µg/L
3,3-Dimethoxybenzidine	588.00		199904	µg/L
3,3-Dimethylbenzidine	589.00	73560	119937	µg/L
3,4-Benzofluoranthene	99.00	34230	205992	µg/L
3,4-Dichlorobenzyl N-methylcarbama+	571.00		1966581	µg/L
3,5-Dichlorobenzoic acid	240.00		51365	µg/L
3-Chloro octane	528.00			

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
3-Nitroaniline	30.00	78300	99092	µg/L
4,4'-DDD	208.01	39360	72548	µg/L
4,4'-DDE	209.01	39365	72559	µg/L
4,4'-DDT	210.01	39370	50293	µg/L
4,4-Methylene bis(n,n-dimethyl) an +	592.00	101611		µg/L
4,6-Dinitro-2-methylphenol	96.01	34657	534521	µg/L
4,6-Dinitrophenol	101.00	82226	88857	µg/L
4,7-Methanoisobenzofuran-1(3H) -one +	570.00			µg/L
4-Bromophenoxybenzene	102.00			
4-Bromophenyl phenyl ether	103.00	34636	101553	µg/L
4-Chloro-2-methyl analine hydrochl +	590.00		3165933	µg/L
4-Chloro-2-methyl aniline	591.00		95692	µg/L
4-Chloro-3-methylphenol	31.00	34452	59507	µg/L
4-Chloro-m-cresol	31.01	34452	59507	µg/L
4-Chloroaniline	464.00	78303	106478	mg/Kg
4-Chlorophenyl phenyl ether	33.00	34641	7005723	µg/L
4-Chlorotoluene	540.00	77277	106434	µg/L
4-Methyl-2-pentanone	34.00	78133	108101	µg/L
4-Methyl-o-cresol	17.02	34606	105679	µg/L
4-Methylphenol	35.00	77146	106445	µg/L
4-Nitroaniline	36.00	73278	100016	µg/Kg
4-Nitrophenol	37.00	34646	100027	µg/L
5-Bromopyrimidine	104.00			
5-Hydroxy Dicamba	256.00			µg/L
AAtrex	281.01	39033	1912249	µg/L
Acenaphthene	38.00	34205	83329	µg/L
Acenaphthylene	39.00	34200	208968	µg/L
Acephate	385.02	81815	30560191	µg/L
Acetone	40.00	81552	67641	µg/L
Acifluorfen	215.00	79193	6247659	µg/L
Acrolein	105.00	34210	107028	µg/L
Acrylamide	593.00	38576	79061	µg/L
Acrylonitrile	106.00	34215	107131	µg/L
Alachlor	273.00	77825	15972608	µg/L
Alanex	273.01	77825	15972608	µg/L
Aldicarb	274.00	39053	116063	µg/L
Aldicarb sulfone	320.00	82587	1646884	µg/L
Aldicarb sulfoxide	318.00	82586	1646873	µg/L
Aldrin	107.00	39330	309002	µg/L
Alkalinity as CaCO3, Total	453.00	00410	471341	mg/L
Alkalinity, Total (CaCO3)	246.00	00410	471341	mg/l
Alpha Particle Activity, gross	611.00	01519	12587461	pCi/L
Aluminum, Dissolved	511.00	01106	7429905	µg/L
Aluminum, Total	510.00	01105	7429905	µg/L
Aluminum, Total Recoverable	108.00	01104	7429905	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Ametryn	275.00	82184	834128	µg/L
Amiben	276.00	82051	133904	µg/L
Aminocarb	277.00	38404	2032599	µg/L
Aminotriazole	278.00	73509	61825	µg/L
Amitrole	278.01	73509	61825	µg/L
Ammonia-N, Total as-N	109.00	00610	17778880	mg/L
Aniline	110.00	77089	62533	µg/L
Anion Balance	111.00			
Anthracene	112.00	34220	120127	µg/L
Antimony, Dissolved	524.00	01095	7440360	µg/L
Antimony, Total	113.00	01097	7440360	µg/L
Antimony, Total Recoverable	21.00	01268	7440360	µg/L
Aqualin	105.01	34210	107028	µg/L
Aramite	594.00		140578	µg/L
Aroclor 1016	114.00	34671	12674112	µg/L
Aroclor 1221	115.00	39488	1104282	µg/L
Aroclor 1232	116.00	39492	11141165	µg/L
Aroclor 1242	117.00	39496	53469219	µg/L
Aroclor 1248	118.00	39500	12672296	µg/L
Aroclor 1254	119.00	39504	11097691	µg/L
Aroclor 1260	120.00	39508	11096825	µg/L
Arsenic, Dissolved	322.00	01000	7440382	µg/L
Arsenic, Inorganic (dissolved)	121.00	01000	7440382	µg/L
Arsenic, Total	137.00	01002	7440382	µg/L
Arsenic, Total Recoverable	122.00	00978	7440382	µg/L
Asbestos	123.00	34225	1332214	µg/L
Atraton	280.00	82185	1610179	µg/L
Atrazine	281.00	39033	1912249	µg/L
Avadex	532.00	73386	2303164	mg/Kg
Avenge	330.01	78882	43222486	µg/L
Azinphos-Ethyl	282.00	81292	2642719	µg/L
Azinphos-Methyl (Guthion)	359.01	39580	86500	µg/L
Azobenzene	595.00	77625	103333	µg/L
Azodrin	383.01	81890	6923224	µg/L
BFB	459.00			%
BHC	132.00	81283	608731	µg/L
BOD	499.01	00310		mg/L
Balan	283.00	39002	1861401	µg/L
Banvel	284.00	82052	1918009	µg/L
Barium, Dissolved	508.00	01005	7440393	µg/L
Barium, Total	509.00	01007	7440393	µg/L
Barium, Total Recoverable	124.00	01009	7440393	µg/L
Basagran	286.01	38710	25057890	µg/L
Basalin	354.01	79194	3324539	µg/L
Basanite	337.01	81287	88857	µg/L
Baygon	424.01	38537	114261	µg/L
Baymix	307.02	81293	56724	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Baytex	351.01	38685	55389	µg/L
Benefin	283.01	39002	1861401	µg/L
Benfluralin	283.02	39002	1861401	µg/L
Benlate	285.01	38705	17804352	µg/L
Benomyl	285.00	38705	17804352	µg/L
Bensulide	288.01	82197	741582	µg/L
Bentazon	286.00	38710	25057890	µg/L
Benz(a)anthracene	130.01	34526	56553	µg/L
Benzene	41.00	34030	71432	µg/L
Benzene, 1-chloro-4-(methylsulfony +	572.00			
Benzidine	125.00	39120	92875	µg/L
Benzo(a)anthracene	130.00	34526	56553	µg/L
Benzo(a)pyrene	126.00	34247	50328	µg/L
Benzo(b)fluoranthene	127.00	34230	205992	µg/L
Benzo(b/k)fluoranthene	531.00	34242	207089	µg/L
Benzo(g,h,i)perylene	128.00	34521	191242	µg/L
Benzo(ghi)perylene	128.01	34521	191242	µg/L
Benzo(k)fluoranthene	129.00	34242	207089	µg/L
Benzoic acid	42.00	77247	65850	µg/L
Benzol	41.01	34030	71432	µg/L
Benzotrichloride	596.00		98077	µg/L
Benzyl alcohol	43.00	77147	100516	µg/L
Benzyl chloride	597.00	73520	100447	µg/L
Beryllium, Dissolved	515.00	01010	7440417	µg/L
Beryllium, Total	514.00	01012	7440417	µg/L
Beryllium, Total Recoverable	131.00	00998	7440417	µg/L
Beta Particle Activity, gross	612.00	85817	12587472	pCi/L
Betasan	288.00	82197	741582	µg/L
Bicarbonate as CaCO3	454.00	00425	471341	mg/L
Bicarbonate as HCO3	133.00	00440	71523	mg/L
Bidrin	328.01	38454	141662	µg/L
Bifenox	382.01	78883	42576023	µg/L
Biochemical Oxygen Demand	499.00	00310		mg/L
Bis(2-chloroethoxy)methane	44.00	34278	111911	µg/L
Bis(2-chloroethyl)ether	45.00	34273	111444	µg/L
Bis(2-chloroisopropyl)ether	46.00	34283	108601	µg/L
Bis(2-ethylhexyl) ester hexanedioi +	577.00	103321		
Bis(2-ethylhexyl)phthalate	140.00	39100	117817	µg/L
Bis(chloromethyl)ether	598.00	34268	542881	µg/L
Bis(n-octyl)phthalate	465.01	34596	117840	µg/L
Boron	134.00	01020	7440428	µg/L
Bravo	313.02	70314	1897456	µg/L
Bromacil	289.00	82198	314409	µg/L
Bromex	386.01	38855	300765	µg/L
Bromide(dissolved)	135.00	82298	24959679	µg/L
Bromobenzene	542.00	81555	108861	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Bromochloromethane	533.00	32105	124481	µg/L
Bromodichloromethane	47.00	32101	75274	µg/L
Bromoform	48.00	32104	75252	µg/L
Bromomethane	49.00	34413	74839	µg/L
Bromoxynil (Water, Whole)	556.00	70979	1689845	µg/L
Butachlor, Water/Whole/Recoverable	633.00	30235	23184669	µg/L
Butanone	376.02	81595	78933	µg/L
Butyl benzyl phthalate	136.00	34292	85687	µg/L
Butylate	290.00	81410	2008415	µg/L
Butylbenzenes, Total	292.01	45049		µg/L
C3-Alkylbenzenes, Total	291.00	45046		µg/L
C4-Alkylbenzenes, Total	292.00	45049		µg/L
CEC	161.01	81356		meq/100G
CIPC	305.01	81322	101213	µg/L
COD	492.01	81319		mg/L
Cadmium, Dissolved	406.00	01025	7440439	µg/L
Cadmium, Total	407.00	01027	7440439	µg/L
Cadmium, Total Recoverable	138.00	01113	7440439	µg/L
Calcium	521.00	00910	7440702	mg/L as CaCO3
Calcium, Dissolved	520.00	00915	7440702	mg/L
Calcium, Total	141.00	00916	7440702	mg/L
Camphor (ACN)	287.00	81324	76222	µg/L
Captan	293.00	39640	133062	µg/L
Carbaryl	294.00	77700	63252	µg/L
Carbazole	329.00	77571	86748	µg/L
Carbendazim	295.00	38735	10605217	µg/L
Carbofuran	296.00	81405	1563662	µg/L
Carbon disulfide	50.00	77041	75150	µg/L
Carbon tetrachloride	51.00	32102	56235	µg/L
Carbon, Total Organic	250.00	00680	7440440	µg/L
Carbonate as CO3	142.00	00445	3812326	mg/L
Carbonate as CaCO3	455.00	00430	471341	mg/L
Carbophenothion	297.00	39786	786196	µg/L
Carboxin	139.00	70987	5234684	µg/L
Cation Balance	143.00			
Cation Exchange Capacity	161.00	81356		meq/100G
Chemical Oxygen Demand	492.00	81319		mg/L
Chloramben	276.01	82051	133904	µg/L
Chlordane	144.00	39350	57749	µg/L
Chlordecon	298.00	81281	143500	µg/L
Chlordimeform	299.00	77953	6164983	µg/L
Chloride, Total	145.00	00940	16887006	mg/L
Chlorine, Total Residual	146.00	50060	7782505	mg/L
Chlorobenzene	52.00	34301	108907	µg/L
Chlorobenzilate	300.00	39460	510156	µg/L
Chlorocyclohexane	86.00	77217	542187	µg/L
Chlorodibromomethane	58.01	32105	124481	µg/L
Chloroethane	53.00	34311	75003	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Chloroethene	82.03	39175	75014	µg/L
Chloroethylene	82.02	39175	75014	µg/L
Chloroform	54.00	32106	67663	µg/L
Chloromethane	55.00	34418	74873	µg/L
Chloroneb	301.00	38423	2675776	µg/L
Chloropicrin	303.00	77548	76062	µg/L
Chloropropham	305.00	81322	101213	µg/L
Chloropropylate	302.00	38429	5836102	µg/L
Chlorothalonil	313.01	70314	1897456	µg/L
Chlorpyrifos	304.00	77969	2921882	µg/L
Chlorthal	314.02	39770	1861321	µg/L
Chromium VI	506.01	01032	18540299	µg/L
Chromium, Dissolved	516.00	01030	7440473	µg/L
Chromium, Hexavalent	506.00	01032	18540299	µg/L
Chromium, Total	491.00	01034	7440473	µg/L
Chromium, Total Recoverable	147.00	01118	7440473	µg/L
Chrysene	148.00	34320	218019	µg/L
Cinnamene	74.03	77128	100425	µg/L
Ciodrin	306.00	82565	7700176	µg/L
Co-Ral	307.01	81293	56724	µg/L
Cobalt	149.00	01037	7440484	µg/L
Coliform, Fecal	505.01	31616		#/100ml
Coliform, Total	150.00	31628		#/100ml
Color	599.00		00080	std. units
Conductivity	449.02		00094	µmhos/cm
Copper, Dissolved	408.00	01040	7440508	µg/L
Copper, Total	442.00	01042	7440508	µg/L
Copper, Total Recoverable	152.00	01119	7440508	µg/L
Corrosivity	600.00			std. units
Coumaphos	307.00	81293	56724	µg/L
Creosote	308.00	39140	8801589	µg/L
Crotoxyphos	306.01	82565	7700176	µg/L
Cumene	309.00	77223	98828	µg/L
Cyanazine	310.00	81757	21725462	µg/L
Cyanide	153.00	78248	57125	µg/L
Cyanide, Dissolved Std Method	279.00	00723	57125	µg/L
Cycloate	311.00	81892	1134232	µg/L
Cyclohexane	254.00	81570	110827	µg/L
D-D Mix	441.01	81610	96184	µg/L
DBCP	315.00	38761	96128	µg/L
DCNA	316.00	38447	99309	µg/L
DCOD	168.01	80116		mg/L
DCPA	314.01	39770	1861321	µg/L
DDD	208.00	39360	72548	µg/L
DDE	209.00	39365	72559	µg/L
DDT	210.00	39370	50293	µg/L
DDVP	317.00	73071	62737	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
DEF	324.00	81295	78488	µg/L
DMPA	336.00	81285	299854	µg/L
DNBP	337.00	81287	88857	µg/L
DNOC	338.00	34657	534521	µg/L
DO	169.01	00299	7782447	mg/L
Daconil	313.00	70314	1897456	µg/L
Dacthal	314.00	39770	1861321	µg/L
Dalapon	312.00	38432	75990	µg/L
Dasanit	350.01	38684	115902	µg/L
Demeton	325.00	39560	8065483	µg/L
Devrinol	387.01	79195	1529999	µg/L
Di-n-butylphthalate	155.00	39110	84742	µg/L
Di-n-octylphthalate	465.00	34596	117840	µg/L
Diallate	532.01	73386	2303164	mg/Kg
Diazinon	158.00	39570	333415	µg/L
Dibenz(a,h)anthracene	159.01	34556	53703	µg/L
Dibenz(a,h)anthracene-d	14557.00	79040	53703	mg/Kg
Dibenzo(a,h)anthracene	159.00	34556	53703	µg/L
Dibenzofuran	57.00	81302	132649	µg/L
Dibromochloromethane	58.00	32105	124481	µg/L
Dibromochloropropane	315.01	38761	96128	µg/L
Dibromodichloromethane	489.00	77779	594183	µg/L
Dibromomethane	160.00	81522	106934	µg/L
Dicamba	284.01	82052	1918009	µg/L
Dichloran	316.01	38447	99309	µg/L
Dichlorobromomethane	47.01	32101	75274	µg/L
Dichlorodifluoromethane	162.00	34668	75718	µg/L
Dichloromethane	68.02	34423	75092	µg/L
Dichloroprop	244.00	30190	120365	µg/L
Dichlorvos (DDVP)	317.01	73071	62737	µg/L
Dicofol	327.00	39780	115322	µg/L
Dicrotophos	328.00	38454	141662	µg/L
Dicyclopropyl methanone	579.00			µg/L
Dieldrin	164.00	39380	60571	µg/L
Diesel	472.00	78939	68476346	µg/L
Diethyl ether	165.00	81576	60297	µg/L
Diethylphthalate	59.00	34336	84662	µg/L
Diethylphthalate-d4	558.00			
Difenson	397.01	39022	80331	µg/L
Difenzoquat	330.00	78882	43222486	µg/L
Diisopropyl ether	154.00	81577	108203	µg/L
Dimecron	414.01	78881	13171216	µg/L
Dimethoate	331.00	46314	60515	µg/L
Dimethyl ketone	40.02	81552	67641	µg/L
Dimethyldisulfide	166.00	81580	624920	µg/L
Dimethylphthalate	60.00	34341	131113	µg/L
Dimethyltetrachlorophthalate	314.03	39770	1861321	µg/L
Dinitro-o-cresol	338.01	34657	534521	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Dinoseb	337.02	81287	88857	µg/L
Dioxathion	332.00	38783	78342	µg/L
Dioxin	87.01	34675	1746016	µg/L
Diphenamide	333.00	78004	957517	µg/L
Diphenoloxide	167.00	77587	101848	µg/L
Diquat	334.00	78885	85007	µg/L
Direct Black 38	601.00			µg/L
Direct Blue 6	602.00		2602462	µg/L
Direct Brown 95	603.00		16071866	µg/L
Dissolved COD	168.00		80116	mg/L
Dissolved Oxygen	169.00	00299	7782447	mg/L
Dissolved TOC	170.00	00679	7440440	kg/100GAL
Disufoton sulfone	642.00			µg/L
Disulfoton (Di-Syston)	171.00	81888	298044	µg/L
Disulfoton sulfoxide	643.01	81030	2497076	µg/L
Dithane	365.01	38831	8018017	µg/L
Dithiocarbamate	446.01	38917	137304	µg/L
Diuron	335.00	39650	330541	µg/L
Dowpon	312.01	38432	75990	µg/L
Dursban	304.01	77969	2921882	µg/L
Dyfonate	339.00	81294	944229	µg/L
Dylox	340.00	39014	52686	µg/L
EC	449.01	00094		µmhos/cm
EDB	8.01	77651	106934	µg/L
EPN	344.00	81290	2104645	µg/L
EPTC	345.00	81894	759944	µg/L
Endosulfan	341.00	34361	959988	µg/L
Endosulfan I	341.01	34361	959988	µg/L
Endosulfan II	342.00	34356	33213659	µg/L
Endosulfan Sulfate	172.00	34351	1031078	µg/L
Endothall	343.00	38926	145733	µg/L
Endrin	174.00	39390	72208	µg/L
Endrin Aldehyde	173.00	34366	7421934	µg/L
Endrin Ketone	490.00	78008	53494705	µg/L
Enide	333.01	78004	957517	µg/L
Epichlorohydrin	604.00	106898		µg/L
Eptam	345.01	81894	759944	µg/L
Etazine	428.01	38542	26259450	µg/L
Ethanol	346.00	77004	64175	µg/L
Ethenylbenzene	74.04	77128	100425	µg/L
Ethion	175.00	39398	563122	µg/L
Ethoprop	634.00	81758	13194484	µg/L
Ethyl acetate	176.00	81585	141786	µg/L
Ethyl acrylate	605.00		140885	µg/L
Ethyl alcohol	346.01	77004	64175	µg/L
Ethyl isopropyl ketone	95.01	78133	108101	µg/L
Ethylan	411.01	39034	72560	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Ethylbenzene	61.00	34371	100414	µg/L
Ethylene dibromide	8.02	77651	106934	µg/L
Ethylene dichloride	10.01	34531	107062	µg/L
Ethylene glycol	347.00	77023	107211	µg/L
Ethylene thiourea	348.01	38928	96457	µg/L
Ethylidene thiourea	348.00	38928	96457	µg/L
Evik	275.01	82184	834128	µg/L
Fecal Coliform, MFM-FCBR	505.00	31616		#/100ml
Fenamiphos	349.00	38929	22224926	µg/L
Fenarimol	635.00			µg/L
Fensulfothion	350.00	38684	115902	µg/L
Fenthion	351.00	38685	55389	µg/L
Fenuron	352.00	38468	101428	µg/L
Ferbam	353.00	38806	14484641	µg/L
Ferric(3+)	188.01	01045	7439896	µg/L
Ferrous(2+)	188.02	01045	7439896	µg/L
Fluchloralin	354.00	79194	3324539	µg/L
Fluoranthene	177.00	34376	206440	µg/L
Fluorene	62.00	34381	86737	µg/L
Fluorescein(Sodium)	178.00		518478	
Fluoride	179.00	00950	16984488	mg/L
Fluormeturon	355.00	38811	2164172	µg/L
Fluridone	636.00		59756604	µg/L
Foaming Agents	606.00	01288		mg/L
Folex	369.01	39019	150505	µg/L
Folpet	607.00	46351	133073	µg/L
Fonofos	339.01	81294	944229	µg/L
Formaldehyde	356.00	71880	50000	mg/L
Freon 113	3.01	77652	76131	µg/L
Freon 12, Halon	162.01	34668	75718	µg/L
Furadan	296.01	81405	1563662	µg/L
Furazolidone	608.00	67458		µg/L
Furium	609.00			µg/L
Furmecyclox	610.00		60568050	µg/L
Gardona	581.01	38877	961115	
Gardoprim	436.01	38559	5915413	µg/L
Gasoline	471.00		6842596	
Gesatamin	280.01	82185	1610179	µg/L
Glyphosate	358.00	79743	1071836	µg/L
Grain alcohol	346.02	77004	64175	µg/L
Guthion	359.00	39580	86500	µg/L
Hardness, Total	248.00	00900	471341	mg/L CaCO3
Heptachlor	181.00	39410	76448	µg/L
Heptachlor Epoxide	180.00	39420	1024573	µg/L
Heptene	182.00	81589	25339564	µg/L
Hexachlorobenzene	183.00	39700	118741	µg/L
Hexachlorobutadiene	63.00	34391	87683	µg/L

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Hexachlorocyclohexane	132.01	81283	608731	µg/L
Hexachlorocyclohexane (alpha)	265.04	39337	319846	µg/L
Hexachlorocyclopentadiene	64.00	34386	77474	µg/L
Hexachloroethane	65.00	34396	67721	µg/L
Hexazinone	360.00	38815	51235042	µg/L
Hydram	394.02	82199	2212671	µg/L
Hydrazine	184.00	81313	302012	mg/L
Hydrocarbons, Total	473.00	81336		mg/L
Hydrocarbons, Total Fuel	462.00			
Hydrocarbons, Total Petroleum	461.00	46116	14280309	mg/L
Hydroxide	185.00	71830	14280309	mg/L
Hydroxide as CaCO3	456.00			
Hyvar	289.01	82198	314409	µg/L
IPC	423.01	39052	122429	µg/L
Imidan	361.00	39800	732116	µg/L
Indeno(1,2,3-cd)pyrene	186.00	34403	193395	µg/L
IntStd: 2,4,6-Tribromophenol	559.00	34719	118796	µg/L
IntStd: Hexabromobenzene	560.00			
Ion Balance	451.00			%
Ioxynil	561.00		16898341	µg/L
Iron, Dissolved	323.00	01046	7439896	µg/L
Iron, Total	188.00	01045	7439896	µg/L
Iron, Total Recoverable	362.00	00980	7439896	µg/L
Isobutylbenzene	552.00	77334	538932	µg/L
Isophorone	66.00	34408	78591	µg/L
Isopropyl carbanilate	423.02	39052	122429	µg/L
Isopropylbenzene (Cumene)	309.01	77223	98828	µg/L
Karmex	335.01	39650	330541	µg/L
Kepone	298.01	81281	143500	µg/L
Kerb	419.01	39080	23950585	mg/Kg
Kerosene	363.00	78878	8008206	µg/L
Kjeldahl-N, Total	249.00	00625	17778880	mg/L as N
Langlier Index	500.00			
Lead, Dissolved	402.00	01049	7439921	µg/L
Lead, Organic	463.00			
Lead, Total	403.00	01051	7439921	µg/L
Lead, Total Recoverable	189.00	01114	7439921	µg/L
Lindane	357.01	39340	58899	µg/L
Linuron	364.00	39530	330552	µg/L
Lithium	466.00	01130	7439932	µg/L
Lorsban	304.02	77969	2921882	µg/L
MBAS	233.01	34790	7429905	mg/L
MCPA	367.00	39151	94746	µg/L
MCPA Dimethylamine Salt	367.01	39151	94746	µg/L
MCPB	368.00	38486	94815	µg/L
MCPP (Water, Total)	562.00	38491	93652	µg/L
MEK	376.01	81595	78933	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
MIBK	34.02	78133	108101	µg/L
MSMA	385.00	38935	2163806	µg/L
Magnesium as CaCO3	519.00	00920	7439954	mg/L
Magnesium, Dissolved	518.00	00925	7439954	mg/L
Magnesium, Total	191.00	00927	7439954	mg/L
Malathion	192.00	39530	121755	µg/L
Mancozeb	365.00	38831	8018017	µg/L
Maneb	366.00	38835	12427382	µg/L
Manganese, Dissolved	404.00	01056	7439965	µg/L
Manganese, Total	193.00	01055	7439965	µg/L
Manganese, Total Recoverable	405.00	01123	7439965	µg/L
Matacil	277.01	38404	2032599	µg/L
Mercury, Dissolved	477.00	71890	7439976	µg/L
Mercury, Total	476.00	71900	7439976	µg/L
Mercury, Total Recoverable	194.00	71901	7439976	µg/L
Merphos	369.00	39019	150505	µg/L
Mesitylene	370.00	77226	108678	µg/L
Metasystox	371.00	39020	8022002	µg/L
Methidathion	374.00	78879	950378	µg/L
Methiocarb	373.00	38500	2032657	µg/L
Methomidophos	372.00	38927	10265926	µg/L
Methomyl	375.00	39051	16752775	µg/L
Methoxychlor	195.00	39480	72435	µg/L
Methyl Phenols, Total	378.00	45058	1319773	µg/L
Methyl Trithion	197.00	39790	953173	µg/L
Methyl Xylenes, Total	444.01	78136	25551137	µg/L
Methyl bromide	49.01	34413	74839	µg/L
Methyl chloride	55.01	34418	74873	µg/L
Methyl ethyl ketone	376.00	81595	78933	µg/L
Methyl isobutyl ketone	34.01	78133	108101	µg/L
Methyl ketone	40.03	81552	67641	µg/L
Methyl n-butyl ketone	25.01	77103	591786	µg/L
Methyl n-propyl ketone	97.01	77060	107879	µg/L
Methyl paraoxon	637.00			µg/L
Methylbenzene	76.01	34010	108883	µg/L
Methylcyclohexane	198.00	77100	108872	µg/L
Methylene Blue Active Substances	493.00	38260	61734	
Methylene bromide	160.01	81522	106934	µg/L
Methylene chloride	68.00	34423	75092	µg/L
Metolachlor	163.00		51218452	µg/L
Metribuzin	379.00	81408	21087649	µg/L
Mevinphos	413.01	39610	7786347	µg/L
Mexacarbate	380.00	38507	315184	µg/L
Mirex	381.00	39755	2385855	µg/L
Modown	382.00	78883	42576023	µg/L
Molinate	394.01	82199	2212671	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Molybdenum	467.00	01060	7439987	µg/L
Monitor	372.01	38927	10265926	µg/L
Monochloroethene	82.04	38175	75014	µg/L
Monochloroethylene	82.01	39175	75014	µg/L
Monocrotophos	383.00	81890	6923224	µg/L
Monsodium methyl arsonate	385.01	38935	2163806	µg/L
Monuron	384.00	38511	150685	µg/L
N-Nitroso-N-methylethylamine	613.00	73613	10595956	µg/L
N-Nitroso-di-n-butylamine	614.00	73609	924163	µg/L
N-Nitroso-di-n-propylamine	69.00	34428	621647	µg/L
N-Nitrosodiethanolamine	615.00	73610	1116547	µg/L
N-Nitrosodiethylamine	616.00	73611	55185	µg/L
N-Nitrosodimethylamine	392.00	34438	62759	µg/L
N-Nitrosodiphenylamine	199.00	34433	86306	µg/L
N-Nitrosopyrrolidine	617.00	78206	930552	µg/L
NH3-N, Total	109.01	00610	17778880	mg/L as N
NO3 + NO2-N, Total	321.01	00630	17778880	mg/L as N
Naled	386.00	38855	300765	µg/L
Naphthalene	70.00	34696	91203	µg/L
Napropamide	387.00	79195	1529999	µg/L
Neburon	388.00	38521	555373	µg/L
Nemacure	349.01	38929	22224926	µg/L
Nickel, Dissolved	481.00	01065	7440020	µg/L
Nickel, Total	483.00	01067	7440020	µg/L
Nickel, Total Recoverable	200.00	01074	7440020	µg/L
Nitrate + Nitrite-N, Total	321.00	00630	17778880	mg/L as N
Nitrate-N	452.00	00620	17778880	mg/L as N
Nitrite-N	202.00	00615	17778880	mg/L as N
Nitrobenzene	71.00	34447	98953	µg/L
Nitrofen	389.00	81303	1836755	µg/L
Nitrofurazone	618.00	59870		µg/L
Nitroguanidine	203.00	79753	556887	µg/L
Nonadecane	391.00	77822	629925	µg/L
Norflurazon, in Water	639.00	78064		µg/L
OBPA	206.00	58366		
Octachloronaphthalene	563.00		2234131	µg/L
Odor	619.00			std. units
Oil & Grease	207.00	03582		mg/L
Ordram	394.00	82199	2212671	µg/L
Orthene	395.00	81815	30560191	µg/L
Oryzalin	396.00	78884	19044883	µg/L
Ovex	397.00	39022	80331	µg/L
Oxamyl	398.00	38865	23135220	µg/L
Oxydisulfoton (Disyston Sulphoxide)	643.00	81030	2497076	µg/L
PAH (Polyaromatic hydrocarbons)	620.00			µg/L
PBB (Polybrominated Biphenyls)	621.00		59536651	µg/L
PCB	219.01	76012	1336363	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
PCB-1016	114.01	34671	12674112	µg/L
PCB-1221	115.01	39488	1104282	µg/L
PCB-1232	116.01	39492	11141165	µg/L
PCB-1242	117.01	39496	53469219	µg/L
PCB-1248	118.01	39500	12672296	µg/L
PCB-1254	119.01	39504	11097691	µg/L
PCB-1260	120.01	39508	11096825	µg/L
PCE	75.01	34475	127184	µg/L
PCNB	409.00	39029	81316	µg/L
PCP	213.01	39032	87865	µg/L
PID Reading	470.00			
Paraquat	399.00	82416	4685147	µg/L
Parathion	212.00	39540	56382	µg/L
Parathion, Ethyl-	400.00	46315	56382	µg/L
Parathion, Methyl-	401.00	39600	298000	µg/L
Pebulate, Water, Whole	640.00	79192		µg/L
Pendimethalin	222.02	79190	40487421	µg/L
Penoxalin	222.00	82410	40487421	µg/L
Pentachlorobenzene	410.00	77793	608935	µg/L
Pentachlorophenol	213.00	39032	87865	µg/L
Perchlorate	214.00			
Perchloroethene	75.03	34475	127184	µg/L
Perchloroethylene	75.02	34475	127184	µg/L
Persulfate-N, Total	580.00		7727540	µg/L
Perthane	411.00	39034	72560	µg/L
Phenanthrene	216.00	34461	85018	µg/L
Phencapton (Water, Whole)	564.00	81289	2275141	µg/L
Phenol	73.00	34694	108952	µg/L
Phenol, 4-AAP	217.00		108952	
Phenylethylene	74.02	77128	100425	µg/L
Phorate	218.00	46313	298022	µg/L
Phosalone	412.00	81291	2310170	µg/L
Phosdrin	413.00	39610	7786347	µg/L
Phosmet	361.01	39800	732116	µg/L
Phosphamide	331.01	46314	60515	µg/L
Phosphamidon	414.00	78881	13171216	µg/L
Phosphate-P, Diss Ortho	498.00	00671	7723140	mg/L as P
Phosphate-P, Ortho	205.00	00660	14265442	mg/L as PO 4
Phosphorodithioic acid, O,O,S-trim +	573.00	39580	86500	µg/L
Phosphorous-P, Total	251.00	00665	7723140	mg/L as P
Picloram	257.00	39720	1918021	µg/L
Polychlorinated biphenyl	219.00	76012	1336363	µg/L
Potassium, Dissolved	517.00	00935	7440097	mg/L
Potassium, Total	220.00	00937	7440097	mg/L
Princep	430.01	39055	122349	µg/L
Profluralin	415.00	38872	26399360	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Prometon	416.00	39056	1610180	µg/L
Prometryn	417.00	39057	7287196	µg/L
Pronamide	419.00	39080	23950585	µg/L
Propachlor	418.00	38533	1918167	µg/L
Propane	420.00	82358	74986	µg/L
Propanone	40.01	81552	67641	µg/L
Propargite	421.00	82065	2312358	mg/L
Propazine	422.00	39024	139402	µg/L
Propham	423.00	39052	122429	µg/L
Propoxur	424.00	38537	114261	µg/L
Propylbenzenes, Total	291.01	45046		µg/L
Propylene oxide	622.00	77011	75569	µg/L
Prowl	222.01	79190	40487421	µg/L
Prowl, Lechate	221.00	79190	40487421	µg/L
Prowl, Soil	223.00	85793	40487421	µg/L
Pyrene	224.00	34469	129000	µg/L
Pyrethrins	425.00	39930	8003347	µg/L
Radium 226	623.00	09501	13982633	pCi/L
Radium 226 & 228	624.00	11503		pCi/L
Retene	457.00	73076	483658	µg/L
Roneet	311.01	81892	1134232	µg/L
Ronnel	427.00	39357	299843	µg/L
Round-up	426.00	39941	1071836	µg/L
SCA	225.00			
Secbumeton	428.00	38542	26259450	µg/L
Selenium, Dissolved	484.00	01145	7782492	µg/L
Selenium, Total	485.00	01147	7782492	µg/L
Selenium, Total Recoverable	226.00	00981	7782492	µg/L
Sencore	379.01	81408	21087649	µg/L
Sevin	294.01	77700	63252	µg/L
Siduron	429.00	38548	1982496	µg/L
Silica (SIO2)	227.00	00992	7631869	µg/L
Silicate	497.00	00958		mg/L
Silver, Dissolved	495.00	01075	7440224	µg/L
Silver, Total	234.00	01077	7440224	µg/L
Silver, Total Recoverable	228.00	01079	7440224	µg/L
Simazine	430.00	39055	122349	µg/L
Simetryn	431.00	39054	1014706	µg/L
Sodium Absorption Ratio	501.00	00931	7440235	SAR
Sodium Chlorate	229.00	00726	7775099	µg/L
Sodium, Total	450.00	00929	7440235	mg/L
Solids, Total Dissolved	247.03	70300		µg/L
Solids, Total Suspended	496.01	74016		mg/L
Specific Conductance (Field)	502.00	00094		µmhos/cm
Specific Conductance @ 25C (LAB)	151.00	00095		µmhos/cm
Specific Conductance(fIELD)	449.00	00094		µmhos/cm

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Stirofos	432.00	38877	961115	µg/L
Strontium-90	625.00	13501	10098972	pCi/L
Styrene	74.00	77128	100425	µg/L
Sulfate, Total	230.00	00945	14808798	mg/L as SO4
Sulfide, Total	231.00	00745	18496258	mg/L
Sulfite, Total	232.00	00740	14265453	mg/L as SO3
Sumitol	428.02	38542	26259450	µg/L
Supracide	374.01	78879	950378	µg/L
Surfactants	233.00	03581		mg/L
Surflan	396.01	78884	19044883	µg/L
Surrog: 1,2-Dichloroethane-d4	460.00			%
Surrog: 1,4-Bromofluorobenzene	187.00			
Surrog: 1-Bromo-2-floroethane	157.00			
Surrog: 2-Chlorophenol-d4 (spike)	565.00	95978		
Surrog: 2-Fluorobiphenyl	479.00			
Surrog: 2-Fluorophenol	480.00			
Surrog: 4-Chloroaniline-d4	566.00			
Surrog: Dibutylchlorendate (spike)	567.00			
Surrog: Fluorene-d10 (spike)	568.00			
Surrog: Nitrobenzene-d5	474.00			
Surrog: Phenol-d5	526.00			
Surrog: Pyrene-d10 (spike)	377.00			
Surrog: Toluene-d8	458.00			%
Surrog: p-Terphenyl-d14	525.00			
Sutan	290.01	81410	2008415	µg/L
Swep	433.00	38555	918189	µg/L
Systox	325.01	39560	8065483	µg/L
T3	236.00	78166		µg/L
T4	237.00	51489		µg/L
TCE	80.01	39180	79016	µg/L
TDS	247.01	70300		µg/L
TEPP	435.00	39620	107493	µg/L
TFH	462.01			
TKN	249.01	00625	17778880	mg/L as N
TOC	250.01	00680	7440440	µg/L
TOS (Calculated)	245.00			
TPH	461.01	46116	14280309	mg/L
TPN, Total Persulfate Nitrogen	580.01		7727540	µg/L
TSS	496.00		74016	mg/L
Tebuthiuron	190.00		34014181	µg/L
Tedion	434.00	39808	116290	µg/L
Temik	274.01	39053	116063	µg/L
Temperature, 0 C	238.00	00010	0	C
Temperature, 0 F	239.00	00011	0	F
Terbacil	204.00		5902152	µg/L
Terbuthylazine	436.00	38559	5915413	µg/L
Terbutryn	437.00	38887	886500	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Tetrachloroethene	75.00	34475	127184	µg/L
Tetrachloroethylene	75.04	34475	127184	µg/L
Tetrachloromethane	51.01	32102	56235	µg/L
Tetrachlorophenol	438.00	81849	25167833	µg/L
Tetrachlorvinphos	581.00	38877	961115	
Tetradifon	434.01	39808	116290	µg/L
Tetraethyldiphosphate	435.01	39620	107493	µg/L
Tetrahydrofuran	241.00	81607	109999	µg/L
Thallium, Dissolved	522.00	01057	7440280	µg/L
Thallium, Total	523.00	01059	7440280	µg/L
Thallium, Total Recoverable	242.00	00982	7440280	µg/L
Thiophanate	439.01	78880	23564069	µg/L
Thiosulfate	243.00			
Tin, Dissolved	513.00	01100	7440315	µg/L
Tin, Total	512.00	01102	7440315	µg/L
Tin, Total Recoverable	468.00	00983	7440315	µg/L
Titanium	469.00	01150	7440326	µg/L
Toluene	76.00	34010	108883	µg/L
Topsin-MR	439.00	78880	23564069	µg/L
Total BTEX	478.00	34103		µg/L
Total BTX	72.00	34103	n/a	µg/L
Total Dissolved Solids (residue)	247.00	70300		µg/L
Total Filterable Residue	247.02	70300		µg/L
Total Organic Halides	503.00	70353		µg/L
Total Organics	486.00	81299		µg/L
Total Solids	253.00	70297		Kg/100Gal
Total Solids	252.00	70318		%
Total Trihalomethanes	494.00	82080		µg/L
Toxaphene	255.00	39400	8001352	µg/L
Treflan	443.01	81284	1582098	µg/L
Triadimefon	440.00	38892	43121433	µg/L
Trichlorobenzoic acid	551.00	50317		
Trichloroethene	80.00	39180	79016	µg/L
Trichloroethylene	80.02	39180	79016	µg/L
Trichlorofluoromethane	83.00	34488	75694	µg/L
Trichloromethane	54.01	32106	67663	µg/L
Trichlorophon	340.01	39014	52686	µg/L
Trichlorotrifluoroethane	3.02	81611	26523648	µg/L
Trichlorotrinitrobenzenes,Total	258.00			
Tricyclazole, Water, Whole	641.00	38902	41814782	µg/L
Trifluralin	443.00	81284	1582098	µg/L
Trimethyl Benzenes, Total	444.00	78136	25551137	µg/L
Trimethyl phosphate	626.00		512561	µg/L
Trinitrobenzenes, Total	259.00			
Triphenyl phosphate (Water, Whole)	569.00	77881	115866	µg/L
Trithion	297.01	39786	786196	µg/L
Tritium	627.00	07000	10028178	pCi/L

APPENDIX D: CHEMICAL DICTIONARY
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COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
Turbidity(Lab)	260.00	82079		NTU
UDMH	261.00	81314	57147	mg/L
Vanadium (Dissolved)	262.00	10085	7440622	
Velpar	360.01	38815	51235042	µg/L
Vernam	445.01	82200	1929777	µg/L
Vernolate	445.00	82200	1929777	µg/L
Vinyl acetate	81.00	77057	108054	µg/L
Vinyl chloride	82.00	39175	75014	µg/L
Vinyl trichloride	4.01	34511	79005	µg/L
Vinylbenzene	74.01	77128	100425	µg/L
Volatile Dissolved Solids	263.00			
Volatile Organic Compounds	487.00		78733	mg/L
Xylene Isomers, M + P, Whole Water	578.00		85795	µg/L
Xylene Isomers, O + P, Whole Water	32.00		80353	µg/L
Xylene, m-	67.00	77134	108383	µg/L
Xylene, o-	77.00	77135	95476	µg/L
Xylene, p-	475.00	77133	106423	µg/L
Xylenes, Total	201.00	34020	1330207	µg/L
Zinc, Dissolved	504.00	01090	7440666	µg/L
Zinc, Total	507.00	01092	7440666	µg/L
Zinc, Total Recoverable	264.00	01094	7440666	µg/L
Zineb	447.00	38912	12122677	µg/L
Ziram	446.00	38917	137304	µg/L
Zolone	412.01	81291	2310170	µg/L
Zytron	336.01	81285	299854	µg/L
a-BHC	265.00	39337	319846	µg/L
a-Endosulfan	266.01	34361	959988	µg/L
alpha-BHC	265.03	39337	319846	µg/L
alpha-Benzene hexachloride	265.01	39337	319846	µg/L
alpha-Chlordane	530.00	39348	5103719	µg/L
alpha-Endosulfan	266.00	34361	959988	µg/L
alpha-Lindane	265.02	39337	319846	µg/L
b-BHC	267.00	39338	319857	µg/L
b-Endosulfan	268.00	34356	33213659	µg/L
beta-BHC	267.03	39338	319857	µg/L
beta-Benzene hexachloride	267.01	39338	319857	µg/L
beta-Endosulfan	268.01	34356	33213659	µg/L
beta-Lindane	267.02	39338	319857	µg/L
cis-1,2-Dichloroethene	326.00	77093	156592	µg/L
cis-1,2-Dichloroethylene	326.01	77093	156592	µg/L
cis-1,3-Dichloropropene	56.00	34704	10061015	µg/L
cis-1,3-Dichloropropylene	56.01	34704	10061015	µg/L
d-BHC	269.00	34259	319868	µg/L
delta-BHC	269.03	34259	319868	µg/L
delta-Benzene hexachloride	269.01	34259	319868	µg/L

APPENDIX D: CHEMICAL DICTIONARY
01/27/93

COMP_NAME	JHK_NO	STORET_NO	CAS_NO	UNITS
delta-Lindane	269.02	34259	319868	µg/L
g-BHC	357.00	39340	58899	µg/L
gamma-BHC (Lindane)	357.04	39340	58899	µg/L
gamma-Benzene hexachloride	357.03	39340	58899	µg/L
gamma-Chlordane	529.00	39065	5103742	µg/L
gamma-Lindane	357.02	39340	58899	µg/L
m-Diethylbenzene	549.01	77348	141935	µg/L
m-Dimethylbenzene	67.04	77134	108383	µg/L
m-Xylene	67.03	77134	108383	µg/L
meta-Xylene	67.02	77134	108383	µg/L
n-Butylbenzene	539.00	78483	104518	µg/Kg
n-Octacosane	390.00	78116	630024	µg/L
n-Propylbenzene	393.00	77224	103651	µg/L
o,p'-DDT	270.00	39305	789026	µg/L
o,p'-TDE	271.00	39315	53190	µg/L
o-Chloronitrobenzene	628.00		88732	µg/L
o-Chlorophenol	24.01	34586	95578	µg/L
o-Diethylbenzene	548.01	77340	135013	µg/L
o-Dimethylbenzene	77.03	77135	95476	µg/L
o-Phenylenediamine	629.00	73628	106503	µg/L
o-Toluidine	630.00	77142	95534	µg/L
o-Xylene	77.01	77135	95476	µg/L
ortho-Xylene	77.04	77135	95476	µg/L
p,a,a,a-Tetrachlorotoluene	632.00			µg/L
p,p'-DDD	208.02	39360	72548	µg/L
p,p'-DDE	209.02	39365	72559	µg/L
p,p'-DDT	210.02	39370	50293	µg/L
p,p'-TDE	272.00	39360	72548	µg/L
p-Chloro-m-cresol	31.02	34452	59507	µg/L
p-Chloronitobenzene	631.00		100005	µg/L
p-Cresol	35.01	77146	106445	µg/L
p-Diethylbenzene	550.01	77345	105055	µg/L
p-Dimethylbenzene	475.04	77133	106423	µg/L
p-Isopropyltoluene	538.00	77356	99876	µg/L
p-Nitroaniline	36.01	73278	100016	µg/Kg
p-Nitrophenol	37.01	34646	100027	µg/L
p-Xylene	475.02	77133	106423	µg/L
pH	448.00	00400		std. units
para-Xylene	475.01	77133	106423	µg/L
propyzamide	419.02	39080	23950585	mg/Kg
sec-Butylbenzene	543.00	78485	135988	µg/Kg
tert-Butylbenzene	537.00	78448	98066	µg/Kg
trans-1,2-Dichloroethene	78.00	34546	156605	µg/L
trans-1,2-Dichloroethylene	78.01	34546	156605	µg/L
trans-1,3-Dichloropropene	79.00	34699	10061026	µg/L
trans-1,3-Dichloropropylene	79.01	34699	10061026	µg/L
269	338.40			

APPENDIX E: LABORATORY QUALIFIERS

LIST OF QUALIFIERS FOR NUMERIC RESULTS

REMARK CODE	DEFINITION
B	Analyte is found in the blank as well as the sample, indicated possible/probable blank contamination.
J	Estimated value; not accurate.
M	Presence of material verified but not quantified
U or K	Compound was analyzed for but not detected. The associated numerical value is the sample quantitation detection limit.
UJ	Compound was analyzed for but not detected. The number is the estimated minimum detection limit.
C	The value is one of, or the sum of both, Benzo (b) Fluoranthene and Benzo (k) Fluoranthene.
X	Many background organisms.
H	Over holding time. Analysis run.
G	Improper container.
Z	Sample low due to interfering substance.
D	Sample high due to interfering substance.
IS	Interfering Substance.
P	Greater than (>).
A	Less than (<).
LMX	Lab Matrix Number.
LBK	Lab Blank Number.