Sampling and Analysis Plan for Vashon-Maury Island Groundwater Management Area

December 22, 2000

King County

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Vashon-Maury_Island_SAP

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1. INTRODUCTION

1.1 Project Description

Between 1988 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 Vashon–Maury Island. Each GWMP included proposals for data collection and management, with the purpose of monitoring both the groundwater quality and quantity.

The Vashon-Maury Island GWMA was designated a Sole Source Aquifer by the United States Environmental Protection Agency (USEPA) in June 1994. Island ground and surface water provide all of the water needed for residential, commercial and agricultural needs. Water quality in the Vashon-Maury Island GWMA is generally excellent. The emphasis of the GWMP is therefore to protect existing water quality. As such, the GWMP proposed thirteen goals to address hazardous materials management, infrastructure (e.g. sewage treatment, underground storage tanks, and landfills), pesticides, and sand and gravel mining to prevent ground water contamination (Vashon-Maury Island 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 Vashon–Maury Island, and in combination with sampling in the other GWMAs, throughout King County as a whole. Under this plan, the majority of the sampling will be conducted at wells previously sampled during development of the Vashon–Maury Island 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.

In addition to sampling wells previously sampled during development of the Vashon-Maury Island GWMP, more wells and springs in other areas of the island may be sampled when possible, as recommended in Appendix E of the GWMP. Examples of these areas include the Vashon Landfill, the NIKE Battery Site, the Vashon Sand & Gravel site, and various agricultural areas across the island.

1.2 Purpose

This Sampling and Analysis Plan (SAP) has been developed to guide the initial groundwater sampling on Vashon–Maury Island. Initial efforts under this SAP will begin in late 2000 and continue though 2001. Following receipt and interpretation of the results of this effort, the data

collection program will be revised in conjunction with the Vashon–Maury Island 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 Vashon-Maury Island Groundwater Management Area is a thirty-seven square mile area located in the southern end of Puget Sound. The island is bordered on the west by Colvos Passage from the Kitsap Peninsula, on the south by Dalco Passage from Tacoma, on the East by Puget Sound and King County, and on the north by Puget Sound (Figure 1). Low-density residential development covers much of the Island with zoning of one home per five and ten acres. Higher density residential areas are concentrated in the Vashon Town Center, Vashon Heights, Burton, Dockton and along parts of the shoreline. Multifamily, commercial and industrial uses are presently concentrated in the unincorporated town of Vashon and adjacent areas where sewer and other urban services are available (Vashon-Maury Island Ground Water Advisory Committee, 1998)

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 nineteen wells and 4-6 springs on Vashon–Maury Island will be sampled will be sampled initially. The locations of these wells and springs are shown in Figure 2. Groundwater sampling under this Plan will be conducted semi-annually. The first round of sampling will be conducted in January 2001. Another round of sampling will be conducted in summer 2001. As such, samples will be collected during both wet and dry seasons.

As mentioned, additional sampling locations recommended in Appendix E of the GWMP may be added when appropriate and necessary.

1.6 Project Organization and Responsibilities

Activities outlined in this SAP will be conducted by personnel from the King County Department of Natural Resources (KCDNR. Ken Johnson (KCDNR) will assume the role of Project ManagerContact 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

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;
- Field documentation of each well site;
- 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.

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 on Vashon-Maury Island. The wells and springs selected for monitoring provide good geographic coverage of the study area. During well selection, representation from major geologic units was considered, although a strong emphasis was placed on selecting wells completed in the shallowest hydrostratigraphic zone (Zone 1). This zone is the most susceptible to contamination and serves as an "early warning" to deeper zones.

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 therefore included an evaluation of susceptible areas based on land use. For example, groundwater sampling will be conducted downgradient of Island ranches to identify impacts to groundwater quality, specifically potential nitrate contamination. Salt-water intrusion will be evaluated by sampling wells near coastal areas. It should be noted that no attempt has been made to sample known 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. 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. 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.

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. 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 analytes such as nitrate, nitrite, and coliform necessitate this.

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-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 Designation

Each sample will be clearly labeled with a unique identification number, which will also be used on 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.

3.1.3 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.

3.2 Laboratory Analysis

Groundwater samples will be submitted to Laucks Laboratory for analysis.

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 Laucks Laboratory 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.

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 Laucks Laboratory'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.

Vashon–Maury Island Ground Water Advisory Committee, 1998. Vashon–Maury Island 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

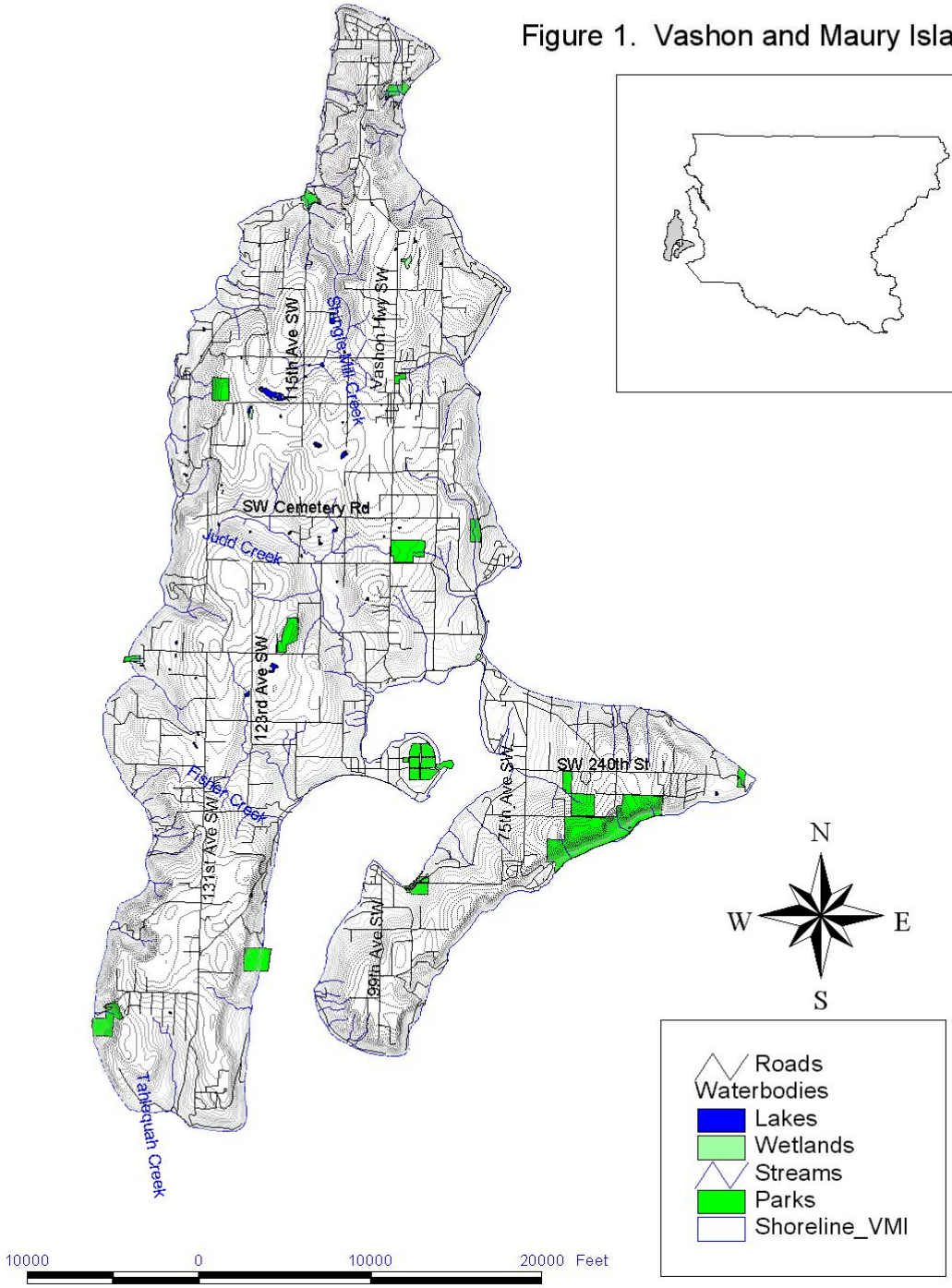
Figure 1. Vashon and Maury Islands
115th Ave SW
Vashon Hwy SW
Shawnee Creek
SW Cemetery Rd
Judd Creek
123rd Ave SW
Fisher Creek
131st Ave SW
Tahlequah Creek
SW 240th St
75th Ave SW
98th Ave SW
N
W
E
S
Roads
Waterbodies
Lakes
Wetlands
Streams
Parks
Shoreline_VMI
10000
0
10000
20000 Feet

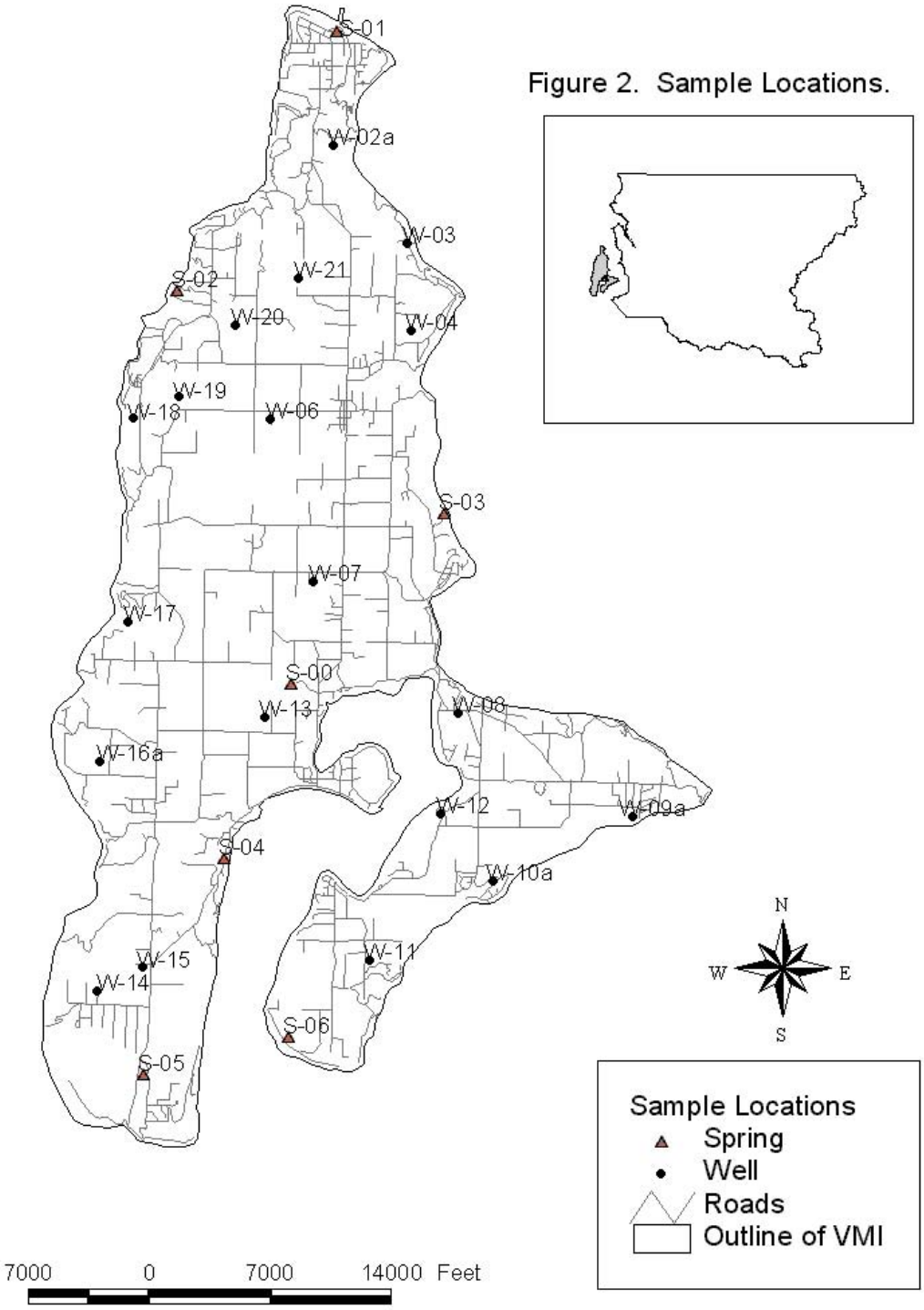

Figure 2. Sample Locations.

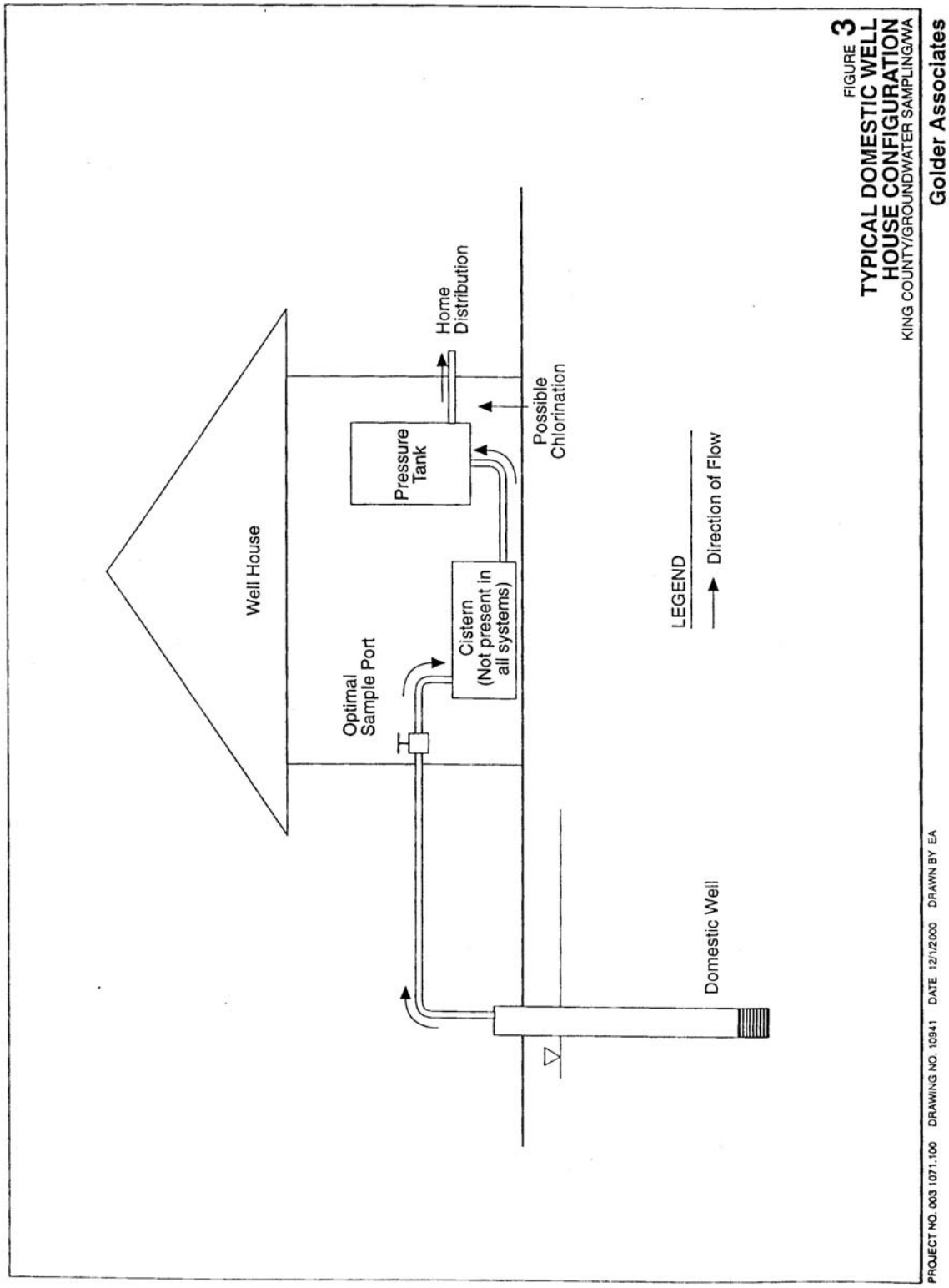

FIGURE 3
TYPICAL DOMESTIC WELL HOUSE CONFIGURATION
KING COUNTY/GROUNDWATER SAMPLING/WA
Golder Associates

ATTACHMENT A

WELL SAMPLING FIELD FORM

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

Well Specifications	**System Configuration**
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 =	

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

0219cr1 Tables.xls/Sampling Form

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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