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SAMPLING AND ANALYSIS PLAN
FOR
EAST KING COUNTY GROUNDWATER MANAGEMENT AREA

Prepared for:

King County Department of Natural Resources
Seattle, Washington

Submitted by:

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Redmond, Washington

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1. INTRODUCTION

1.1 Project Description

Between 1989 and 1996, the Seattle - King County Dept. of Public Health, under Washington Dept. of Ecology guidance (according to WAC 173-100), developed Ground Water Management Plans (GWMPs) for five Ground Water Management Areas (GWMAs) in King County, including the East King County GWMA (Figure 1). Each GWMP included proposals for data collection and management, with the purpose of monitoring both the groundwater quality and quantity.

Water quality in the EKC GWMA is generally excellent. The emphasis of the GWMP is therefore to protect existing water quality. The GWMP proposed eighteen goals to address groundwater quality and quantity, including hazardous materials management, infrastructure (e.g. sewage treatment, underground storage tanks and pipelines, and landfills), pesticides, golf courses, well construction, and sand and gravel mining (East King Co. Ground Water Advisory Committee, 1998).

In 1999, County Council passed enabling legislation for the Rural Drainage and Water Quality Program, which provides Surface Water Management services throughout the entirety of unincorporated King County. As part of the development of this program and in conjunction with concerned citizens, groundwater has been formally included as an essential component of the water resources to be protected. This Program supports the Groundwater Program financially in the Vashon-Maury Island and East King County GWMAs.

The study served by this SAP is intended to provide an overall description of groundwater conditions in the EKC GWMA and, in combination with sampling in the other GWMAs, throughout King County as a whole. Under this plan, sampling will be conducted at wells previously sampled during development of the EKC GWMP. Comparison of water quality results from the current study to previous sampling events will permit evaluation of long term changes in water quality. To this end the selection of wells, sampling techniques, and analytical methods for this present study have been made as compatible as possible with the previous GWMP sampling. Variability among replicate samples for a given parameter during the original GWMP sampling should provide an indication of the significance of any observed changes during the present sampling round(s). Water levels recorded at the time of the present round(s) of sampling will be compared to earlier measurements to evaluate changes in groundwater quantity.

1.2 Purpose

This Sampling and Analysis Plan (SAP) has been developed to guide the initial groundwater sampling in the East King County GWMA. Initial efforts under this SAP will begin in 2001. Following receipt and interpretation of the results of this effort, the data collection program will be revised in conjunction with the EKC Ground Water Management Committee, according to the new information available or new areas of concern identified. This SAP will be revised to cover subsequent sampling efforts.

1.3 Study Area Description

The East King Co. Groundwater Management Area (GWMA) is an approximately 225-square mile area located in the Snoqualmie River valley in north central King County. The GWMA is

bounded by the Union Hill and Sammamish Plateaus on the west, the Snohomish County line on the north, the Cascade Mountain foothills on the east, Rattlesnake Ridge on the south, and the topographic divide between the Snoqualmie and Cedar Rivers on the southeast. The area includes four small cities, the unincorporated communities of Fall City and Preston, low-density rural areas; and forestry and agriculture (East King County Ground Water Advisory Committee, 1998). Water purveyors that provide most of their water supply from groundwater in the GWMA include the cities of North Bend, Carnation, and Snoqualmie, and water districts such as Fall City, Sallal, and Ames Lake.

1.4 Sampling Plan Objectives

Data collected under this SAP is intended for use by both the public (including Management Committees) and technical people to assess groundwater quality and develop future sampling needs. This data will also be used for Environmental Benchmarks under the Growth Management Act. This SAP outlines field procedures and quality control procedures that will be followed to ensure a complete and accurate data set. Although groundwater will be analyzed for drinking water parameters, analysis need not be by drinking water methods or be performed by a lab certified to perform drinking water analyses. Drinking Water Analysis Reporting Forms also do not need to be used. However, method detection limits (MDLs) below maximum contaminant levels (MCLs) will be attained.

1.5 Sampling Locations and Frequency

Approximately eighteen wells in the EKC GWMA will be sampled. The locations of these wells are shown in Figure 2. Groundwater sampling under this Plan will be conducted semi-annually. The first round of sampling will be conducted in February 2001. Another round of sampling will be conducted in summer 2001. As such, samples will be collected during both wet and dry seasons.

1.6 Project Organization and Responsibilities

Activities outlined in this SAP will be conducted by personnel from both King County Department of Natural Resources (KCDNR) and Golder Associates (Golder). Ken Johnson (KCDNR) and Bob Anderson (Golder) will assume the roles of Project Managers in their respective organizations. Contact information is provided below:

Ken Johnson
King County Department of Natural Resources
Water and Land Resources Division
Regional Water Resources Services Unit
201 S. Jackson St. (King Street Center), Suite 600
Seattle, WA 98104-3855
(206) 296-8323

Bob Anderson
Golder Associates
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052-3333
(425) 883-0777

1.6.1 King County DNR Responsibilities

Chris Hughes will be in charge of the groundwater sampling program under the direction of Ken Johnson. DNR's responsibilities will include:

- Confirmation of sampling locations;
- Arranging site access with land owners;
- Provision of a GPS unit for locating wells;
- Provision of all sample bottles and coolers;
- Transmission of samples to the King County Environmental Laboratory (KCEL); and
- Processing and management of water quality results.

1.6.2 Golder Associates Responsibilities

Golder personnel will assist in the collection of one round of samples, during which they will train KCDNR personnel in sampling procedures. Paul Conrecode will conduct sampling. Golder's responsibilities will include:

- Preparation of this sampling and analysis plan (SAP);
- Field documentation of each well site; and
- Submission of a brief report summarizing the round one sampling event.

2. DATA QUALITY OBJECTIVES

2.1 Overview

As stated previously, the goal of groundwater sampling under this SAP is to evaluate groundwater quality and quantity in the EKC GWMA. The wells selected for monitoring provide good geographic coverage of the study area. During well selection, representation from major geologic units was considered, but the well selection criteria included the potential or previous detection of contamination. These wells should be more likely than others in the area to show problems and thus would be an "early warning" system for contamination in the GWMA.

Because the goal of this study is to evaluate groundwater quality on a regional scale, the primary focus of this study is the identification of widespread water quality problems. Well selection included an evaluation of susceptible areas based on land use, though no attempt has been made to sample any areas of possible small scale or point source impacts.

2.2 Target Analytes

Samples will be analyzed for the constituents listed in Table 1. Field parameters (pH, conductivity, dissolved oxygen, turbidity, and temperature) will be monitored at all wells.

3. SAMPLING AND ANALYSIS PROCEDURES

3.1 Field Data Collection

3.1.1 Sample Collection

The wells chosen for this study are primarily domestic wells. Figure 3 illustrates a typical configuration of a domestic well house. Because well configurations will vary from site to site, guidelines will be provided for the point in the distribution system where samples should be collected and the volume of water that should be purged prior to sample collection. At each site, professional judgement will be exercised in implementing these guidelines. To ensure comparability of the data between sample rounds, well-specific sampling protocols will be documented.

The goal of groundwater sampling is to collect a sample that is representative of subsurface conditions. Water samples should therefore be collected from a hose bib in the well distribution system as close to the wellhead as possible. Three well volumes should be purged prior to sample collection. For some wells, purging three full well volumes may not be possible due to slow pumping rates. In these cases, a minimum of one well volume will be purged and then samples will be collected once field parameters (pH, conductivity, temperature, dissolved oxygen and turbidity) have stabilized. If feasible, samples should be collected upstream of any holding tank (e.g., cistern, water heater, pressure tank). If samples are collected downstream of a holding tank, the full volume of the holding tank should be purged prior to sample collection. In systems where this would amount to large volumes of water, samplers should consult the Project Manager. Samples should be collected ahead of any water treatment such as chlorination, fluoridation, or softening.

A photograph (or sketch) will be taken to document each systems configuration. At each well, a well sampling field form (Attachment A) will be completed. Prior to sampling, the water level will be recorded, provided the well head is accessible. Well details and purge volumes will be recorded on the well sampling form. At each well, field parameters (pH, conductivity, dissolved oxygen, turbidity, and temperature) will be recorded during purging. Purge water will be directed away from the well house using a garden hose. Field parameter samples will be collected at the end of this hose. Water samples will be collected once field parameters have stabilized and turbidity is less than 5 NTU, as outlined in Golder Technical Procedure TP 1.2-20. Whenever possible, samples will be collected directly from the hose bib. A complete set of field parameters will be measured on a sample collected directly from the hose bib (as opposed to at the end of the garden hose) to ensure transmission through the garden hose has not affected field parameters.

In cases where samples cannot be collected directly from the hose bib (e.g. high pressures, potential flooding of the well house) polyethylene or tygon tubing will be used. This tubing will be attached to the hose bib with a hose clamp. Tubing will be decontaminated by the KC Environmental Laboratory prior to sampling. No de-con of sampling collection apparatus (with the exception of field parameter sample bottles) will occur in the field. Separate tubing will be used for metals and bacteriology samples. Sterile tubing will be used to collect bacteriological and all other samples with the exception of metals. Metals will be collected using a second acid-washed tube. Acid-washed tubing must not be used to collect conventional parameters.

Groundwater sampling will be conducted in accordance with Golder Technical procedure TP 1.2-20, “Collection of Groundwater Quality Samples.” This procedure describes sample purging,

sample collection, and measurements to ensure representative groundwater samples are obtained using bailers, a variety of portable pumps or with dedicated pumps.

Table 2 provides sample volumes, preservation and holding times for groundwater samples to be collected at each well. One inch of headspace will be left in all bottles, if possible. If a bottle is overfilled, excess water will not be decanted from the bottle. The metals collection bottle will be rinsed three times with sample water prior to filling. Samples for all other parameters will be collected directly into the appropriate sample bottles. A water sample collected for bacteriology must not contact any surface that is not sterile prior to transfer to the bacteriology bottle.

All samples will be placed in the appropriate sample containers and labeled. Golder Chain of Custody procedure TP-1.2-23 will be followed during storage and shipment of all samples for analysis. Samples will be shipped or dropped off at the laboratory for analysis at the end of each day. Short holding times for nitrate, nitrite, and coliform necessitate this. At the request of KCEL, sample collection will not be conducted on Fridays. This will ensure that all analyses are conducted within the appropriate holding times.

Because of the low detection limits required for the metals tests, precautions will be taken during sampling to minimize contamination. Sample containers for metals samples will be sealed in zip lock bags before and after sample collection. Sample collection personnel will wear clean, powder free vinyl gloves while handling the zip lock bags and the sample containers. Gloves will be changed frequently. The field blank, a sample bottle containing reagent water from the lab, will be handled in the same manner as the samples. This includes removing the bottle from the zip lock bag, opening the bottle, exposing the blank water to the ambient conditions at a typical sampling site for the duration of sample collection, and returning the bottle to the zip lock bag.

Field analysis of total nitrate, iron, and manganese will be conducted with HACH kits at the discretion of the Project Manager. HACH kits allow rapid and easy determination of nitrate, iron and manganese concentrations using colorimetric methods. The method detection limits of these analyses are 1 mg/L (nitrate), 0.1 mg/L (iron), and 0.02 mg/L (manganese). Concentrations are determined by comparison of the color of a groundwater solution following treatment with reagents to a color chart. These analyses are therefore appropriate as “screening” tools. The precision and accuracy of these results are considered secondary to laboratory determined values.

Field-tests to evaluate biological activity (BART tests) may also be employed at the direction of the Project Manager. BART tests provide an easy way to detect specific bacterial groups and algae in water. Bacteria may impart offensive taste and odor in potable water or result in plugging of wells. The following types of bacteria can be evaluated using BART tests: iron-related, nitrifying, sulfate reducing, slime-forming, and total aerobic. Personnel are referred to the BART manual for specific instructions regarding each test.

3.1.2 Sample Collection from Holding Tanks

Spring sampling may require sample collection from a tank or reservoir. Changes to standard procedures may also result in sampling from a well’s holding tank. When sampling directly from a holding tank or other reservoir, the sampler shall wear new disposable gloves. A sterilized bailer will be used to collect the bacteriology and conventional samples. A separate, acid-washed bailer will be used to collect the metals samples. All samples collected with the bailers will be transferred directly into the correct lab containers. If the holding tank is part of a potable water

system, extreme care must be taken to prevent contamination of the water source with the sampling equipment. Bailers will be provided by King County Laboratory.

3.1.3 Sample Designation

Each sample will be clearly labeled with a unique identification number, which will also be used on the Chain of Custody, and field logbooks for identification and tracking and for use in the database that will be developed. The sample identification code format will consist of a unique number and increment sequentially for each new sample. The following information will be collected on the sample integrity sheets or a field book for entry into the database to further describe samples:

1. Sample Location (including LIMS Locator and GIS Coordinates);
2. Filtered/Unfiltered: Filtered = F; Unfiltered = U;
3. Filter Size;
4. QC Type: (Blank = Bk, Duplicate = Dp);
5. Date: Mo/Da/Yr;
6. Time: Hour and Minutes HH:MM; and
7. Sampler's initials.

3.1.4 Equipment

During all sampling activities, disposable equipment will be used whenever possible. All non-dedicated sampling equipment (in contact with sample) shall be thoroughly cleaned prior to each sampling event to prevent cross-contamination between samples and to ensure accurate representation of analytes of interest in each sample. No field cleaning procedures shall be performed for any bacteriology sampling; all sample containers and sampling equipment shall be sterilized and transported to the field under conditions to preserve its sterility. Personnel performing decontamination shall wear gloves, eye-protection, and such other safety equipment as needed. Equipment decontamination procedures are described in Golder Technical Procedure TP 1.2-20. Field meters (pH, dissolved oxygen, conductivity, temperature, and turbidity) will be thoroughly rinsed with distilled or deionized water before and after each reading.

The analytical laboratory as part of their agreement shall provide all sample containers, container preparation services, preservatives, gloves, and field blanks.

3.1.5 Field Filtration

The present analyte list does not include analysis of dissolved metals. If dissolved metal analysis is conducted in the future, the following procedures will be followed. Groundwater samples for dissolved metal analysis will be field filtered immediately following sample collection using either a syringe or a pump equipped with an in-line 0.45-µm disposable filter cartridge. Filters to be used in this case will be specified, prior to sampling, by brand and model to KCEL, who will then evaluate to confirm that these filters are free from contamination that could affect results.

Another option is to filter the samples once received at KCEL. This option requires that the samples be collected without acid preservation and samples should be filtered within 24 hrs of collection.

Syringe Procedure. Samples collected using a syringe with an in-line filter will be collected as follows:

a. Sampler will wear non-powdered disposable vinyl gloves.

b. Use only new, disposable, or decontaminated 60 mL syringe and new filter.

c. Pull plunger out of syringe and place filter cartridge on end of syringe.

d. Pour sample water from one-liter sample bottle into syringe and insert plunger.

e. Alternatively, withdraw 60 mL of sample directly into syringe, place filter on end.

f. Slowly force sample water through the filter. Discard first 5-10 mL.

g. After discarding first 5-10 mL, collect filtered sample in a pre-cleaned bottle containing preservative prepared by the laboratory (reagent grade nitric acid - HNO_3) for metals analyses. Samples for anion analyses should be placed in pre-cleaned sample bottles without preservative.

h. Repeat filtration procedure until container is full.

Pump Procedure. Samples collected with a pump and an in-line filter will be collected as follows:

a. Sampler will wear non-powdered disposable vinyl gloves.

b. Replace pump tubing with new tubing and decontaminate the pump tubing.

c. Attach an in-line 0.45 μm filter cartridge on the outlet end of the pump.

d. Discard the first 50-mL pumped.

e. Direct the discharge from the pump into a pre-cleaned sample bottle containing reagent grade nitric acid (HNO_3) for metals analysis, and a sample bottle without preservative for anion analyses. Continue until sample bottle is full.

3.2 Laboratory Analysis

Groundwater samples will be submitted to KCEL for analysis. KCEL will arrange for a subcontract with AmTest, Inc., located in Redmond, Washington for the analysis of Total Organic Halides, Silica and Fluoride.

3.2.1 Analytes and Method Detection Limits

Table 1 lists the parameters to be analyzed at each well. Groundwater will be analyzed for drinking water parameters using method detection limits (MDLs) below the maximum contaminant levels (MCLs). Table 3 lists the MDL that will be achieved for each parameter based on the chosen analytical method. This table also provides Washington State Drinking Water Limits and Groundwater Limits for comparison. All metals (except for Hg, Ag, As, Cd, Pb, and Se) will be initially analyzed by ICP-OES and then reanalyzed by ICP-MS, as necessary, to achieve the lowest detectable values. The elements Fe, Na and K will not be analyzed by ICP-MS due to instrument technical limitations.

4. QUALITY ASSURANCE/QUALITY CONTROL

4.1 Field Equipment Calibration and Maintenance

Calibration of all measuring and test equipment, whether in existing inventory or purchased for this investigation, shall be controlled as required by Golder procedure QP-11.1, "Calibration and Maintenance of Measuring and Test Equipment." Lease equipment shall require certifications or other documentation demonstrating acceptable calibration status for the entire period of use for this project. Field calibration requirements shall be in compliance with the technical procedure describing the instruments use and/or with the manufacturer's instructions issued with the equipment.

4.2 Field Measurement QC

To assess the precision of field measurements, duplicate measurements will be obtained at a frequency of 1 in 10 measurements or 1 set per day, whichever is greater. Duplicate measurements should be made using a fresh portion of sample relative to the original measurement and after rinsing the meter using the same procedures used between wells.

To assess the accuracy of the field measurements, 1 in 10 samples or at least one per sampling day, will be measured in the laboratory for pH, conductivity and turbidity.

A copy of the field results for pH, conductivity and turbidity will be left with the laboratory at sample delivery.

4.3 Field Replicates and Blanks

To assess the precision of field sampling procedures and the variability of the sample source, field replicates will be collected at a frequency of 1 in 10 samples or 1 per day, whichever is greater. Each field replicate is to be collected after performing the decontamination and purging routines used for normal sample collection. One atmosphere blank will also be collected each day for metals analysis. Atmosphere blanks will be provided by KCEL. The information obtained by collecting field replicates will be taken into account by the data user when making decisions based on data generated under this QA plan.

4.4 Laboratory QA/QC

4.4.1 Precision

Laboratory precision will be assessed using laboratory duplicates. When both sample results exceed the RDL (reporting detection limit) the RPD (relative percent difference) should be less than 25% or the current lab acceptance limit, whichever is lower. For microbiology measurements, the RPD should meet the method requirements. No criteria are presented for duplicate results that are below the RDL, but above the MDL, as these RPD are provided for informational purposes only.

4.4.2 Accuracy

For this project, laboratory control samples, or blank spikes, whichever are available, will be used to assess accuracy. Results should be within 20% of the true value or within the criteria provided with the purchase of the control sample.

Accuracy will also be assessed by the evaluation of method blank data. Analytical results for method blanks should be less than the MDL (method detection limit). Note that some common organics laboratory contaminants may exceed the reported MDL. Sample results that are less than 10 times the concentration detected in the method blank will be qualified with a "B" flag to indicate the sample results may be biased.

The use of matrix spike recovery data will provide additional information regarding method performance on actual samples. The laboratory will use professional judgment regarding assessment of data quality and any subsequent action taken as a result of matrix spike recoveries.

4.4.3 Representativeness

Representative samples will be obtained through the following practices:

- The use of generally accepted sampling procedures will allow for the collection of representative samples.
- Subsampling within KCEL will be conducted according to lab standard operating procedures. These procedures are designed to obtain representative subsamples.

4.4.4 Comparability

Data comparability will be obtained through the use of standard sampling procedures and trained personnel as described in this plan, and through standard analytical methods used by the laboratory. Additionally, adherence to the procedures and QC approach contained in this QA Plan will provide for comparable data throughout the duration of this project.

4.4.5 Completeness

Completeness will be evaluated by the following criteria:

- The number of usable data points compared to the projected data points as detailed in this plan.
- Compliance with the data quality criteria as presented in this section.
- Compliance with required holding times.

The goal for the above criteria is to obtain 100% data completeness. However, where data are not complete, decisions regarding resampling and/or reanalysis will be made by a collaborative process involving both data users and data generators. These decisions will take into account the project data quality objectives as presented above.

4.5 Personnel Training

Golder personnel will train KCDNR employees during the first round of groundwater sampling on the procedures outlined in this SAP. Paper and electronic copies of all Golder Procedures identified in this SAP will be provided by Golder to DNR prior to the first round of sampling. Golder personnel are agreeable to volunteers being included in sample collection; however, Golder will not assume responsibility for their training. Training will include instruction on operation and calibration of field meters and review of the technical procedures outlined in this SAP. If HACH kit testing or BART tests are to be conducted, these analyses will be included in training.

5. DATA MANAGEMENT AND REPORTING

5.1 Field Reports

Personnel will record daily sampling activities in a field book or field reporting form. A well sampling form (Attachment A) will be completed at each site. At least one photograph (or sketch) will be taken to document each well.

5.2 Laboratory Reports

Data reduction, review, and reporting will be performed under KCEL's standard operating procedures. Data will be provided to data recipients within 30 days of receipt of the last sample for a sampling event. Data will be reported in the standard laboratory reporting format. This includes an analytical result, MDL (method detection limit), and RDL (reporting detection limit).

All analytical data packages submitted by the analytical laboratory shall include the following:

- Sample receipt, chain-of-custody and shipping documentation, including identification of field sampling personnel, shipping personnel (or organization);
- Analytical results for each sample containing the reduced results for all analytes/constituents requested in the chain of custody, request for analysis or purchase order; and
- Sample results will be available through LIMS or in an electronic version (Excel) of the hardcopy report (Comprehensive Report). QC summaries are available in hardcopy form only.

5.3 Database Management

Prior to entry into the database, all analytical data will be validated. The Project Manager will dictate the level of data validation. Procedures outlined in USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA, 1994) may be used as a reference during data validation.

Each sampling event for a specific well will be assigned a unique numerical identifier for use in the database. Water quality data will be entered into EQUIS or Access.

5.4 Annual Water Quality Report

At the completion of one year of sampling (two rounds), water quality data will be summarized in an annual report. This report will include:

- Tabulation of all water quality data;
- Identification of exceedences to drinking water and groundwater standards;
- Water quality trend analysis;
- Graphical representation of water quality types (stiff or piper diagrams); and
- Mapping of water quality data to show geographical distributions.

This report should also include an evaluation of the QA/QC protocols. This evaluation may include evaluation of field replicates and field blanks. Charge balances may also be performed on individual water analyses as a tool in assessing analytical accuracy.

6. REFERENCES

EPA, 1994. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA-540/R-54-013.

East King Co. Ground Water Advisory Committee, 1998. East King County Ground Water Management Plan: Supplement 1 – Area Characterization, Final. Submitted December 1998.

TABLES

Analyte List for Groundwater Sampling

Total Metals
Arsenic
Cadmium
Lead
Selenium
Barium
Calcium
Chromium
Copper
Iron
Magnesium
Manganese
Potassium
Silver
Sodium
Zinc
Mercury
Cyanide
Total Phosphorus
Conventionals
Total Dissolved Solids
Total Alkalinity
Chloride
Nitrate + Nitrite
Sulfate
Subcontracted Analyses
Silica
Fluoride
Special Study/Requested
Microbiology
Total Coliform
Fecal Coliform
Special Study/Requested
Organic-Chlorinated Herbicides
2,4,5-T
2,4,5-TP (Silvex)
2,4-D
2,4-DB
Dalapon
Dicamba
Dichloroprop
Dinoseb
MCPA
MCPP

Special Study/Requested
Organic-BNA
1,2,4-Trichlorobenzene
1,2-Dichlorobenzene
1,2-Diphenylhydrazine
1,3-Dichlorobenzene
1,4-Dichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
2-Chloronaphthalene
2-Chlorophenol
2-Methylnaphthalene
2-Methylphenol
2-Nitroaniline
2-Nitrophenol
3,3'-Dichlorobenzidine
3-Methylphenol
3-Nitroaniline
4,6-Dinitro-O-Cresol
4-Bromophenyl Phenyl Ether
4-Chloro-3-Methylphenol
4-Chloroaniline
4-Chlorophenyl Phenyl Ether
4-Methylphenol
4-Nitroaniline
4-Nitrophenol
Acenaphthene
Acenaphthylene
Aniline
Anthracene
Atrazine
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene

BNA list continued
Benzoic Acid
Benzyl Alcohol
Benzyl Butyl Phthalate
Bis(2-Chloroethoxy)Methane
Bis(2-Chloroethyl)Ether
Bis(2-Chloroisopropyl)Ether
Bis(2-Ethylhexyl)Phthalate
Caffeine
Carbazole
Chrysene
Coprostanol
Diazinon
Dibenzo(a,h)anthracene
Dibenzofuran
Diethyl Phthalate
Dimethyl Phthalate
Di-N-Butyl Phthalate
Di-N-Octyl Phthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-Cd)Pyrene
Isophorone
Naphthalene
Nitrobenzene
N-Nitrosodimethylamine
N-Nitrosodi-N-Propylamine
N-Nitrosodiphenylamine
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
Pyridine
Simazine

Special Study/Requested
Organic-VOA
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2-Trichloroethylene
1,1-Dichloroethane
1,1-Dichloroethylene
1,2-Dichloroethane
1,2-Dichloropropane
2-Butanone (MEK)
2-Hexanone
4-Methyl-2-Pentanone (MIBK
Acetone
Acrylonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon Disulfide
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
Cis-1,3-Dichloropropene
Ethylbenzene
Methylene Chloride
Styrene
Tetrachloroethylene
Toluene
Total Xylenes
Trans-1,2-Dichloroethylene
Trans-1,3-Dichloropropene
Trichlorofluoromethane
Vinyl Acetate
Vinyl Chloride

Sample Volumes, Preservation, and Holding Times

Conventionals				
TDS	KCEL	1 L polyethylene	Cool 4°C +/- 2	7 days
Alkalinity (total)	KCEL	500 mL polyethylene	as above	14 days
Chloride, Sulfate	KCEL	250 mL polyethylene	as above	28 days
Nitrate, Nitrite	KCEL	125 mL polyethylene	as above	48 hours
Subcontracted Analyses				
Fluoride, Silica	AmTest	250 mL polyethylene	Cool 4oC +/- 2	28 days
Analyte:				
Microbiology				
Total and Fecal Coliform	KCEL	500 mL HDPE, sterile, leave one inch of headspace	Cool 4oC +/- 2	30 hours
Organics				
Volatile Organic Acids (VOA)	KCEL	40mL glass (4)	Cool 4oC +/- 2	14 days before extraction
Chlorinated Herbicides	KCEL	1L Amber glass (1)	Cool 4oC +/- 2	14 days before extraction
Base Neutral Acids (BNA)	KCEL	1L Amber glass (3)	Cool 4oC +/- 2	14 days before extraction

KCEL - King County Environmental Laboratory.
AmTest - AmTest Laboratories, Inc.

Analyte Analytical Techniques and Method Detection Limits

Parameter	Method	Analytical Technique	MDL (mg/L)	Method	Analytical Technique	MDL (mg/L)	WAC 246-290-310 Drinking Water Standards (mg/L)	WAC 173-200-050 Ground Water Quality Criteria (mg/L)
Total Metals								
Arsenic	EPA 200.8	ICP-MS	0.0005	EPA 200.7	ICP-OES	0.05	0.05	0.05
Cadmium	EPA 200.8	ICP-MS	0.0001	EPA 200.7	ICP-OES	0.003	0.005	0.01
Lead	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.03	0.015[a]	0.05
Selenium	EPA 200.8	ICP-MS	0.0015	EPA 200.7	ICP-OES	0.05	0.05	0.01
Barium	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.001	2.0	1.0
Calcium	EPA 200.8	ICP-MS	0.02	EPA 200.7	ICP-OES	0.05	-	-
Chromium	EPA 200.8	ICP-MS	0.0004	EPA 200.7	ICP-OES	0.005	0.1	0.05
Copper	EPA 200.8	ICP-MS	0.0004	EPA 200.7	ICP-OES	0.004	1.3[a]	1.0
Iron	N/A	N/A	N/A	EPA 200.7	ICP-OES	0.05	0.3 (S)	0.3
Magnesium	EPA 200.8	ICP-MS	0.02	EPA 200.7	ICP-OES	0.03	-	-
Manganese	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.002	0.05 (S)	0.05
Potassium	N/A	N/A	NA/	EPA 200.7	ICP-OES	2	-	-
Silver	EPA 200.8	ICP-MS	0.0002	EPA 200.7	ICP-OES	0.004	0.1 (S)	0.05
Sodium	N/A	N/A	N/A	EPA 200.7	ICP-OES	0.5	20[b]	-
Zinc	EPA 200.8	ICP-MS	0.0005	EPA 200.7	ICP-OES	0.005	5.0 (S)	5.0
Mercury	EPA 245.2	CVAA	0.0002				0.002	0.002
Cyanide	EPA 335.2 ?	?	?				0.2	0.2
Total Phosphorus	SW 9010 ?	?	?				-	-
Conventionals								
Total Dissolved Solids	SM 2540-C	Gravimetric	5				500	500
Total Alkalinity	SM2320-B	Titrimetric	0.2				-	-
Chloride	SM 4110B	IC	0.05				250 (S)	250
Nitrate + Nitrite	SM 4500	Colorimetric	0.02				10 as N	10 as N
Sulfate	SM 4110B	IC	0.1				250	250
Subcontracted Analyses								
Silica	SM 4500-SI-E	Colorimetric	0.04				-	-
Fluoride	EPA 340.2	Alpchem Autoanalyzer	0.1				2.0 (S)	4
Special Study/Requested								
Microbiology								
Total Coliform	SM9222-B	Membrane Filtration	1 CFU per100mL					
Fecal Coliform	SM9222-D	Membrane Filtration	1 CFU per100mL					
Organic								
VOA	EPA 624	GC/MS	varies per analyte				varies per analyte	varies per analyte
Chlorinated Herbicides	SM 8151	GCMS MODIFIED	varies per analyte				varies per analyte	varies per analyte
BNA	SM 3520C/8270C	GC/MS	varies per analyte				varies per analyte	varies per analyte

[a] Action Level (S) Secondary MCL

[b] Recommended Level '-' parameter not regulated.

FIGURES

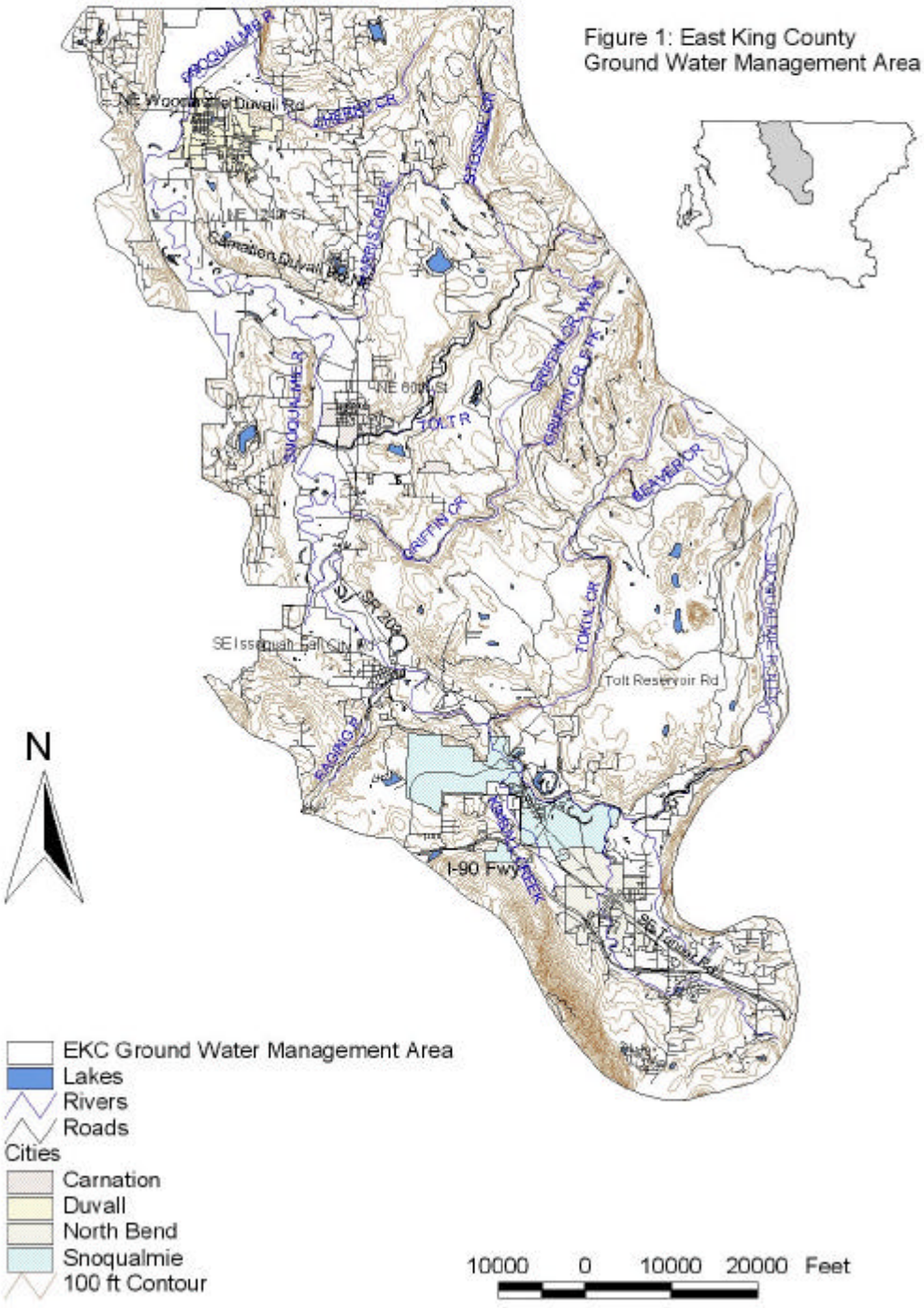


Figure 1: East King County
Ground Water Management Area
SNOQUALMIE R
NE Woodinville Duvall Rd
NE 124th St
Carnation Duvall Rd NE
PATTERSON CR
HARRIS CREEK
STOSSEL CR
NE 60th St
SNOQUALMIE R
TOLT R
GRIFFIN CR W FK
GRIFFIN CR E FK
BEAVER CR
GRIFFIN CR
SR 203
SE Issaquah Fall City Rd
TOKUL CR
SNOQUALMIE R
Tolt Reservoir Rd
RAGING R
I-90 Fwy
SE Issaquah
N
EKC Ground Water Management Area
Lakes
Rivers
Roads
Cities
Carnation
Duvall
North Bend
Snoqualmie
100 ft Contour
10000 0 10000 20000 Feet

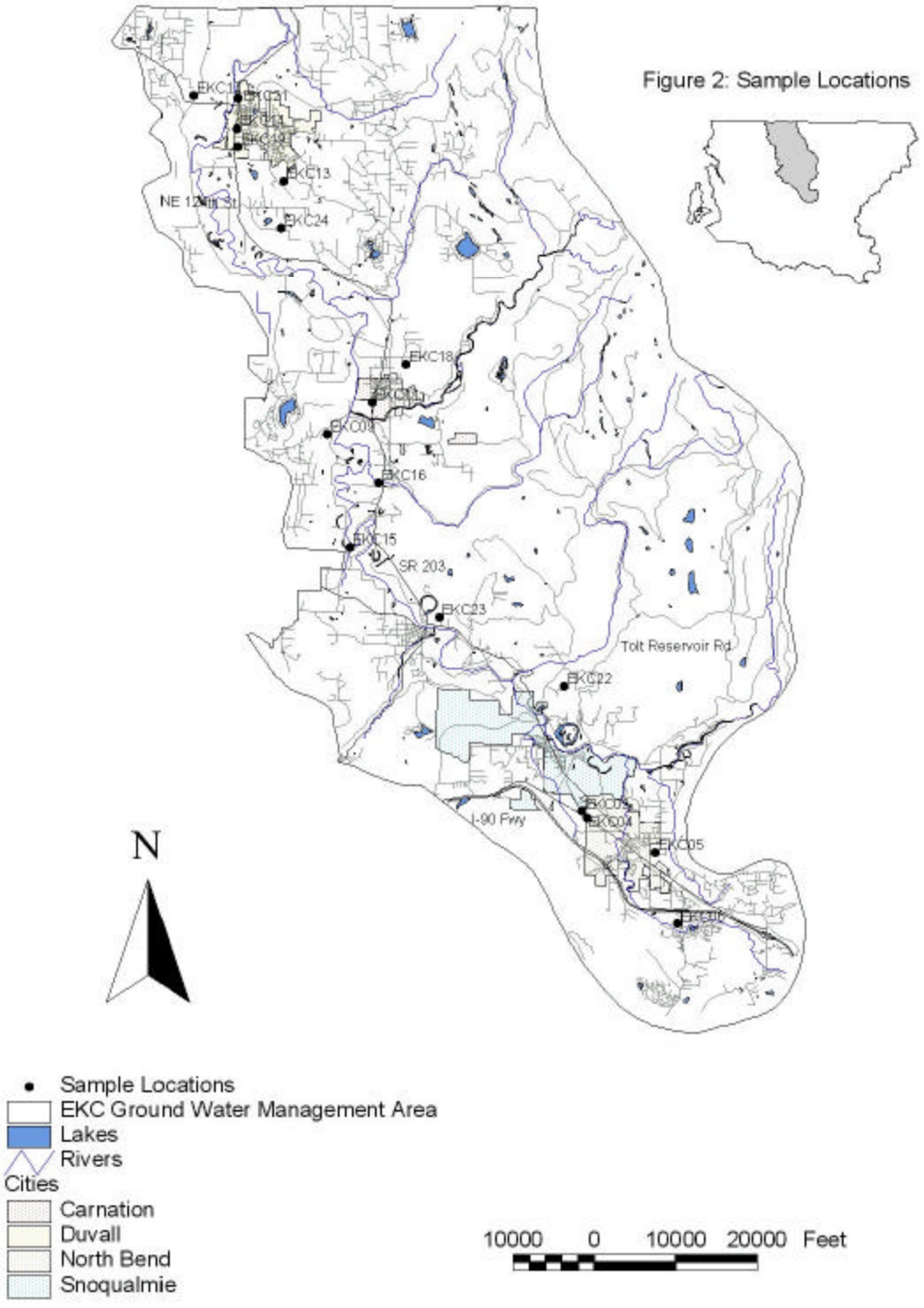
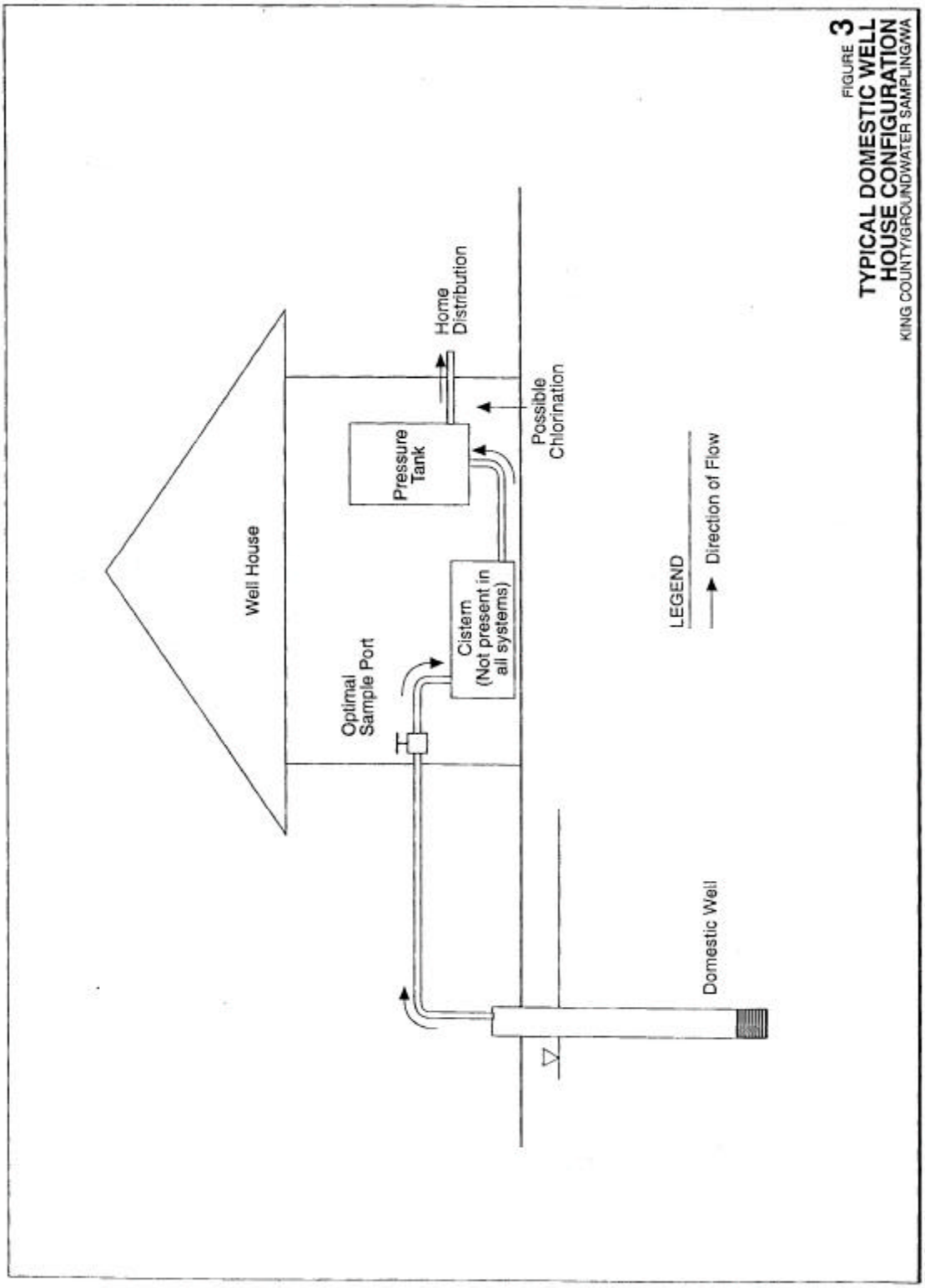


Figure 2: Sample Locations
EKC13
NE 124th St
EKC24
EKC18
EKC16
EKC15
SR 203
EKC23
Tolt Reservoir Rd
EKC22
I-90 Fwy
EKC05
N
Sample Locations
EKC Ground Water Management Area
Lakes
Rivers
Cities
Carnation
Duvall
North Bend
Snoqualmie
10000 0 10000 20000 Feet


Well House
Home Distribution
Possible Chlorination
Pressure Tank
Cistern (Not present in all systems)
Optimal Sample Port
LEGEND
Direction of Flow
Domestic Well
FIGURE 3
TYPICAL DOMESTIC WELL HOUSE CONFIGURATION
KING COUNTY/GROUNDWATER SAMPLING/WA
Golder Associates
PROJECT NO. 003 1071.100 DRAWING NO. 10941 DATE 12/1/2000 DRAWN BY EA

ATTACHMENT A

WELL SAMPLING FIELD FORM

Project:	Well Identification:
Site:	Sampling Method:
Job Number:	Purge Method:

Well Specifications

Hole Diameter d_h =
Well Casing
Inside Diam d_wID =
Water Level H =
Depth of Well TD =

Purge Volume Calculations

Well Volume (ft^3)= $V_c = \pi(d_w ID/2)^2(TD-H)$=
Vt = Vc * 7.482 gal/ft^3 or Vt = (TD-H) * wcgf

Minimum Purge Volume (gallons)=
Vp = Vt x 3 =

Holding Tank Volume =

System Configuration

Date	Time Begin	Time Finish	Water Purged (gal)	Cumulative Water Purged (gal)	Cumulative Water Purged Well Vol	Water Characteristics pH	Conductivity (µ mhos/cm)	Turbidity (NTU)	DO (mgdo/L)	Temperature (° Celsius)	Comments

Sampling Date:
Sample Number:
Analyses to be Performed:
No. and Type of Sample Containers/Preserve:
Chain of Custody Seal Number:
Analytical Laboratory:
Date Shipped:
Carrier:

well casing diameter to gallons per foot of head: wcgf =
8 " = 2.637 6" = 1.468 4" = 0.653 3" = 0.367 2" = 0.163

TECHNICAL PROCEDURES

TP 1.2-20	**Collection of Groundwater Quality Samples**
TP-1.2-23	**Chain of Custody Procedure**
QP-11.1	**Calibration and Maintenance of Measuring and Test Equipment**

Note: Printed copies of the Technical Procedures section are available by request. Please contact:

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