King County Groundwater Management Program

2001 Annual Report

photo: Bill Priest

King County

King County Department of Natural Resources and Parks

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2001 Annual Report

April 1, 2002

KING COUNTY

EXECUTIVE SUMMARY

Assuring the public health and safety of King County citizens requires the protection of groundwater against threats to its quality and quantity in order to provide citizens with safe and reliable water supplies in the future. Protection of groundwater resources is also part of King County's commitment to meeting environmental stewardship obligations to King County citizens through proper management and protection of the groundwater vital to fish and wildlife habitat and important ecosystems.

2001 was a landmark year for King County and its groundwater protection activities. The King County Council adopted an ordinance formally establishing the Groundwater Protection Program, and naming the Department of Natural Resources and Parks as the lead agency for ensuring implementation of that Program. A major part of that ordinance was the establishment of locally based Groundwater Protection Committees for the purpose of implementing the four certified Groundwater Management Plans for Vashon-Maury Island, East King County, Issaquah Creek Valley, and Redmond-Bear Creek Valley.

During 2001, the Groundwater Protection Program engaged in a number of activities, and achieved a number of successes. Some of those include:

- Completion of a new round of ambient groundwater sampling and analysis, which show a continued high level of water quality in the County.
- Institution of focused groundwater sampling and analysis on Vashon-Maury Island and along the Sammamish River to address specific issues related to groundwater quality or fish habitat/water temperature.
- Presentations on groundwater protection to over 2,800 students in 33 schools, and at a variety of festivals, fairs and other events in King County.
- Responses to over 100 inquiries from the public on groundwater or resource issues;
- Developing web-based informational resources on a variety of groundwater topics of interest to multiple audiences and users.
- Organizing and participating in the initial meeting of the Vashon-Maury Island Groundwater Protection Committee, and establishing a schedule of monthly meetings during early 2002 to begin implementation of that area's Groundwater Management Plan.
- Renewal of routine meetings with the Department of Public Health on groundwater-related topics, such as on-site septic systems and small drinking water systems.

During 2002, King County will be facing a number of issues and challenges as it pursues its groundwater protection objectives. Some that have been identified are:

- Participating in the activities of three new Groundwater Protection Committees, in addition to the currently functioning one on Vashon-Maury Island, and working to implement the Groundwater Management Plans for each of them.
- Identifying and developing long-term, stable funding sources for King County and regional groundwater protection services.
- Improving the County's data management, including its ability to evaluate data and identify trends in quality and quantity that may be of concern.
- Developing cooperative projects and relationships within King County and with outside agencies and groups to further the County's groundwater protection interests.
- Responding to discrete or localized groundwater issues, such as arsenic contamination, and developing strategies to address them.

In 2002, developing partnerships will be essential to maintaining and protecting King County's important groundwater resources, especially in times of multiple environmental stresses and difficult economic times for local governments. The Groundwater Protection Program expects to do its part in providing value to King County residents through groundwater services.

Chapter 1: INTRODUCTION

Mission

The mission of the King County Groundwater Protection Program is to protect the quality and quantity of the groundwater resources in King County through policy and a variety of management and technical activities. King County's Program aims to protect the health and safety of King County citizens who use groundwater for drinking water supplies, and to preserve fish and wildlife habitat by ensuring for future generations the replenishment of streams, lakes and wetlands through groundwater.

This mission is particularly important in King County, where:

- Nearly 30% of the population relies on groundwater as their sole or primary drinking water source.
- Almost all of the nearly 1,800 water systems, and approximately 12,000 private wells, use groundwater as all or part of their supply.
- Under state and federal regulations, many groundwater-supplied water systems have developed and are implementing programs to protect their groundwater sources of supply.
- The adopted countywide Planning Policies for King County require all jurisdictions within the County to protect the quality and quantity of groundwater. Specifically require development of best management practices, mapping of groundwater resources, establishment of wellhead protection areas, and protection of critical groundwater areas.
- All four major watersheds within King County are conducting assessments of factors contributing to the decline of salmon–including flows, levels, water temperature and quality, and water-related habitat–as part of salmon conservation and recovery for the region.
- The County is participating in a Tri-County Endangered Species Act planning process to produce a model program of activities to protect and restore habitats in order to recover salmon, bull trout, and other species of fish that are or may be listed as threatened or endangered under the Endangered Species Act.
- The County is pursuing a comprehensive regional water supply plan that will address domestic water supplies, conservation, and reclaimed water.
- The County is participating in regional water planning forums, including the Central Puget Sound Initiative, one of three statewide priority areas for water resource planning.
- The County is actively pursuing increased use of reclaimed water as an essential component of its Regional Wastewater Services Plan. A portion of that plan includes extensive technical evaluation of the interplay of groundwater and surface water and opportunities to use reclaimed water to improve both water quantity and water quality.

- The County has adopted groundwater management areas and associated groundwater management plans for much of King County, which contain multiple strategies developed by locally based committees for protecting the quality and quantity of groundwater within communities.

Objectives

In meeting its obligation to ensure that groundwater resources are protected, King County is pursuing a program that does the following:

- Provides stewardship of groundwater in King County, sustains the people and habitats that depend on it, and establishes it as a safe and clean resource.
- Develops technical expertise and comprehensive data that pinpoints trends and provides the basis for strategies to respond groundwater threats.
- Coordinates activities and issues with tribes, purveyors, regional water supply forums, and planning groups, county departments, state and federal agencies and others to ensure information sharing and avoid duplication or conflicting efforts.
- Within available resources and on a priority basis, implements recommended strategies and activities that have been developed within the groundwater management plans. Pursues a comprehensive long-term funding approach for regional groundwater activities.
- Advocates for King County, at state and federal forums, and relevant groups.
- Integrates groundwater activities, programs, and objectives into a comprehensive, countywide water strategy that includes surface and ground water supplies, stormwater, and reclaimed water.
- Includes participation, including financial, by all parties who benefit from King County's program, including water purveyors and other groundwater users.
- Supports the startup and ongoing work of each of the Groundwater Protection Committees in each of the four Groundwater Management Areas.

History

For many years, groundwater protection and related groundwater management activities have been an important part of King County's public health and environmental stewardship responsibilities. Public Health-Seattle & King County (Public Health) administered programs related to drinking water and on-site septic systems as part of its public health responsibilities. Since its creation, and as part of the Metro merger in 1996, the King County Department of Natural Resources and Parks (DNRP) has been involved in groundwater issues as part of a mandate for resource management and environmental protection. (Note: Prior to January 1, 2002, the agency was the Department of Natural Resources; effective January 1, DNR merged with the King County Park System and took its current name)

Public Health and DNRP worked closely with locally established committees over 10-15 years to develop the Groundwater Management Plans for five Groundwater Management areas (Figure 1-1) in King County. Significant groundwater problems that threatened the resources had been identified in the five areas and led to the creation of the committees to address the problems in each of those distinct geographic areas. Following certification of four of the plans by the Department of Ecology in 2000, the King County Council provided interim funding to DNRP to move forward with implementation of the plans. With this interim funding, the DNRP program has focused on public education and outreach, data collection and management, policy and regulatory development, and coordination between related county efforts affecting groundwater protection. DNRP has also developed and strengthened relationships with state agencies—such as the Departments of Ecology and Health—and federal agencies such as the Environmental Protection Agency (EPA) and the United States Geological Survey (USGS).

DNRP also worked to establish the local groundwater committees that each Groundwater Management Plan proposed to coordinate implementation of each plan. Partly in response this need, the King County Council created, by ordinance, a Groundwater Protection Program for King County. The ordinance was adopted in October 2001 and went into effect on December 6, 2001. (A more complete description of content of the ordinance is provided in Chapter 2; the full text of the ordinance is in Appendix A.) The Ordinance named DNRP as the lead agency for all groundwater-related work within King County. The ordinance spelled out specific responsibilities for the program, and directed DNRP to coordinate pursuit of the County's groundwater protection objectives with other County departments, such as Public Health, and with other federal and state agencies. The ordinance created Groundwater Protection Committees for each of the four

Groundwater Management Areas with completed Groundwater Management Plans that had been certified by the Department of Ecology. The Council Ordinance directed DNRP to participate in the organization of these committees and provide support to them within available resources.

Scope of The Program

The ordinance lays out a core set of activities related to groundwater protection in King County. To a large extent, they reflect groundwater objectives and activities that have been underway for several years, including:

- Data management, including obtaining available data from other local jurisdictions in King County, federal and state agencies and tribal nations; reviewing and mapping data; maintaining a clearinghouse of data on groundwater in King County; and responding to data.
- Groundwater protection planning, including assisting with updating groundwater management plans; coordinating groundwater protection activities with water purveyors, water users, tribal nations, adjoining counties where appropriate, the Washington state departments of Health, Ecology, Fish and Wildlife, and other appropriate state and federal agencies; and participating in County activities and

forums where groundwater protection may be a significant issue, in areas such as water resource inventory area work and Endangered Species Act work.

- Coordination of technical expertise in groundwater, including but not limited to geology, hydrology; geophysics and geophysical methods; and mapping.
- Monitoring countywide tracking of environmental benchmarks in accordance with King County's countywide planning policies.
- Monitoring and data collection in the Vashon-Maury Island and east King County groundwater management areas from existing sampling sites, and monitoring and data collection pilot projects in incorporated and unincorporated areas of King County.
- Stewardship of groundwater in the unincorporated areas of King County where stewardship services are not provided by special purpose districts, sewer and water utilities and associations and water purveyors.
- Regional education and public involvement in groundwater protection issues.
- Participation in the development of strategies to prevent the contamination of sensitive aquifer areas from spills of hazardous materials.
- Identification and mapping of critical groundwater recharge areas and participation in the protection and development of protection or remediation strategies for these areas.
- Serving as a clearinghouse for groundwater models that address cross-jurisdictional groundwater problems within a groundwater management area or among groundwater management areas.
- Reviewing and recommending health regulations related to groundwater protection;
- Recommending amendments to the countywide planning policies and environmental benchmarks related to groundwater protection.
- Recommending any combination of activities, policies and procedures to public and private entities that have impacts on groundwater or that may be necessary to implement elements of the groundwater protection program.
- Developing comprehensive policies that integrate groundwater protection, surface water, stormwater, wastewater, and reclaimed water and protect critical water recharge areas.

As lead agency, DNRP is responsible for the following:

- Providing support and serving as liaison to the Groundwater Protection Committees, and participating in implementation of the Groundwater Management Plans.
- Developing short- and long-term work plans for the Program.
- In cooperation with local jurisdictions, water purveyors, special purpose districts and other interested parties, developing a long-term funding strategy to meet the needs of the County's program.

- Providing reports and meeting other commitments as provided in the Ordinance.
- Coordinating groundwater activities with state and federal agencies, tribes, local governments, water purveyors and users and participating in such activities as Endangered Species Act studies and plans where groundwater may be an issue.
- Coordinating groundwater activities within King County with Public Health, the Office of Regional Policy and Planning (ORPP) and the Department of Development and Environmental Services (DDES).
- Recommending possible changes in the areas of public health regulation, countywide planning policies, land use practices (e.g., critical recharge area protection) and tracking of groundwater trends in environmental benchmarks.
- Developing comprehensive policies that integrate groundwater protection, surface water, stormwater, wastewater, and reclaimed water.

Potential Program Scope

In 2001, the Groundwater Protection Program had staffing and funding levels that were residual from the "Early Start" program that was authorized by the King County Council in 1999. This level of resources allows for a limited water quality/quantity monitoring and data management program, with some countywide tracking of Growth Management Act Environmental Benchmarks; an education/outreach program that reaches a limited number of schools and other events; participation in the work of the Groundwater Protection Committees and other forums; and some work with other agencies and King County programs on groundwater issues.

In order to fully address groundwater issues within the geographic area of King County, a regional Groundwater Protection Program could ultimately include:

- Activities that directly benefit the groundwater resources under King County's control or management.
- Regional activities that can be accomplished at a minimal cost or expanded to the extent there is regional participation in funding.
- Stewardship of groundwater in the rural areas, based on local input, and in the remainder of King County based on agreements with local jurisdictions.
- A basic level of the highest priority strategies from the Groundwater Management Plans, ultimately coupled with fully funded activities agreed to by all necessary and interested groups.

As directed by the County Council, in 2002, DNRP will be pursuing with its partners the desired scope of a regional program, and options to fully fund it.

Chapter 2: GROUNDWATER PROTECTION SERVICES IN 2001

The Department of Natural Resources and Parks (DNRP) is the lead agency for the King County Groundwater Protection Program. While the agency maintains partnerships with numerous federal, state, and local agencies, also responsible for aspects of groundwater protection in King County, this report emphasizes the role of DNRP.

The agency's activities in the Groundwater Protection Program are grouped into four categories:

- Data Collection and Management.
- Education and Public Involvement.
- Regulatory and Policy Development.
- Program Coordination.

The following describes the basic elements and activities during 2001 of each program element, including its overall objective. Specific results from work in 2001; e.g., the results of ambient groundwater monitoring—are contained in Chapter 3 of this report.

Program Services – Data Collection and Management

Gathering new data and making existing information more accessible and useable emerged as central themes of groundwater management and data collection in 2001. In some cases, actions were taken as a direct response to vital projects and issues in King County. In other cases, action was focused on maintaining and improving the general knowledge of groundwater in King County. Knowledge of groundwater continues to affect future decisions and policy questions. Efforts at maintaining and improving King County's information about groundwater could change because of budget challenges in 2002.

Data Objectives

A main objective of the King County Groundwater Protection Program is to protect the region's groundwater from reductions in quantity and quality. To do this, it is essential to identify any groundwater problems and develop approaches to solve them. A wide-ranging monitoring program, designed to detect changes and trends early, is an integral part of understanding the issues.

Data Compilation and Database Development

The purpose of the groundwater database is to compile information about groundwater quantity and quality, to allow it to be compared over time and space, and to use it to generate conclusions about how and where the resource is changing. This kind of analysis is essential to design appropriate groundwater protection efforts. Entering data is extremely important. However, it is equally important to extract information in an

organized way for analysis, and to provide the information for independent interpretation by the public or the groundwater consulting community.

The Groundwater Protection Program's main tool for managing data is King County's comprehensive database called EQuIS. The database contains information for more than 6,800 locations, including well location/owner information, well log, water level quantity and water quality. This includes data for 1,300 locations, from a variety of sources, that the Program added in 2001.

The lack of a central clearinghouse for the data has made research on groundwater problems difficult in the past. A variety of people and agencies have collected groundwater information from wells in King County. For instance, water purveyors are required to compile and submit data that measures water quality and quantity, and DNRP has access to that information. During 2001, DNRP worked with Public Health to collect all information from small "Group B" water systems in King County. It already had similar data from the state Department of Health for larger, "Group A" systems in the County. The locations of public water systems are shown in Figure 2-1. State and federal agencies—including EPA, USGS, and Ecology—that are involved in groundwater issues also keep track of data on new well locations. All their information can now be found in EQuIS.

One of the sources of data for the Groundwater database is the "ambient" sampling program described later in this report. The information was first collected approximately 10 years ago at more than 60 sites as shown in Figure 2-1. Those sources were resampled in 2001 for pH, conductivity, temperature, dissolved oxygen, turbidity and water level as part of the certified Groundwater Management Plans, and the results from the chemical analysis of the samples were entered into EQuIS.

Responding to data inquires and requests from King County employees and the public is part of managing the groundwater data warehouse. Information is disseminated through spreadsheets, maps, graphics and files in the DNRP Geographic Information System (GIS). The Groundwater Protection Program also creates separate computer files with geographic data relevant to groundwater issues.

The DNRP GIS staff has created an interactive map program that contains groundwater data (iMap). The program allows data to be shared visually via the Internet. It can be found at **http://www.metrokc.gov/gis/mapportal/iMAP_main.htm**, under the title "groundwater project."

King County and the University of Washington Center for Urban Water Resources Management developed a data-sharing partnership in 2001. The project was part of an ongoing effort to map the geology of King County. The Groundwater Program shared its entire EQuIS well information with the University of Washington.

The Groundwater Protection Program and the Department of Natural Resources and Parks Solid Waste Landfill Unit are utilizing the EQuIS software. Both departments

work cooperatively in managing data with EQuIS by sharing software upgrades, discussing data input and output issues and resolving any problems related to data management.

Ambient Groundwater Monitoring

Protecting the health of King County citizens and the County's vital drinking water sources is an important part of the King County Groundwater Protection Program. Frequent sampling and analysis of groundwater is effective in providing early detection of water quality problems. Both DNRP and Public Health are engaged in this effort.

King County's Groundwater Protection Program conducted a comprehensive set of groundwater sampling in 2001. Two rounds of water samples were collected from nearly 70 groundwater wells in King County for the main component of the program (Figure 2-1). Samples were analyzed for a wide range of elements potentially in the water, including coliform, metals, nitrates, pesticides, and herbicides. The wells tested were located within the four King County groundwater management areas with State certified management plans (see Figure 1-1). The sampling wells were chosen over ten years ago because they provide a good representation of each area's entire groundwater aquifer, were evenly spread throughout the area, and reached varied ground depths. Results from samples taken during the initial development of the Groundwater Management Plans could be compared with the results from 2001 to look for significant or threatening changes in water quality or quantity that have occurred since the initial sampling (in some cases, 14 years ago).

The results of this monitoring did not demonstrate and widespread or serious groundwater contamination issues. See Chapter 3 for detailed results.

Partnerships with private citizens and local governments give King County access to other sampling sites and historical data within the County. Plans in 2002 include the completion of two more rounds of sampling in the wells, and development of an ongoing sampling regime, which is essential to track trends in groundwater.

Water Level Measurement

In addition to protecting King County's groundwater quality, it is equally important to monitor groundwater quantity. Monitoring water levels in wells documents any short-term fluctuations in groundwater aquifers (e.g., seasonal) and, over time, long-term increases or decreases in available water. It helps ensure that King County residents will have adequate water supplies for drinking, agriculture, and other uses.

The Groundwater Protection Program monitored water levels in approximately 50 wells as part of the ambient groundwater monitoring described above. The 50 were the only accessible wells for water level measurements of the nearly 70 wells selected for water quality sampling. Measurements were taken at least twice in 2001.

The 2001 sampling did not show any significant trends in groundwater quantity. See Chapter 3 for detailed results.

Partnerships with private citizens and local governments allowed King County the opportunity to obtain historical data and gain access to sampling sites. Plans in 2002 include between six to eight measurements of water levels in the wells. In order to accurately identify and track groundwater level trends, the Program will need to develop either additional sites and do more routine sampling, or will have to develop extensive partnerships and expand existing ones in order to gain access to the necessary data.

Focused Sampling

In addition to the ambient monitoring, DNRP staff conducted or coordinated focused sampling in several areas of known concern, or where additional data was needed for King County or regional water planning needs. Examples include the sampling on Vashon-Maury Island and along the Sammamish River. In nearly all cases, DNRP was able to conduct the sampling because of the willingness of property owners to either provide access or to actually participate in the sampling.

Vashon-Maury Island Focused Sampling for Nitrate and Chloride

In addition to the countywide monitoring program, DNRP staff also coordinates focused monitoring on Vashon-Maury Island. Vashon-Maury Island has been designated by the EPA as a "sole source aquifer." All groundwater on the island comes strictly from rainfall that travels down into the aquifer underlying the island, which is completely isolated from other aquifers by the salt water of Puget Sound. Protecting the aquifer is extremely important since it is the only source of drinking water for island residents.

The Vashon-Maury Island Groundwater Management Plan identified elevated levels of nitrate and chloride in groundwater as two immediate risks to the island's groundwater health. Elevated nitrate levels can result from failing septic systems, over- fertilization, or livestock waste. The condition can lead to adverse health effects for humans, especially young children. Elevated chloride levels can result from saltwater intrusion into the freshwater aquifer, which makes the water undrinkable. As a result, early detection of high nitrate and chloride levels is essential for protecting the island's drinking water.

In 2001, DNRP coordinated sampling at five groundwater wells in areas with apparently elevated nitrate levels, and three wells in areas with possible elevated chloride levels. The test results generally confirmed the elevated levels of these two contaminants. DNRP will arrange additional sampling in adjacent areas in 2002 to try to identify the source and extent of the elevated levels. These locations are shown in Figure 2-2.

Vashon-Maury Island Landfill Water Quality Sampling

During 2001, DNRP staff developed a plan for increased groundwater quality sampling in the landfill area on the west side of the island. The King County Solid Waste Division is monitoring groundwater on the actual landfill site; the DNRP effort added monitoring of groundwater in the adjacent areas downgradient from the landfill. DNRP planned to water quality samples from 11 groundwater wells located around the landfill site in February 2002 (Figure 2-2), and analyze them for a comprehensive list of parameters

including metals, herbicides and volatile organics. After evaluating these test results, follow-up sampling will be conducted on an as-needed basis throughout 2002.

Vashon-Maury Island Volunteer Water Level Monitoring

The Vashon-Maury Island Groundwater Management Plan calls for the use of citizen volunteers to collect groundwater level data. In May 2001, the groundwater program recruited and trained 25 Vashon-Maury Island citizens to measure water levels in their private and public groundwater wells (Figure 2-2). The volunteers made a 12-month commitment to measure water levels in their respective groundwater wells on a monthly basis. The data will supplement ongoing monitoring efforts to learn more about the island's groundwater quantity, which ultimately protects the island's groundwater.

The program allows citizens to take an active role in protecting their resources. In doing so, residents learn about their natural resources and what they can do to protect them. The goal is to continue the program through 2002 and beyond, with additional volunteers as needed. The action is an assurance that any significant changes in water levels will continue to be closely monitored.

Sammamish River Valley Groundwater Study

The Sammamish River (Figure 2-3) is the source of approximately 30 percent of the flow into Lake Washington. For many years, this statistic was the basis of the Sammamish River's identity. The river was known as a tributary to the lake. Now, the river and its valley are recognized as a migration corridor for fish and wildlife. The area also is known as the ecological link between Lake Washington, Lake Sammamish, and upland habitats and ecosystems in the Bear, Little Bear, North, and Swamp Creek basins.

Groundwater and outflow from Lake Sammamish are the primary sources of flow in the Sammamish River in the late summer and early fall. Groundwater is extremely important during the summer because it offsets high temperatures in the river caused by warm water from the lake. Without the input of cool groundwater, flow in the river would be too little and too warm to support or allow salmon migration.

King County's Sammamish Valley groundwater study began in 2001. Information in the study will be used to recommend habitat improvements that are well matched with current uses of the river corridor, which include recreation, agriculture, and urban development. The study will contain strategies for dealing with flow and temperature problems in the Sammamish River between Redmond, Woodinville, Bothell, and Kenmore. Input will be provided to help guide development of reclaimed water projects in the river corridor.

The Sammamish Valley groundwater study is based on developing partnerships and strategically combining existing data and resources with new data. For example, the plentiful rains in November and December 2001 provided opportunities to study the response of groundwater levels to changes in the water levels of Lake Sammamish and the Sammamish River. The responses were measured by monitoring wells that had been used in an earlier study by King County in Marymoor Park. The University of

Washington provided the equipment at no cost. The city of Redmond also provided access to a number of its monitoring wells.

Additional information on geology and groundwater in the valley was collected in 2001 through collaboration with the USGS and the Department of Ecology. The USGS provided water level data from more than 90 wells. The Department of Ecology documented the information on 800 pages of well logs. Preliminary cross sections and water level maps were developed through some of the well logs. The well logs represent more than 12,000 feet of drilling and nearly $1 million in drilling costs. The cross sections and groundwater maps will be used in 2002 to enhance future data collection and to develop a groundwater model.

The Sammamish Valley groundwater study, funded by the Reclaimed Water program in King County's Wastewater Treatment Division, also includes:

- Copies of consultant reports on file at the Department of Ecology. The reports document groundwater resources in Water Resource Inventory Area 8, which includes the Sammamish River Valley.
- A work plan for the Center for Urban Water Resources Management at the University of Washington. The plan contains information on obtaining additional boring logs and cross sections on the valley.
- Compiled information and calculations to help estimate how much groundwater in the valley comes from Lake Sammamish to the river valley.
- The completion of a water balance for Bear Creek that contains late summer conditions. The water balance will provide information on groundwater inflow to the Sammamish River Valley from the Bear Creek basin.

Green-Duwamish Water Quality Assessment and Sammamish-Lake Washington Analysis and Modeling Project

Technical support was provided in 2001 through the groundwater program to the Green-Duwamish Water Quality Assessment and the Sammamish-Lake Washington Analysis and Modeling Project. The overall goal of the projects is to provide information on water quantity and quality. The information fulfills requirements imposed by growth management and environmental legislation and is available for decisions related to resource protection.

The water quantity and quality information is obtained through monitoring and modeling activities for the watershed study areas in the Sammamish-Lake Washington Analysis and Modeling Project and Green-Duwamish Water Quality Assessment. The results of the monitoring and modeling activities are used to assess the impacts of land use and legislative changes on King County land and water resources. The projects are an important resource during wastewater capital planning, habitat conservation planning and salmon recovery, and watershed planning efforts. The projects also provide necessary information for ecological and human health risk assessments and habitat and biological assessments in state and federal mandates.

The Sammamish-Lake Washington Analysis and Modeling Project and Green-Duwamish Water Quality Assessment in 2001 focused on surface waters–lakes and streams within the study areas. Since groundwater affects water quantity and quality in these lakes and streams, representatives of the groundwater program helped design an approach for modeling the watersheds and collecting the data to support the models.

The Sammamish-Lake Washington Analysis and Monitoring Project and Green-Duwamish Water Quality Analysis is funded through King County's Wastewater Treatment Division.

Analysis of Arsenic Levels

On October 31, 2001, the U.S. Environmental Protection Agency announced the maximum acceptable level of arsenic in drinking water would be lowered from 50 parts per billion (ppb) to 10 ppb. The announcement followed a study by the National Academy of Sciences on the health risks–principally different forms of cancer–associated with drinking water that contains high levels of arsenic. Federally regulated water systems will have to comply with the new standard on January 1, 2006, and will have to report to customers before that date if they have detected arsenic in their supplies at over half the new regulatory limit. Systems with sources that exceed the new standard will either have to treat their water to remove the arsenic, or will have to find and develop new sources of supply.

Small water systems not subject to federal regulations (generally those with fewer than 15 hookups), and private wells, will only be subject to the new standards if they are adopted by the Washington State Board of Health or the Seattle-King County Board of Health.

King County has approximately 225 water systems that are subject to the new federal rules. There are an additional 1,600+ water systems, and an estimated 23,000 wells supplying water to individual homeowners, that are not subject yet to the new federal standards.

The King County Groundwater Protection Program at DNRP had taken a proactive approach in obtaining information on arsenic issue before the recent change in federal regulations. Existing information within King County's groundwater database has been used to identify the areas with arsenic levels that exceed the new standard. Groundwater samples, collected in December 2001 as part of King County's ambient groundwater monitoring program, were analyzed for arsenic levels. Data on arsenic levels also has been obtained from the U.S. Geological Survey and the Washington State Department of Health.

In general, the concerns regarding arsenic apply only to groundwater sources of water, not rivers and streams that supply the bulk of the population in King County. Several areas in unincorporated King County contain groundwater with arsenic levels that exceed 10 ppb. Many homeowners in these areas get their water from single-family wells or

small water systems regulated by Public Health. These locations are shown in Figure 2-4.

DRNP staff will be working with Public Health, the state Department of Health, and with the Groundwater Protection Committees to address health issues in areas and with systems that have elevated and unsafe levels of arsenic in their groundwater. This will include information now available on groundwater treatment options for private well owners and small water systems. This information will identify technical and other options, and will include address technical feasibility and cost. The information also will be included in education and outreach programs.

Program Services – Education and Public Involvement

Education Objectives

The Groundwater Education Program uses classroom-style presentations and public outreach to help students and adults learn more about the quality and quantity of groundwater. Students take part in interactive classroom activities and home water use inventory/audits. Adults and the general public are educated through community fairs, festivals and environmental gatherings.

Classroom Presentations

The Program includes some basic educational pieces. For example, DNRP staff use an interactive skit to teach children the elements of the water cycle. The "players" include the "sun," a student with gold sunglasses and a golden wand. The "sun" causes the evaporation of "water," blue tennis balls, into the "clouds," a student wearing a cotton-ball-covered cap with blue water beads. Students assume the roles of the chief elements of the water cycle as they follow the raindrops through the cycle.

DNRP staff also use a visual groundwater model to illustrate to students groundwater conservation and contamination. The model is a plastic container filled with pea gravel and covered by artificial turf. A ketchup pump makes it a working model that represents an aquifer, water table, and the infiltration of water and pollutants. By tipping the model, the water table flows out of the ground and will show a lake, stream, or river fed by groundwater. Pumping the model dry and using food coloring, colored drinks, syrup, and other so-called "pollutants" give the students a visual representation of the potential damage to their groundwater supply.

(Pictures by jimmy Johnson, Twin Lakes Elementary)

"CONTAMINATING" GROUNDWATER **THE WATER CYCLE**

The students are also asked to conduct an inventory of their home as part of the lesson on conservation and contamination. They are asked to identify and assess water uses in and around the home. The students use their critical thinking and problem solving skills to make suggestions for groundwater conservation and protection. In the classroom, the students review their findings and the lifestyle changes that could positively affect the environment.

During 2001, DNRP staff made presentations to more than 2,800 students in 33 schools, located in 11 school districts, as shown in Figure 2-5.

Festivals

DNRP staff engage in public outreach for the Groundwater Protection Program primarily through exhibits, discussions and the dissemination of materials at community and environmental fairs. Interactive exhibits allow citizens the opportunity to discuss groundwater with King County employees. A groundwater model often is used to show the relationship of life above the ground to the water below the ground.

The King County Groundwater Protection Program set up a booth at a number of fairs and festivals (Figure 2-5). The asterisk indicates school oriented or sponsored events. (See Appendix B for a complete list.)

General groundwater conservation, protection, and other brochures are available to the public during festivals and fairs that involve the King County Groundwater Program. Through partnerships, local water districts, water departments and/or water purveyors also contribute their materials. The pamphlets cover a wide variety of topics such as:

- Local Groundwater Management Area Plans.
- Groundwater and drinking water.
- Citizen's Guide to Groundwater Protection, Environmental Protection Agency.
- Hazardous waste disposal.

- Natural landscaping and gardening.
- Care, maintenance and landscaping for people who are responsible for on-site sewage (septic tank) systems
- Water conservation.
- Endangered Species Act.
- Activity books for children.

Literature Production/Distribution

The Groundwater Protection Program used existing materials from various governmental agencies for public outreach and the educational programs. DNRP staff provided brochures to teachers to use as a follow-up to the King County presentations. (For a list of the most commonly used brochures, see Appendix B.)

Technical Presentations

The Groundwater Protection Program provides technical presentations tailored to the interests of a variety of groups. Presentations are made to professional societies, at public meetings, or to ad hoc organizations or groups.

The Program has not yet fully developed a cadre of technical speakers or marketed the presentations. However, staff members are getting into the community to educate the public about the importance of protecting groundwater. Presentations have included the following:

- An introductory "Groundwater 101" discussion during the training of volunteer water level monitors on Vashon Island.
- Background information given to the Natural Resources, Parks and Open Space committee of the Metropolitan County Council.
- A presentation on general Program scope and activities to the Maple Valley Unincorporated Area Council.
- A discussion of the Program data aspects with the Monitoring, Assessment, and Analysis Unit in the Water and Land Resources Division.

In 2002, the Groundwater Protection Program will be looking for more presentation opportunities, and will try to set up a technical speaker's bureau to provide a broader service.

Web-Based Materials

During 2001, staff at DNRP began development of an educational web page on the Internet. It will include:

Resources for teachers

- Links to sites designed to assist teachers or group leaders in presenting groundwater topics.

Fun for the young hydrologist

- Sites with enjoyable and interesting things to read and do.

Stewardship

- Information regarding how to work effectively as an individual or group to protect groundwater.

Other links

- Links to associations, agencies, etc., with an interest in groundwater.

Response to Public Inquiries

In 2001, DNRP staff responded to approximately 120 inquiries on groundwater issues from King County residents and others. This informal tally of inquiries does not include ongoing communication related to specific projects involving the Department of Development and Environmental Services, the Groundwater Protection Ordinance or committees.

E-mail addresses and telephone numbers for department employees are included on the King County Groundwater Protection Program Web page. Phone calls are routed to the staff members with the appropriate expertise. Additional questions from citizens have been answered by outreach staff members at festivals, samplers at private wells and with the help of the Water and Land Resources Division receptionist. All questions have been answered via e-mail, telephone, face-to-face discussions, or have been referred to the appropriate agency.

Examples of inquiries from the public include:

- Groundwater regulations for situations such as: setbacks for wells; developments in Well Head Protection Areas, Critical Aquifer Recharge Areas, or Special District Overlay areas.
- Concerns about groundwater quality, water level, or flow direction.
- Identity of the water system in a particular area (questions such as, “who provides water in my area and what is his/her phone number?”).
- Septic systems.
- Consulting firms.
- Groundwater data (water quality and water levels) in the vicinity of a specific project or where to obtain a report.
- Requests for copies of the Ground Water Management Plans.
- Possible frog mutations.

- Water rights associated with a property or the process needed to obtain water and water rights.
- Methods for analyzing water quality.

DNRP staff have been a resource on questions from persons outside of King County. A contractor in Wisconsin wanted to know how to enhance infiltration. A teacher at a school in the Netherlands asked for information about the Groundwater Protection Program in King County. A researcher in Nevada had heard (from South Africa) that in the past, King County investigated impacts from "human remains" on groundwater, and asked for information on that topic.

The Nisqually Earthquake on February 28, 2001, and potential impacts on groundwater, created some concern and generated some questions. Those included groundwater and its effects on a landslide into the Cedar River, reports of "very brown water" from some wells and damage to other wells, and how to find grant money to replace damaged water supplies.

Program Services–Regulatory and Policy Activities

Objectives

A key component of the comprehensive Groundwater Protection Program is a high level of coordination and support for all the elements of the program and related groundwater activities. The King County Council ordinance creating the Groundwater Protection Program (Ordinance 14214) established a number of regulatory and policy elements within the Program, and made the Department of Natural Resources and Parks the lead agency for implementation. The policy and regulatory responsibilities are provided by the Water Resources Policy Unit within the Director's office. As lead agency, the Department of Natural Resources and Parks is and will be responsible for such activities as:

- Providing support and serving as liaison to the Groundwater Protection Committees, and participating in implementation of the Groundwater Management Plans.
- Developing short- and long-term work plans for the Program.
- In cooperation with local jurisdictions, water purveyors, special purpose districts, and other interested parties, developing a long-term funding strategy to meet the needs of the program.
- Providing reports and meeting other commitments as provided in the Ordinance.
- Coordinating groundwater activities with state and federal agencies, tribes, local governments, water purveyors and users, and participating in such activities as Endangered Species Act studies and plans where groundwater may be an issue.
- Coordinating groundwater activities within King County with the Public Health, the Office of Regional Policy and Planning, and the Department of Development and Environmental Services.
- Recommending possible changes in the areas of public health regulation, countywide planning policies, land use practices (e.g., critical recharge area protection) and tracking of groundwater trends in environmental benchmarks.
- Developing comprehensive policies that integrate groundwater protection, surface water, stormwater, wastewater, and reclaimed water.

Some of these activities were already underway prior to the adoption of the Ordinance, and are described below. Others, such as development of an Annual Report, have timeframes that require action by the Department of Natural Resources and Parks over the next several years.

Groundwater Ordinance

Throughout 2001, the Department of Natural Resources and Parks supported the King County Council in its efforts to develop a structure and funding for a comprehensive, regional groundwater program in King County. The process included extensive stakeholder involvement, particularly from representatives of the groups that had

participated in the development of the Groundwater Management Plans. On September 24, the Council adopted the ordinance. It was subsequently signed by the Executive, and became effective in early December. A copy of the Ordinance is attached as Appendix A.

In addition to identifying the Department of Natural Resources and Parks as lead agency for the program, the Ordinance included the following key provisions and features:

- Statement of intent that a regional groundwater program be developed cooperatively.
- Statement of intent that the ordinance did not infringe on existing authorities, nor create new regulatory authority for King County.
- Statement of intent that all parties participating in groundwater protection work—King County, municipalities, special purpose districts, purveyors—are responsible for their own funding, policy and staffing decisions,
- Recognition of the State's legal authority to regulate groundwater withdrawals.
- Identification of a set of non-exclusive activities to be part of the County's groundwater protection program, based on available funding.
- Direction to the King County program to support (subject to available funding) implementation of activities within the certified groundwater management plans.
- Request to the Regional Water Quality Committee to make recommendations to the King County Council, between April and September 2003, on the efficacy of the program and on other specific elements (e.g., development of agreements and funding for regional groundwater protection services).
- Direction to the King County auditor to provide a report to the Council by July 2003 on groundwater services being provided.
- Creation of, and prescribing the responsibilities and procedures for, local Groundwater Protection Committees.

Groundwater Protection Committees

The Ordinance adopted by the King County Council established three Groundwater Protection Committees—one each for Vashon-Maury Island, East King County and Issaquah Creek Valley. The Council later amended the Ordinance to establish a Committee for Redmond-Bear Creek Valley. These four areas have certified Groundwater Management Plans. In the intent section of the Ordinance, the Council recognized that a draft plan is being developed for the South King County area and stated that the legislation was intended to complement and not replace the efforts of the advisory committee working on the plan. Each of the committees is to remain in existence through December 31, 2004.

Each Committee is to have at least ten members with representatives from various groups interested in groundwater issues. The groups include local governments, water and sewer purveyors, business, agriculture, and environmental and residential well users. Each

tribal nation with federally recognized rights within each groundwater management area is invited to participate. The state Departments of Ecology and Health, adjacent county governments, and Public Health as ex officio members also are invited to participate.

The Committees are to meet at least three times each year, and have a detailed set of responsibilities, which include:

- Advising the King County Executive and County Council on groundwater activities and issues and keeping elected officials and their organizations informed;
- Monitoring and participating in implementation of the Groundwater Management Plans and developing and recommending modifications to the plans;
- Reviewing and making recommendations on the short- and long-term work plans for regional groundwater needs;
- Coordinating community groundwater needs with local organizations;
- Providing annual status reports on their activities;
- Making recommendations on distribution and use of aquifer protection funds;
- Recommending changes to county planning policies affecting groundwater protection;
- Recommending services tailored to the unique needs of the local area;
- Providing advice on state groundwater regulation.

Appointments to the Committee are to be made by the King County Executive, subject to confirmation by the Council. The Committees are to operate under a set of bylaws developed by the County and adopted by the Committee, which may include creation of subcommittees. All meetings are to be open. Each committee is to solicit input from individuals, groups, agencies, and elected officials with interests in groundwater.

The Vashon-Maury Island Groundwater Protection Committee was the only Committee to begin operation in 2001. The committee held its first meeting on December 12. Members selected interim officers and developed a schedule of meetings and a list of agenda items through April 2002. The group also reviewed information provided by the Department of Natural Resources and Parks on activities and budget for groundwater protection services on the island for 2001, as required in Section 7 of the Ordinance.

A status report for the Vashon-Maury Island Groundwater Protection committee is included as Appendix C.

The Department of Natural Resources and Parks expects the remaining three Committees to begin meeting during the first half of 2002.

Assistance to the Department of Development and Environmental Services

Staff at DNRP in the Groundwater Protection Program provides technical expertise and support to King County's Department of Development and Environmental Services, the environmental/land use permit agency for King County.

Services provided in 2001 included:

- A review of the analysis of groundwater impacts in the Environmental Impact Statement and State Environmental Policy Act checklists.
- A review of groundwater monitoring plans (part of required mitigation).
- Testimony before the Hearing Examiner regarding the technical basis for a Department of Development and Environmental Services decision.
- A review of public comments.

The Department of Development and Environmental Services list of active groundwater projects in 2001 included:

- North Bend (Grouse Ridge) Gravel Mine (L01RE060).
- Snoqualmie Hard Rock Quarry (L00RE012).
- Trilogy & Redmond Ridge UPDs.
- Icy Creek (Franklin Plat) (L01P0001).
- Northwest Pipeline, Evergreen Expansion Project.
- Treemont Plat (L00MI078).

For additional information, refer to the Department of Development and Environmental Services web site at http://www.metrokc.gov/ddes/.

Assistance to Public Health–Seattle & King County

During 2001, staff at DNRP and Public Health initiated an regular series of meetings to discuss overlapping issues between the two agencies. These included development and funding of the Operation and Maintenance Program for On-Site Sewage (Septic) Systems at Public Health; implementation of the new federal standard for arsenic on small systems in King County; exchange of data regarding small public water systems; and participation in the Groundwater Protection Committees and implementation of the Groundwater Management Plans. For both agencies, the development of stable, reliable, and adequate sources of funding for their programs is a high priority that both agencies expect to address cooperatively in order to provide high quality and efficient services to the public. The ongoing meetings begun in 2001 are expected to continue in 2002.

Assistance to the Department of Ecology on Underground Injection Control Regulations

The EPA regulates the practice of injecting waste fluids into underground geologic formations. Originally, this Underground Injection Control (UIC) program was designed to protect groundwater from the injection of materials such as toxic wastes. EPA has broadened the scope of regulated practices to cover any waste, even stormwater runoff. In Washington, the Department of Ecology administers the federal regulations.

In 2000, EPA extended the program to additional "wells." The new definition of "wells" meant that large septic drainfields or similar infiltration facilities qualified as UIC facilities. DNRP owns and manages numerous such facilities as part of its stormwater flow control and water quality inventory. The new regulations required King County to provide information on these facilities to the Department of Ecology. Groundwater Protection Program staff helped classify the facilities, create the necessary database, and submit the required information to Ecology, through a partnership with DNRP's Stormwater Services unit. The database contains 31 Underground Injection Control facilities owned or maintained by DNRP.

Program Services – Program Coordination

An effective and efficient Groundwater Protection Program requires coordination of efforts with by DNRP with agencies and entities across jurisdictional authorities. The following sections describe some of these activities in 2001.

Coordination Objectives

The purpose of the program coordination is to assure efficient and effective use of public resources to provide groundwater protection to provide high value to King County residents in these services.

King County Agencies

The DNRP Groundwater Protection Program is a cooperative effort between agencies underneath the King County umbrella. In some cases, the coordination involves a service such as a technical review to the Department of Development and Environmental Services (DDES), groundwater investigation work on a Wastewater Treatment Division project, or land surveying work by the Department of Transportation for a groundwater project. Interfund transfers provide full budgetary accounting. Often, the coordination efforts happen because the various agencies provide overlapping services to the public.

<u>Water and Land Resources Division</u>

Groundwater Protection Program employees have a wide variety of responsibilities within King County:

- Groundwater data collection, management and analysis efforts take place in the Scientific and Technical Support area of the Science, Monitoring and Data Management unit in the Water and Land Resources Division.
- Groundwater Outreach and Public Involvement is mostly performed in conjunction with other outreach efforts in the Land and Water Stewardship Services unit in the Water and Land Resources Division.
- Groundwater Policy is handled in the Water Policy Unit, within the Director's Office of the Department of Natural Resources and Parks.

Employees with the Groundwater Protection Program also work with other units within the Water and Land Resources Division, mainly to coordinate efforts and provide technical support. The groups include:

- Basin Stewards, who coordinate monitoring efforts and outreach.
- Surface water monitors (stream gaugers), who provide data collection coverage for the entire water cycle.
- Data management and laboratory for statistical and analytical laboratory services.
- Surface Water Engineering Services and Ecological Services, sharing data and technical expertise. This unit often installs and monitors wells, especially for wetland investigations.

- Drainage Investigation and Facilities Maintenance, and Regulations and Compliance, which coordinates review of the State Environmental Policy Act, revision of the National Pollutant Discharge Elimination System, development of the Total Maximum Daily Load and Underground Injection Control compliance.

Solid Waste Division

The Groundwater Protection Program coordinates closely with King County's Solid Waste Division, specifically the Landfill/Environmental Unit in Engineering Services. The two divisions share the EQuIS database program, support each other on technical issues, training and data sharing. Solid Waste Division employees also participate in the Groundwater Protection Program Committees.

Through a partnership with the Solid Waste Division Landfill/Environmental Unit, the Groundwater Protection Program will sample private water supply wells near the closed Vashon landfill site in 2002.

Wastewater Treatment Division

Groundwater Protection Program staff work on several projects with the Wastewater Treatment Division (WTD), which is the source of funding for the work. The largest projects are connected to the Regional Wastewater Services Plan. Monitoring and modeling projects such as the Green/Duwamish Water Quality Assessment and the Sammamish-Lake Washington Analysis and Modeling Project are two examples in this category. Both projects will require input of groundwater data/expertise.

The additional use of Reclaimed Water is proposed in the Regional Wastewater Services Plan. The Sammamish River Valley Groundwater Investigation, regarding one of the most viable sites for the use of reclaimed water, is a requirement in the plan.

The Regional Wastewater Services Plan addressed the Inflow and Infiltration ("I&I") problem with the regional wastewater facilities. WTD and Groundwater Protection Program staff are engaged in a project specifically targeting I&I, with its relationship to groundwater as the source of infiltration. This project and others are managed through the Major Capital Improvements Section of the Wastewater Treatment Division.

Department of Development and Environmental Services

Coordination with the Department of Development and Environmental Services (DDES) focuses on projects that involve groundwater and trigger the State Environmental Policy Act (SEPA) review of plans and environmental impact statements. Developing and modifying local land use and permitting ordinances to protect groundwater from development impacts was identified as a priority in each of the Groundwater Management Plans, and will likely be a high priority for Program staff in the coming year.

Department of Transportation

The Groundwater Protection Program coordinates with King County's Department of Transportation in sharing data from a number of monitoring wells near Department of Transportation facilities. Department of Transportation survey services provide accurate elevations and locations of monitoring facilities. In the future, increased coordination will involve consideration of roadway drainage features as sources of infiltration to groundwater.

Public Health – Seattle & King County

One of the Groundwater Protection Program's most significant partnerships continues with the Public Health–Seattle & King County (Public Health). The two agencies share similar responsibilities. Public Health's public health mission includes possible health impacts from inadequate or unsafe groundwater (e.g., contamination); DNRP's mission focuses on management of groundwater as part of overall responsibilities for protection and preservation of public resources.

The two agencies initiated coordination meetings in 2001, and anticipate continuing them indefinitely to accomplish outreach, data collection, and sharing and policy objectives. Public Health is also an ex-officio member of the Groundwater Protection Committees, and is expected to participate in those committees during 2002.

Water Resource Inventory Areas (WRIAs)

Major resource management and protection activities are underway as part of the development of salmon recovery plans within each of the Water Resource Inventory Areas (WRIAs) in King County. Each WRIA group is organized under an Interlocal Agreement (ILA) that created a Steering Committee of elected officials, a Forum of all interested parties, and a Technical Committee of staff that focus on issues related to restoring fisheries in King County. DNRP staff participate in the technical work related to flows and groundwater, including sophisticated modeling that is being done. To the extent that base flows in streams from groundwater are identified as priority issues for fish habitat, Groundwater Protection Program staff will be engaged in WRIA efforts in the future.

Metropolitan King County Council

In 2001, the King County Council drafted and passed the Groundwater Protection Ordinance. The council also appointed members to the Groundwater Protection Committees (presently only Vashon–Maury Island). Members will be appointed to three more Groundwater Protection Committees in 2002.

State Agencies

King County maintains partnerships with agencies at other levels of government. The Departments of Ecology and Health are two of the agencies in the State of Washington that work with the Department of Natural Resources and Parks, and Public Health. Coordination activities with the state agencies are described in the following sections:

Washington State Department of Ecology

The Washington State Department of Ecology has responsibility for managing the "waters of the State," which includes groundwater. The agency's Water Resources Program maintains water rights and its Water Quality Program controls groundwater quality. The King County Groundwater Protection Program works closely with the Department of Ecology on data and policy issues. These coordination efforts include:

- King County is represented on the Department of Ecology's Interagency Groundwater Committee, which meets bimonthly.
- King County's Surface Water Management program has a National Pollution Discharge Elimination System (NPDES) permit for its control structures, which includes some consideration of groundwater impacts from Surface Water Management facilities. The terms of the permit are being negotiated with Ecology.
- As part of the Sammamish River Valley Groundwater study, Ecology's Environmental Assessment Program is assisting with a study of surface/ groundwater interactions through the placement of mini-piezometers adjacent to the river.
- Ecology staff are ex officio members of each of the Groundwater Protection Committees, and have been attending the meetings of the Vashon-Maury Island Groundwater Protection Committee.

Washington State Department of Health

Groundwater Protection Program staff work with the Washington State Department of Health (DOH) on projects mainly related to the state agency's responsibility for large ("Group A") public water systems across the state. Through its water system water quality database ("SADIE"), DOH provides important data for the Groundwater Protection Program.

DOH is also an ex officio member of each Groundwater Protection Committee, and is expected to participate in their activities during 2001.

Local Governments

King County is a regional government as well as a local government for the unincorporated areas. In 2001, the Groundwater Protection Program maintained partnerships with local governments for a variety of reasons:

- The cities of Redmond, Issaquah and Duvall shared the use of their water supply wells for ambient water quality sampling and data; Redmond has made some wells and data loggers available as part of the Sammamish River Valley Groundwater Study.
- Shoreline and Bothell staff managing their surface water have interests in groundwater interaction with their systems, including observation of significant infiltration rates to the Bothell system and into the Sammamish River.

- The Auburn Public Works Department has coordinated with DNRP regarding its Well Head Protection Area delineation.
- Kent and Renton have strong aquifer protection ordinances and efforts; Redmond is developing its own such program and has contacted the Groundwater Protection Program about pursuing this.
- The development of the Groundwater Protection Ordinance has involved various cities in King County and will continue through the representation by cities on Groundwater Protection Committees.

Special Purpose Districts

The main special purpose districts that the Groundwater Protection Program works with are water purveyors. Program staff frequently meet with a purveyor group on Vashon–Maury Island and have instituted a data-sharing program with them. Water districts such as Heights Water System and Gold Beach Water Association on Vashon, and Union Hill Water Association and Sammamish Plateau Water and Sewer District on the mainland of King County have allowed the use of wells for ambient water quality sampling.

Other Counties

Other counties in Washington are developing their own programs to protect groundwater. In 2001, King County maintained partnerships with Snohomish County, Mason County, and Island County to share approaches, data, analysis methods, and policy approaches. At the end of 2001, the Department of Natural Resources and Parks was preparing to train staff members in the EQuIS software system and to offer the same opportunity to employees with groundwater programs in Snohomish and Skagit Counties.

The counties of Pierce, King, and Snohomish also constitute the Tri-County grouping that has been developing a model response to the Endangered Species Act listings of chinook salmon and bull trout. Since groundwater provides base flow to tributary and mainstem streams that are important fish habitat, the Groundwater Protection Program coordinates with the Tri-County efforts.

The Groundwater Ordinance requires that each county adjacent to a Groundwater Management Area be invited to participate in the relevant Groundwater Protection Committee. As these Committees are established and begin functioning, adjacent counties may become engaged in groundwater work, particularly where there are shared aquifers across county boundaries.

Chapter 3: RESULTS

What We Learned and Achieved In 2001

All of the efforts described in Chapter 2 were aimed at protecting King County's groundwater resources. This is a long-term effort, and results of such effort may only be measurable over time. There are, however, some achievements and results from activities in 2001 that are noteworthy, which will be discussed in this section.

Data Collection and Management

Routine monitoring of groundwater should show the quality of the groundwater resource at any given time, the identity of problems or threats, and any long-term trends that need to be addressed. A comprehensive monitoring program for King County's groundwater, though desirable, has yet to be developed. However, during 2001, the Program conducted ambient monitoring rounds that were the first in nearly a decade. DNRP staff were reviewing the data from these samples as this report was being prepared, so some of the results reported here should be considered provisional.

Ambient water quality monitoring

The results from the groundwater monitoring efforts described in Chapter 2 have been analyzed using a variety of methods. The following parts of this section of the report describe the different kinds of interpretation of the data:

- General appreciation of the data.
- Overall changes in groundwater quality and quantity, as estimated for the Environmental Benchmarks report.
- How the results compare to water quality standards.
- Locations where water quality appears to be changing from the previous sampling in 1989–95.

<u>Summary of results</u>

The results from a sampling in 2001 indicate that groundwater in King County is high quality and has remained that way over the past decade. Isolated locations contain unacceptable concentrations of a few chemicals such as arsenic (a problem nationwide and even worldwide), nitrates, and synthetic organic chemicals. The data suggests that concentrations of different contaminants around the County have increased or decreased since the sampling in the late 1980s to early 1990s. These apparently conflicting trends will require careful analysis to identify the changes and possible explanations.

The chemical data from the sampling rounds is included in a summary table in Appendix B.

What Was Found in King County Groundwater?

EPA and the Washington State Board of Health have established health-based standards for the most common contaminants that appear in drinking water sources. These generally are known as "maximum contaminant levels," or "MCLs," which mean that they are the highest level of that contaminant that may be safely consumed in drinking water over a long period of time without creating a significant human health risk. Some contaminants have a "secondary" MCL, which means that, although water with the contaminant at that level does not create a health risk, it may create aesthetic problems (e.g., taste or odor) that a water system might want to address by treating the water to reduce or eliminate the contaminant. The analytical data from DNRP's 2001 ambient groundwater sampling was compared to these MCLs. The comparison is summarized in Table 3-1.

Table 3-1. Comparison with Drinking Water Standards

Chemical Parameter	Maximum Contaminant Level (MCL)	Wells exceeding MCL
Arsenic	50 µg/l	2*
	new MCL, 10 µg/l	11 over new MCL
Nitrate	10 µg/l	2
	5 µg/l "trigger level"	4 over trigger level
Iron	300 µg/l (Secondary MCL)	22
Manganese	50 µg/l (Secondary MCL)	25
Sodium	20 mg/l ("recommended level")	6

* = One of these samples with an exceedance of arsenic MCL had high turbidity and was resampled immediately and found to be below MCL. The high level is thought to be partly a result of the sampling process.

The Iron and Manganese drinking water standards (MCLs) are considered "secondary" MCLs, with no associated health risk. The "recommended level" for sodium is a concern for people who are on a low sodium diet.

In addition to these samples that showed chemical contaminants above acceptable health standards, a few samples had detections of "total coliform" and other types of bacteria. Drinking water with bacteria and viruses also violate health standards. Generally, detections of bacteria are considered problems of contamination occurring at the well location, as opposed to bacteria being in the groundwater. For each sample where bacteria were detected, Program staff contacted the well owner to advise them of the apparent contamination and methods of disinfecting their well head, and referred them to Public Health. Staff resampled the water at a tap to assure that the water supply was adequately treated.

These data show that groundwater in King County is generally of high quality and meets drinking water standards.

DNRP staff arranged for the samples taken in 2001 to be analyzed for a wide range of organic contaminants, using a variety of laboratory methods. Such organic compounds are man-made, often industrial chemical, and indicate serious contamination problems like those found at hazardous waste sites. As of the date this report was being prepared, the results from these analyses were still somewhat uncertain, and some may require confirmation resampling to be sure of the results.

The wells that were sampled generally are located away from industrial areas that might create contamination from hazardous waste spills. However, the analyses showed the existence of some chemicals at a few locations:

- Trichloroethylene (TCE) was detected at a well in the Issaquah Creek Valley Groundwater Management Area. The well is located on Cedar Grove Road, near the divide between Issaquah Creek and the Cedar River. The TCE concentration was 0.12 µg/l, well below the MCL of 5 µg/l. TCE is known to be in this area, emanating from the Queen City Farms Superfund site just to the north, based on EPA sampling over several years.
- Tetrachloroethylene (PCE) and chloroform were detected in a water supply well belonging to the City of Redmond. The concentrations were (respectively) about 0.2 and 0.1 µg/l, well below the MCLs of 5 and 80 µg/l. The contaminants have been detected in the past and reported to the Washington State Department of Health. They apparently derive from a spill at a dry cleaner across the street from the well.
- Atrazine was detected at a well at a maintenance yard for the King County Dept of Transportation at a concentration of about 0.05 µg/l, which is well below the MCL of 3 µg/l. Atrazine (commercial name Aatrex) is an herbicide that has commonly been used in road rights of way. Discussions with long-time employees indicate the chemical was stored more than ten years ago at this location.

All the detections are consistent with known or potential contamination.

A number of detections were made involving a family of chemicals called *phthalates*, which are used in plastic materials, including plumbing PVC. Of all these phthalates, only the one associated with PVC has a drinking water MCL–of 6 µg/l–which was exceeded at three locations in King County. Because these results were unexpected, and might have been due to sampling problems, DNRP staff is conducting follow-up resampling and reanalysis to confirm the highest levels of phthalates or reject their presence.

Three other organic contaminants were detected: benzoic acid (six wells), phenol (ten wells), and phenanthrene (one well). None of these have health-based MCLs, but will continue to be monitored by DNRP staff.

The laboratory analyses also produced approximately 108 “tentatively identified compounds (TICs).” This means that there may be some other substances in the water, although the analytical methods were not targeting these substances specifically.

Generally, the identities and concentrations of these substances are not considered accurate. The only TICs with MCLs had simultaneously been analyzed with regular laboratory methods. DNRP staff will review the results will be reviewed for significance, and may decide to sample again and test with laboratory methods that target the compounds specifically.

This organic analysis showed no detection of the chemicals associated with gasoline and other petroleum products, which are commonly found at hazardous waste sites because of the widespread use and spillage of petroleum products. The chemicals probably would show up again if groundwater sampling were extended to the more industrial areas of King County, such as the Duwamish flats, or locations where use of petroleum products (e.g., closed gasoline stations) are likely to have produced some contamination from leaking tanks or other facilities.

The data from the 2001 round of samples may be useful as part of salmon recovery and habitat protection efforts. Concentrations of the detected chemicals may be evaluated based on known impacts to fish, especially species listed as threatened under the Endangered Species Act, even where there is no apparent human health risk. This type of an analysis will be complicated because the prioritized "Factors of Decline" for the fish have not been finalized, research on fish impacts from such chemicals is incomplete, and many substances in groundwater change when they emerge into the surface water environment.

Has Groundwater Quality Changed?

The analytical data from the first round of ambient sampling was used to measure how well King County is protecting its water quality and quantity. The results were published in *The 2001 King County Benchmark Report,* September 2001. This report can be reviewed at http://www.metrokc.gov/exec/orpp/benchmrk/bench01/.

Groundwater is considered under the objective, "Protecting Water Quantity and Quality" as Indicator 15: "Changes in groundwater levels and groundwater quality." The analysis done for the Benchmark Report was incomplete because it did not contain all of the monitoring data obtained through the end of 2001.

Following completion of the 2001 round of sampling, DNRP staff compared the water quality data from the current sampling with similar data from the decade-old results in the same wells. The differences between the concentrations were observed at different times. The results were interpreted as long term trends in general groundwater quality. In the preliminary data, some chemicals (potassium, iron, and magnesium) appeared to increase in concentration. With more rigorous analysis, the only changes in average water quality found to be statistically significant were those where 2001 data showed a lowered concentration (i.e., improving water quality) for copper, fluoride, lead, zinc, chromium, nitrate.

A "Change in Concentration" is defined statistically as a change in average concentration, across all the wells sampled, that would occur randomly in only 5% of

analyses ("95% confidence"). It appears from this analysis that health concerns from drinking King County's groundwater have been reduced over the decade.

The statistics indicate that changes in contaminant concentrations are very subtle. The cited effects could be due to other factors such as the season when samples are taken, climatic differences, changes in laboratory methods or detection limits or localized changes over one of the Ground Water Management Areas or even at an individual well (see next section). DNRP staff are presently performing separate statistical and other analyses, to interpret and account for these effects. To gain a higher level of confidence in the results would require a larger number of samples, from a broader geographic area, taken more frequently.

The water level (quantity) data were similarly analyzed as part of the Benchmarks report. However, much of 2001 was a period of drought, so any changes between 2001 data and earlier measurements could be explained by the climatic conditions. Under natural conditions, groundwater levels can also change by several feet because of natural variations, such as normal "wet" and "dry" years. It will take a longer time period and a larger data collection effort to determine any real trends in groundwater levels. DNRP staff is increasing the frequency of water level measurements in the ambient monitoring wells to improve that source of data.

Where Can Possible Changes to the Local Water Quality be Found?

The purpose of the long-term trend analysis for the "Benchmark" report is to determine if groundwater, on average, is better or worse than it was approximately when the initial ambient samples were taken a decade ago. Part of that evaluation included a statistical analysis of the test results to determine major changes in water quality characteristics.

Staff applied various statistical methods because environmental concentrations fluctuate, partly because of natural variations in the aquifer's actual water quality. For example, seasonal variations may cause flow directions to change slightly and different streams of groundwater can arrive at a well. Groundwater recharge rates also are constantly changing, which results in varying qualities of water added to the aquifer. Sampling results may vary because of the methods of sampling or analysis. In addition, the magnitude of these fluctuations can be different for the chemical parameters. For all these reasons, interpretation cannot simply compare the chemical results in 2001 and determine that they are higher or lower than those in 1989-95. Therefore, the statistical analysis is trying to extract the real and persistent changes in water quality in the aquifer, such as those caused by changing land uses.

The statistical method used for this analysis takes all the analytical data and compares the old against the new data for a given chemical in each well. Most wells have the same chemical concentrations as they did a decade ago. As a result, the data plots as a straight line with some "cloudiness" around the line due to uncontrolled variations. Statistics can provide "confidence limits" about the data. A few points (wells) lie outside the limits and are classified as "outliers" (i.e., locations where new data significantly differs from old data).

The statistical analysis showed that relatively few wells constitute the bulk of these "others." Those do not appear to be located in areas with significant sources of groundwater contamination. (See Appendix D for a table of the results.) Ongoing ambient water quality sampling is necessary to verify changes. The locations identified as outliers are still being checked for some explanation of the variation.

Water Level Monitoring

The Groundwater Protection Program is committed to protecting groundwater quantity and quality. This commitment requires knowledge of whether groundwater levels (a measure of water quantity) are remaining high or declining. Water levels are measured in the ambient water quality wells at the same time as samples are taken. Volunteers on Vashon-Maury Island are also taking monthly water level measurements in their own wells (Figure 3-1). All these DNRP monitoring locations have been accurately located using Global Positioning System equipment to estimate the elevation of the measuring point and turn the measurements into groundwater elevations. Many of the larger public water systems are taking regular water level measurements, which DNRP is adding to the EQuIS groundwater database system.

Interpreting these water levels to determine if the groundwater resources are being depleted is not simple. Water levels change drastically due to natural precipitation fluctuations. A drought emergency existed in early 2001 so the ground water levels would be low, even if no withdrawals had taken place. Fortunately, the drought broke in late 2001. Groundwater levels are cumulative, so the effects of the drought may continue into 2002.

DNRP staff will be doing further analysis of water level data for 2001. More data are being gathered on an on-going basis. The effort will allow a more definitive answer in the future.

Other Achievements

Some results in these other areas of the Groundwater Protection Program include:

- Recognition of the value of the education component, through the award of Centennial Clean Water grant from the Washington State Department of Ecology for 2002.
- Passage of the Groundwater Protection Ordinance.
- Formation of, and the first meeting of, the Vashon – Maury Island Groundwater Protection Committee.

One quantitative measure of public outreach success is the automatic recording of usage ("hits") to the Groundwater Web site. These data are available only for the nine months from March to December 2001. During that period, the website recorded 8,790 hits, or an average of 32 hits per day. During the same period of time, 2,521 web users visited the site. Approximately one-third of these people (600) were return visitors.

Chapter 4: BUDGET AND STAFFING

The Groundwater Protection Program has existed in King County since the Ground Water Management Areas were first set up under state law (1989). Until 1996, the effort was centered in Public Health. Funding was based on state grant money, plus some contributions (mainly in kind) from purveyors in the Ground Water Management Areas. In 1996, the Groundwater Protection Program was moved to the Department of Natural Resources and Parks, with some loan-in labor from Public Health, but little extra funding.

When the Groundwater Management Plans were completed in 1998, the program in the Department of Natural Resources and Parks was budgeted from the County's Surface Water Management fund, with one full-time employee and less than $100,000. At that time, at the request of the King County Council, DNRP prepared an estimate of the resources necessary to implement high, medium, and low priority items identified in the four certified Plans. The totals were $9.2 million and 64 full-time equivalent staff positions. DNRP and the Council decided to pursue an interim five-year plan for the Groundwater Protection Program that would ramp up levels of funding and personnel to a maximum of about 6.5 employees and a total budget of more than $800,000. At DNRP, the program is still supported by a set of interim funding sources, as follows:

- Surface Water Management continues to fund the initial core of the program (about one full-time equivalent position).
- In late 1999, the Surface Water Management fee was extended to the rest of unincorporated King County as the Rural Drainage Program (RDP). Based on public input during the development of the RDP, the effort has included significant groundwater protection services, with about two full-time equivalent positions as of the end of 2001.
- The Solid Waste Division recognized the benefits of having groundwater data collected in areas away from its facilities (landfills) and funding an "Early Start" effort that originally included term-limited temporary personnel and has expanded to about one full-time equivalent position.
- The Wastewater Treatment Division contributes funding to the program (about one-point-five full-time equivalent position) to obtain technical support for its Regional Wastewater Services Program, particularly in the Green–Duwamish River and the Lake Sammamish–Lake Washington areas. The agency also contributes to the groundwater education and public involvement effort through its Culver fund (one full-time equivalent position), and to the Regulatory and Policy staffing (one full-time equivalent position).
- The Department of Development and Environmental Services provides funding for groundwater technical support to project review. This is billed out to the permit applicant through the DDES.
- In other years, the Groundwater Protection Program has been sustained to varying degrees through state grants. In 1999-2000, a Washington State Department of

Health grant through the Environmental Protection Agency funded collection of data from the groundwater purveyors and a survey of their wells. In 2002, a Centennial Clean Water grant from the Department of Ecology will support part of the Groundwater Education Program.

The money has allowed the Groundwater Protection Program to reach a funding level that will support 6.5 full-time equivalent employees in 2002. Due to a hiring freeze in 2001, the average staffing level was at about 5.2 full-time equivalent employees. A tabulation of the funding sources and expenditures is presented in Table 4-1.

Meanwhile, the groundwater-related programs at Public Health (on-site septic and drinking water) have been dramatically reduced because of reductions in the County's General Fund revenue. At the same time, the existing sources of funding for the DNRP groundwater staff are declining, and they are also being pressed to support other priority programs and activities that are having their General Fund revenues reduced or eliminated.

The County Council recognized this long-term funding issue by including in the ordinance creating the Groundwater Protection Program provisions that include: (1) review by the Regional Water Quality Committee by September 2003 of progress made in developing agreements and funding for regional groundwater protection services; (2) sunsetting of the Groundwater Protection Committees as of December 31, 2004, to allow time for development of long-term programs and funding; (3) making County support in implementing Groundwater Management Plans subject to available funding; and (4) directing DNRP, as lead agency for the Groundwater Protection Program, to identify sources and methods of funding regional groundwater protection services, and seeking funding for those services.

The current budget crisis being faced by the County is likely to force an acceleration of the identification and development of new or additional funding sources for both the existing "core" services provided by County staff, as well as for expanded regional services that are likely to be desired as part of implementation of the Groundwater Management Plans.

Table 4-1: 2001 Expenditures on Groundwater Protection Program

Category	2001 Total Expenditures	Data Collection & Management	Education	Program Coordination	Regulatory & Policy Development	Vashon Rural	GW Impact Program (East King County)
Labor & Benefits	**243,419**	64,565	69,107	52,134	105,086	43,864	10,463
Administrative Expenditures	**12,640**	3,390	2,094	114	-	4,804	2,238
Consultant & Contract Services	**165,466**	96,766	-	-	-	53,804	42,256
Indirect/Overhead	**127,934**	33,934	36,321	27,400	1,727	23,053	5,499
Total Groundwater Program	**549,459**	**198,655**	**107,522**	**79,648**	**106,813**	**125,525**	**60,456**

Revenue

Solid Waste Revenue	**90,000**	90,000	-	-	-	-	-
Wastewater	**101,800**	-	-	-	101,800		-
Wastewater Culvert	**100,000**	-	100,000	-	-	-	-
Rural Drainage Program	**185,981**	-	-	-	-	125,525	60,456
Total Revenue	**477,781**	**90,000**	**100,000**	**-**	**101,800**	**125,525**	**60,456**

Chapter 5: ISSUES AND RECOMMENDATIONS

The Groundwater Protection Program was just formally established and will be developing over the next year or two. However, King County has been delivering groundwater services for several years and addressing a number of issues that have developed during that time. The following are the anticipated issues of focus in the next year:

- Funding and budget for regional groundwater services: As described in Chapter 4, the existing set of groundwater activities is funded by an assortment of unstable and declining revenue sources. At the same time, there is likely to be a desire to expand the services as each Groundwater Protection Committee begins meeting and implementing its Groundwater Management Plan. Estimates of the cost to fully implement those plans run into the millions of dollars, and far exceed the resources currently available. Given King County's current serious budget difficulties, there is an urgent need to develop a cooperative and long-term funding arrangement that reflects adopted priorities, existing commitments and the benefits of the groundwater program. This action may need to be taken for the 2003 County budget cycle.
- Data collection, management, and use: One of the major challenges with groundwater is developing, compiling, and using the data to support priority program objectives. During the past year, the Groundwater Protection Program was able to complete an ambient monitoring program that updated data collected more than 10 years ago. The program also has made progress in identifying and collecting other groundwater data available from multiple sources and making it available in a user-friendly fashion. More work needs to be done to identify key groundwater trends, share information with other groups and processes and develop long-term strategies that target further data collection. These actions will make the King County analyses useful to anyone who can contribute to King County's goal of protecting groundwater resources.
- Implementation and modification of Groundwater Management Plans, including establishment of the remaining Groundwater Protection Committees: King County is pleased that, after many years of development and approval processes, employees are poised to begin implementation of at least four of the Groundwater Management Plans. The discovery with the Vashon-Maury Island plan is that there are an overwhelming number of groundwater issues requiring attention. These issues have been identified in the Groundwater Management Plans, and new issues have surfaced over the past several years. Additional responsibilities have been assigned to each Groundwater Protection Committee under the Ordinance, so King County will be constantly challenged to develop and implement work plans that reflect the limitations on resources all affected parties face, while still making progress in protecting King County's groundwater resources.

- Opportunities for coordination: In order to gain the most efficient use of resources, King County will have to search out opportunities to work with other agencies and entities to address groundwater problems as they arise. One example is the discussions between the Department of Natural Resources and Parks, and Public Health since late 2001 over development of the Operation and Maintenance components of its On-Site Sewage (Septic) Program. The discussions are largely driven by the need for Public Health to find funding to replace the loss of General Fund money. But opportunities have surfaced to share data, develop joint outreach and education, and work collaboratively with the State Department of Health on both septic and drinking water issues.
- Focused water quality or quantity issues: Although in general the County's groundwater resources appear to be in good shape, there are pockets within King County where that may not be the case. Examples include those places where naturally occurring arsenic may exceed new drinking water standards for health, or where nitrate levels continue to exist at levels of concern. The interrelationships between groundwater and surface water in areas that are critical habit to fish are likely to need further evaluation as part of the commitment by King County and other local governments to salmon recovery plans. As these area-specific issues arise, the Groundwater Protection Program will be challenged to develop cooperative approaches with affected parties in devising solutions.

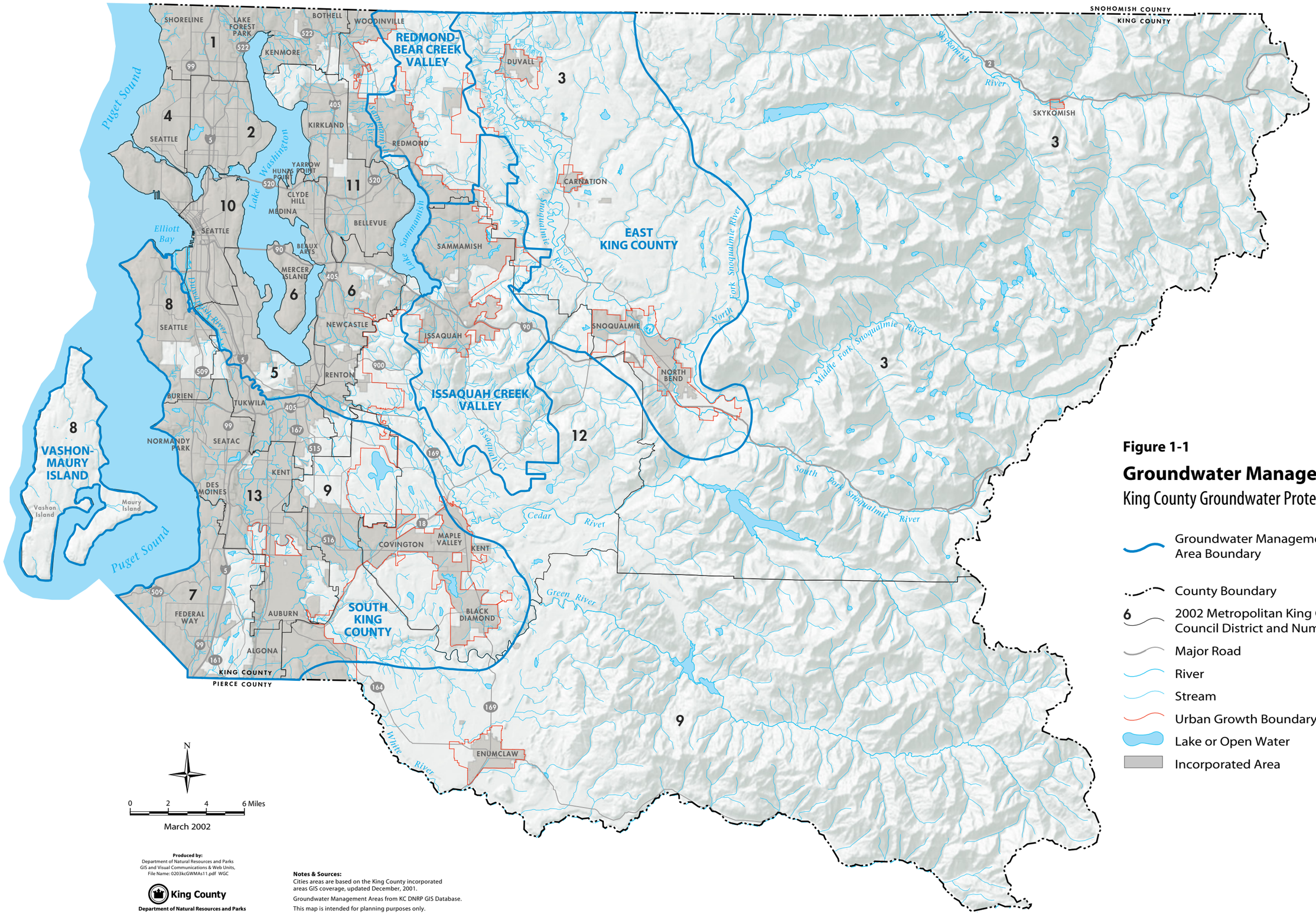


Figure 1-1

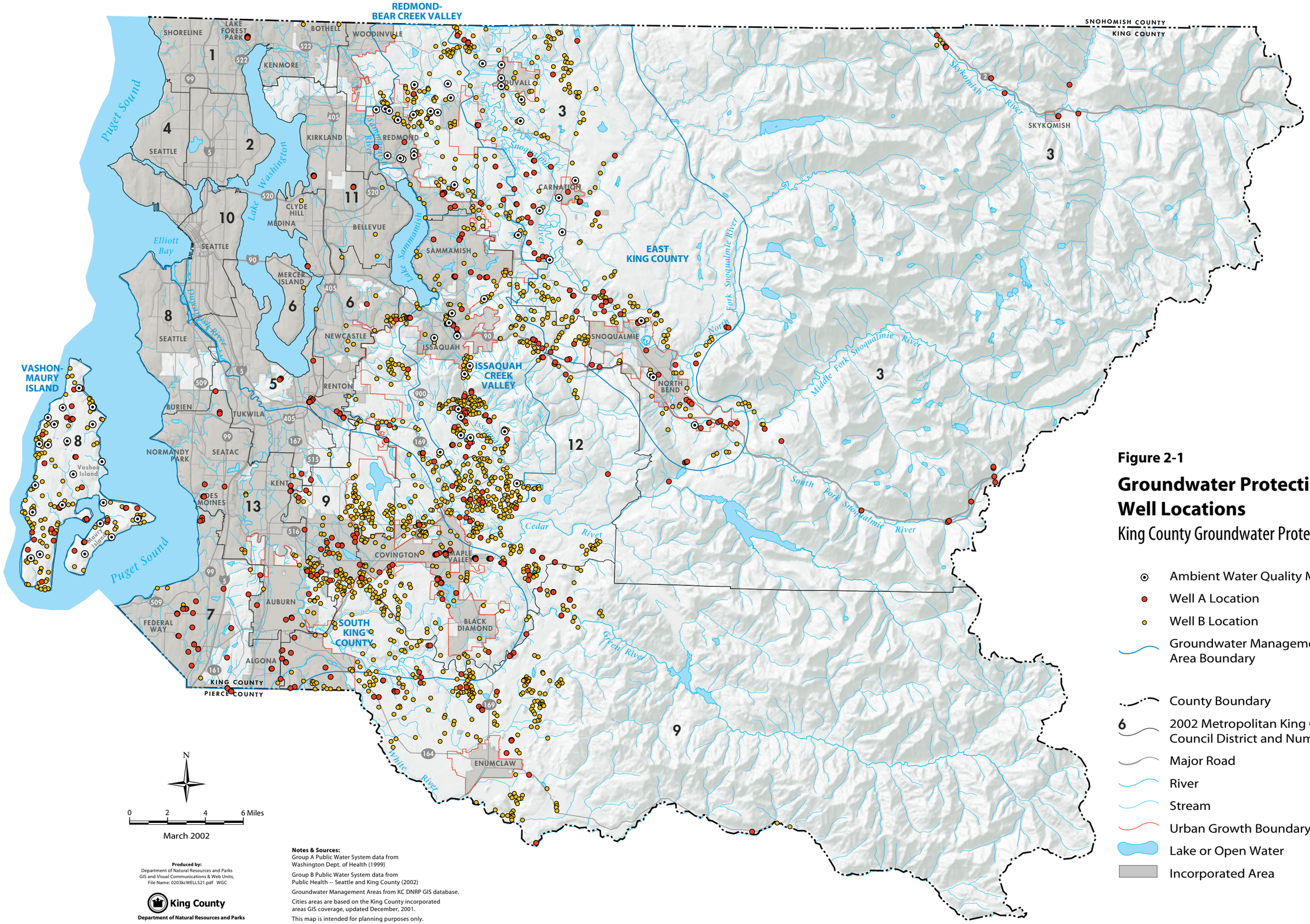
Groundwater Management Areas

King County Groundwater Protection Program

Produced by:
Department of Natural Resources and Parks
GIS and Visual Communications & Web Units,
File Name: 0203kcGWMAs11.pdf WGC

King County
Department of Natural Resources and Parks

Notes & Sources:
Cities areas are based on the King County incorporated areas GIS coverage, updated December, 2001.
Groundwater Management Areas from KC DNRP GIS Database.
This map is intended for planning purposes only.



Produced by:
Department of Natural Resources and Parks
GIS and Visual Communications & Web Units,
File Name: 0203kcWELLS21.pdf WGC

King County
Department of Natural Resources and Parks

Notes & Sources:
Group A Public Water System data from Washington Dept. of Health (1999)

Group B Public Water System data from Public Health -- Seattle and King County (2002)

Groundwater Management Areas from KC DNRP GIS database.

Cities areas are based on the King County incorporated areas GIS coverage, updated December, 2001.

This map is intended for planning purposes only.

Figure 2-1

Groundwater Protection Program Well Locations

King County Groundwater Protection Program

- Ambient Water Quality Monitoring Location
- Well A Location
- Well B Location
- Groundwater Management Area Boundary
- County Boundary
- 6 2002 Metropolitan King County Council District and Number
- Major Road
- River
- Stream
- Urban Growth Boundary
- Lake or Open Water
- Incorporated Area

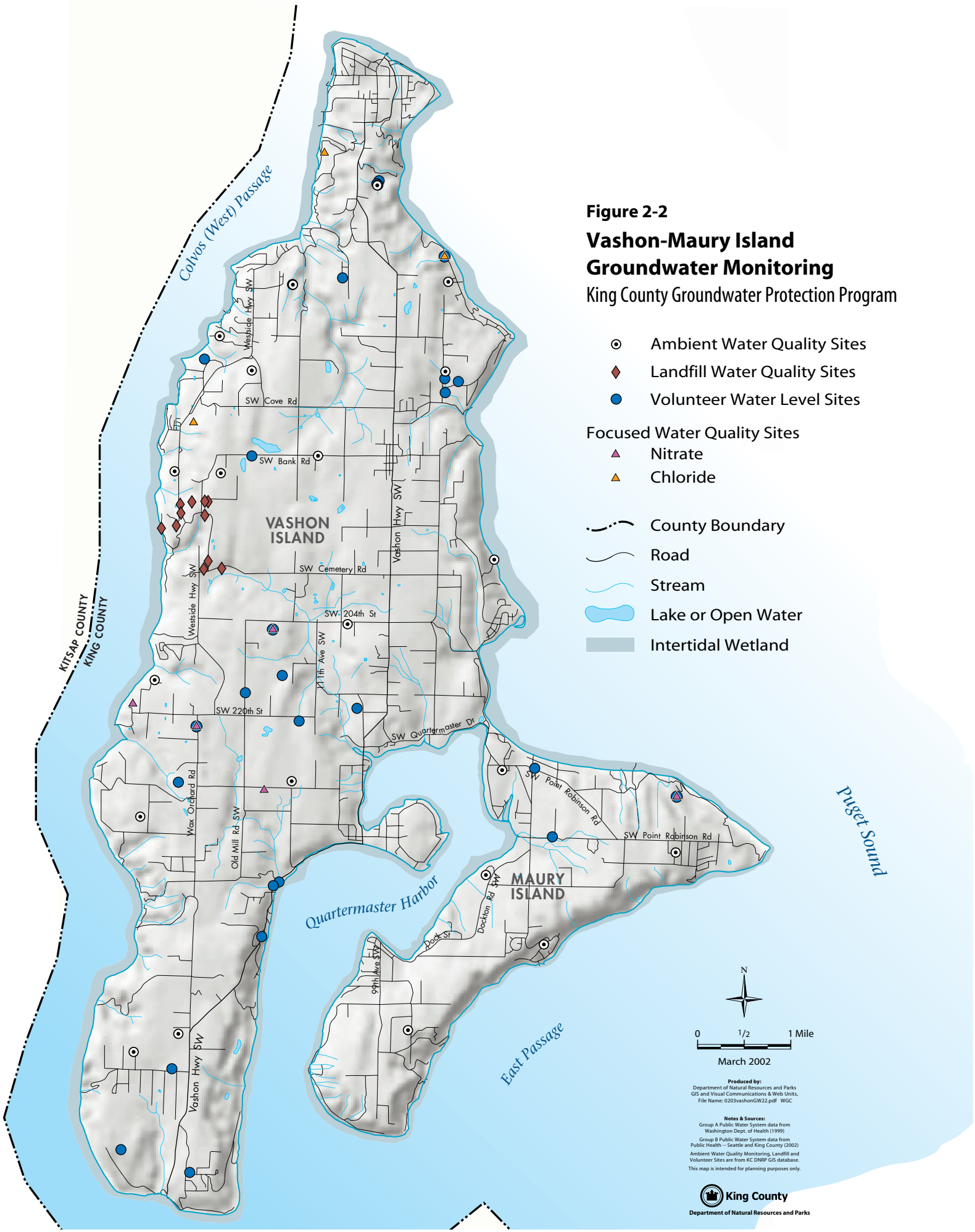


Figure 2-2

Vashon-Maury Island Groundwater Monitoring

King County Groundwater Protection Program

Figure 2-3

Sammamish River Valley Focus Area

King County Groundwater Protection Program

Ambient Water Quality Monitoring Location

County Boundary

Stream

N

0 1/2 1 Mile

March 2002

Produced by:
Department of Natural Resources and Parks
GIS and Visual Communications & Web Units,
File Name: 0203vashonGW23.pdf WGC

King County
Department of Natural Resources and Parks

Notes & Sources:
This map is based on WKLRD Groundwater GIS data and DNRP GIS Data, March 2002.
Aerial Photo: Emerge multispectral aerial photoset licensed to King County by Space Imaging, 2000.
Ambient Water Quality Monitoring Sites are from KC DNRP GIS dtabase.
This map is intended for planning purposes only.

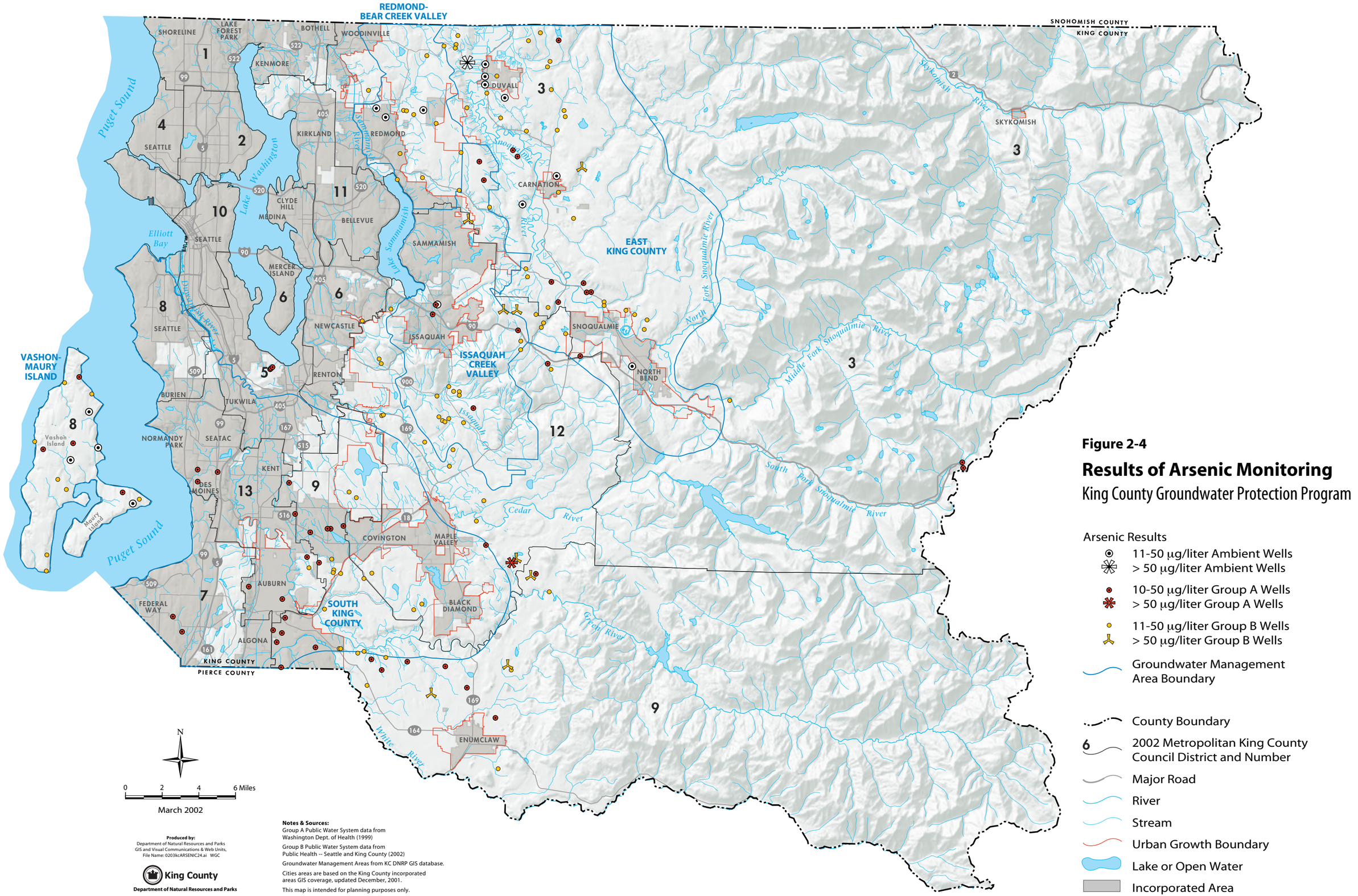


Figure 2-4

Results of Arsenic Monitoring

King County Groundwater Protection Program

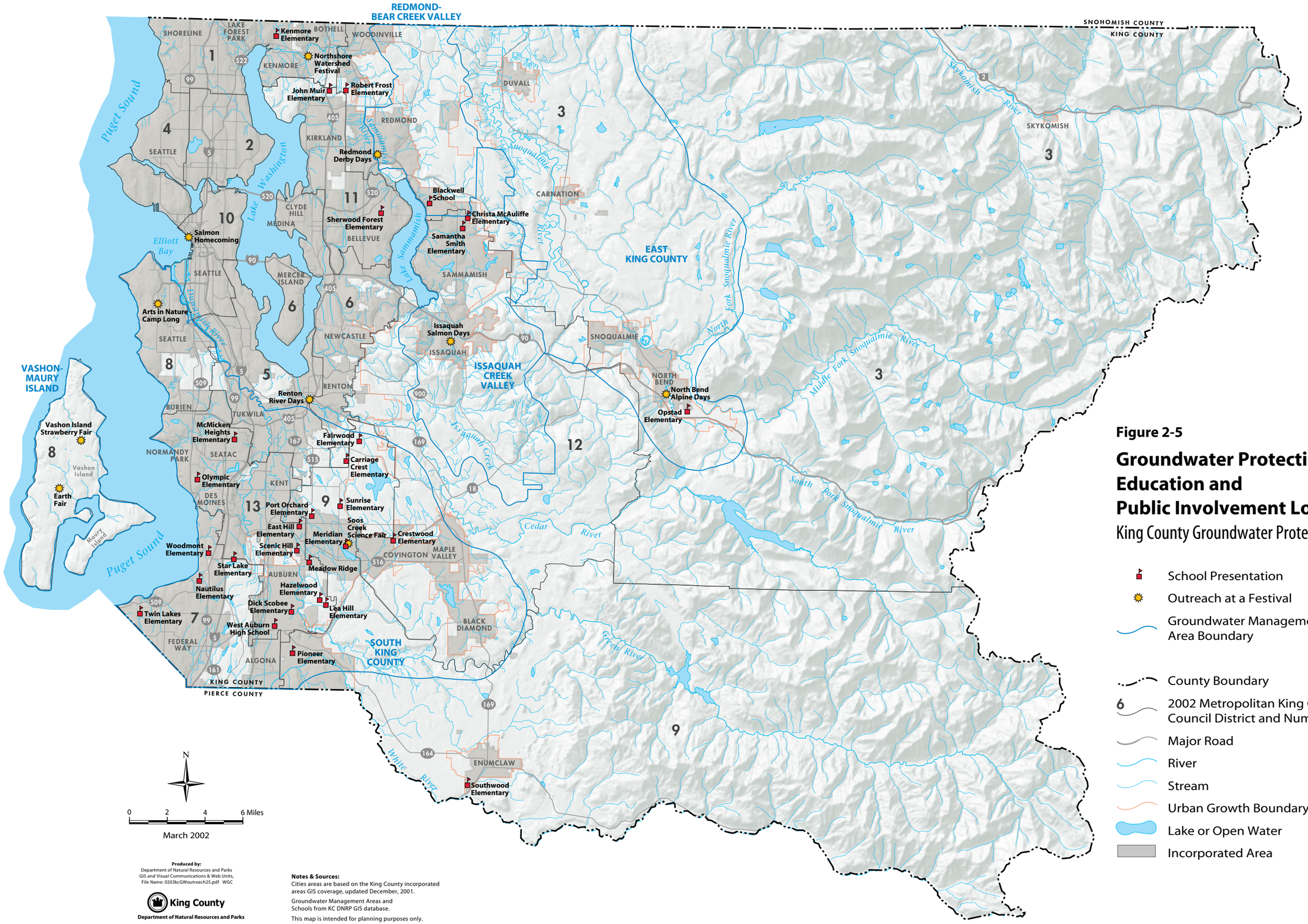


Figure 2-5

Groundwater Protection: Education and Public Involvement Locations

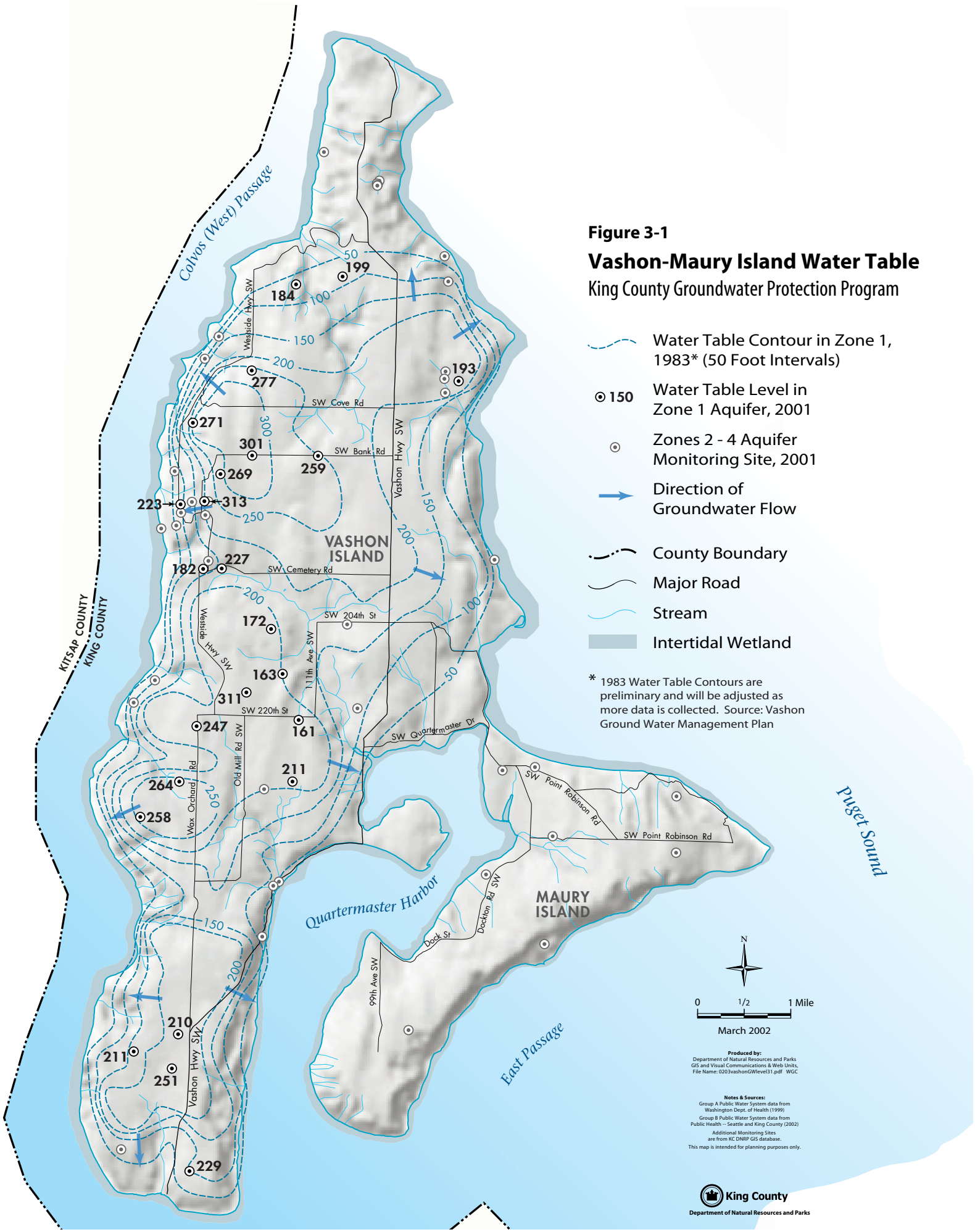
King County Groundwater Protection Program

- School Presentation
- Outreach at a Festival
- Groundwater Management Area Boundary
- County Boundary
- 6 2002 Metropolitan King County Council District and Number
- Major Road
- River
- Stream
- Urban Growth Boundary
- Lake or Open Water
- Incorporated Area

Produced by:
Department of Natural Resources and Parks
GIS and Visual Communications & Web Units,
File Name: 0203kcGWoutreach2S.pdf WGC

King County
Department of Natural Resources and Parks

Notes & Sources:
Cities areas are based on the King County incorporated areas GIS coverage, updated December, 2001.
Groundwater Management Areas and Schools from KC DNRP GIS database.
This map is intended for planning purposes only.


Colvos (West) Passage
Puget Sound
Quartermaster Harbor
East Passage
VASHON ISLAND
MAURY ISLAND
KITSAP COUNTY
KING COUNTY
SW Cove Rd
SW Bank Rd
SW Cemetery Rd
SW 204th St
SW 220th St
SW Quartermaster Dr
SW Point Robinson Rd
Westside Hwy SW
Vashon Hwy SW
111th Ave SW
Old Mill Rd SW
Wax Orchard Rd
Dockton Rd SW
Dock St
99th Ave SW
50
100
150
200
250
300
199
184
193
277
271
301
259
269
223
313
227
182
172
163
311
247
161
211
264
258
210
211
251
229
Figure 3-1
Vashon-Maury Island Water Table
King County Groundwater Protection Program
Water Table Contour in Zone 1, 1983* (50 Foot Intervals)
150 Water Table Level in Zone 1 Aquifer, 2001
Zones 2 - 4 Aquifer Monitoring Site, 2001
Direction of Groundwater Flow
County Boundary
Major Road
Stream
Intertidal Wetland
* 1983 Water Table Contours are preliminary and will be adjusted as more data is collected. Source: Vashon Ground Water Management Plan
N
0 1/2 1 Mile
March 2002
Produced by:
Department of Natural Resources and Parks
GIS and Visual Communications & Web Units,
File Name: 0203vashonGWlevel31.pdf WGC
Notes & Sources:
Group A Public Water System data from Washington Dept. of Health (1999)
Group B Public Water System data from Public Health -- Seattle and King County (2002)
Additional Monitoring Sites are from KC DNRP GIS database.
This map is intended for planning purposes only.
King County
Department of Natural Resources and Parks

Appendix A

Groundwater Protection Ordinance (No. 14214)

Appendix B

Education and Outreach Details: Events and Educational Materials

APPENDIX B

EDUCATION AND OUTREACH

Fairs and festivals attended in 2001

- Water Festival 2001, Highline Community College*
- Northshore Watershed Festival, Bothell*
- Renton River Days
- Meridian Elementary School (Kent School District)/Soos Creek Science Fair*
- Vashon Strawberry Festival
- Vashon EarthFair
- North Bend Alpine Days
- Arts in Nature-Camp Long
- Salmon Homecoming-Seattle Aquarium*
- Issaquah Salmon Days

Pamphlets and brochures distributed

- *Shared Waters-The Bond Between People and Salmon*, the Water Conservation Coalition of Puget Sound
- *Water Conservation—Guidelines to Being Waterwise,* Washington State Department of Health
- *How to Dispose of Household Hazardous Waste and Five Steps to Protect your Family's Health and the Environment,* Seattle-King County Department of Public Health
- *Hazards on the Homefront,* King County Local Hazardous Waste Management Program
- *Natural Lawn Care for Western Washington,* King County Department of Natural Resources and Parks and Seattle Public Utilities.
- *Make Your Mark,* a flyer on King County's Storm Drain Stenciling Program—for possible use as a class project.

Appendix C

Vashon - Maury Island Groundwater Protection Committee, Annual Status Report

APPENDIX C

VASHON-MAURY ISLAND GROUNDWATER PROTECTION COMMITTEE ANNUAL STATUS REPORT 2001

Section 11 of the Ordinance creating the King County Groundwater Protection Program (Ordinance 14214), and establishing the Vashon-Maury Island Groundwater Protection Committee (Committee), requires each of the Groundwater Protection Committees to provide an annual status report on the following:

- Implementation of groundwater protection services in King County;
- Implementation of the certified groundwater management plan, including groundwater protection activities of cities, special purpose districts, sewer and water utilities and associations, and water purveyors within the groundwater management area;
- Efforts to develop interlocal or other agreements relative to implementation of regional groundwater protection services; and
- Trends in groundwater issues.

The Committee was not formally established until November 2001. It held its initial meeting on December 12, 2001. At that meeting, the Committee:

- Discussed the objectives that each member had for the Committee during the coming year, or longer;
- Established an initial schedule of monthly meetings through April, 2002;
- Chose an interim Chair (John Gerstle);
- Discussed the availability and use of Rural Drainage Program funds on VMI during 2001, and the DNR work plan and budget that had been implemented on the island during the year, and requested further information at the Committee's next meeting;
- Reviewed the groundwater activities on VMI during 2001, including a new round of water sampling and testing;
- Discussed the work plan laid out in the certified Groundwater Management Plan, and the need to prioritize the items in it; and
- Agreed to begin addressing specific priority topics by convening subcommittees on substantive areas in early 2002.

The major accomplishment for the Committee in 2001 was participating in the development and enactment of the ordinance that established the King County program, and created groundwater protection committees for each King County groundwater management area with a certified Plan. Because the Committee met only once in 2001, and that meeting focused on organizational issues, it had no opportunity to prepare more substantive information for VMI as part of the Annual Report. The Annual Report does, however, provide information from King County on a variety of educational and data collection activities on VMI during 2001, and an initial analysis of the data from the sampling done during the year. The Committee fully expects to have a high level of activity during its first full year of existence in 2002, and next year's report will have a more complete status report on groundwater and groundwater issues for the island.

Appendix D

Analytical Data for Ambient Water Quality Sampling

APPENDIX D

Results of Statistical Analysis of Water Quality Monitoring

"Outlier" wells from Ambient Water Quality Sampling

Chemical parameter	Wells with increases	Wells with decreases
Alkalinity	R-10*, R-17*, w-13	EKC-16*, ISS-07*
Arsenic	w-07*	
Barium	R-10*	ISS-06*, w-09a*, ISS-11, w-15
Calcium	R-10*	ISS-13*
Chloride	EKC-22*, w-13*, R-10	R-01*
Chromium	R-12*, w-20, s-03	w-08
Copper	ISS-11*	R-17*, EKC-13, w-09a
Fluoride	R-12*, R-14	R-17
Hardness	R-10*, R-17	ISS-13*
Iron		R-21*, R-17*, w-03, w-10a, w-13
Lead	ISS-07	R-21*, w-11, w-15
Magnesium	R-10*, R-17	ISS-13*, R-05
Manganese	ISS-07*	R-35*, w-03*, s-03
Mercury	*No 2001 detections*	
Nitrate	w-13*, w-03, w-17	w-08*, R-30
Nitrite	*Only 2 detections in 2001*	
Potassium	R-17*	R-30*, ISS-05
Selenium	*No 2001 detections*	
Silica	R-12*, w-08*, R-21	
Silver	*No 2001 detections*	
Sodium	R-13*	ISS-07*
Sulfate		w-08*, R-12*, EKC-04*
Total Dissolved Solids	R-10*, R-17*, w-13, w-11	EKC-06
Zinc	*Statistics not applicable*	

Note: * indicates changes were significant at a 99% confidence level
Changes not marked with asterisk are significant at 95% confidence level.

Wells sampled for Ambient Water Quality are referenced to the Groundwater Management Area by their names:

Vashon–Maury Island: wells = w-01 (etc); springs = s-01 (etc)
Redmond–Bear Creek Valley wells = R-01
Issaquah Creek Valley wells = ISS-01 (etc)
East King County = EKC-01 (etc)

East King County -- Round 1

Locator	Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EKC03	0.00089	0.0144	--	12.3	--	--	0.00317	41.2	0.964	--	2.56	0.0683	--	--
EKC04	0.0217	0.00555	--	12.9	--	--	--	42.4	8.97	--	2.48	0.376	--	--
EKC04 (FREP)	0.0208	0.00541	--	12.9	--	--	--	42.6	8.92	--	2.49	0.365	--	--
EKC06	--	0.00228	--	6.64	--	--	0.0228	20.6	--	0.0004	0.984	0.00319	--	--
EKC09	0.0118	0.00997	--	37.8	--	--	0.0011	147	0.07	--	12.7	0.126	--	--
EKC11	--	0.00154	--	6.74	--	--	0.00902	22.7	0.2	0.0007	1.41	0.00323	--	--
EKC13	0.0194	0.00723	--	22	--	--	0.00072	81.4	0.458	0.00059	6.41	0.36	--	--
EKC14	0.0362	0.0133	0.00013	26.1	--	--	0.00585	84.1	0.456	0.00051	4.57	0.0296	--	--
EKC15	0.00478	0.0139	--	26.9	--	--	0.0115	101	--	--	8.23	0.0924	--	--
EKC16	--	0.00637	--	9.11	--	--	0.00862	34.5	--	0.00068	2.86	--	--	--
EKC16 (FREP)	--	0.00644	--	9.04	--	--	0.00916	34.1	--	0.00065	2.81	--	--	--
EKC17	0.0709	0.00356	--	10.1	--	--	0.00095	33.3	--	--	1.93	0.0106	--	--
EKC18	0.0247	0.00832	--	9.86	--	--	0.00045	37.2	0.06	0.00074	3.06	0.0301	--	--
EKC18 (FREP)	0.0256	0.00858	--	9.82	0.00041	--	0.00042	37	0.1	0.00055	3.04	0.0302	--	--
EKC19	0.0456	0.0127	--	20.8	--	--	0.00407	65.2	0.22	0.00113	3.21	0.022	--	--
EKC21	0.0351	0.0217	--	24.4	--	--	--	82.1	0.12	--	5.14	0.0248	--	--
EKC21 (FREP)	0.0363	0.0216	--	23.4	--	--	--	78.5	0.072	--	4.91	0.0225	--	--
EKC22	0.0012	0.00612	--	44.1	--	--	0.0018	195	0.11	0.00082	20.5	0.00233	--	--
EKC24	--	0.00164	--	8.35	--	--	0.0298	39.8	0.19	0.00177	4.6	0.0015	--	--
EKC24 (FREP)	--	0.00162	--	8.47	--	--	0.0893	40.3	0.24	0.00261	4.65	0.00202	--	--

"--" indicates these analytes were not detected

East King County -- Round 1

Locator	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Nitrite Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform
	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	CFU/100 ml
EKC03	--	2.2	--	0.00381	33.8	2.27	0.02	1.66	--	10	4.02	76.8	0	0
EKC04	--	4.09	--	0.00748	52.5	1.65	0.05	--	--	27	--	100	0	0
EKC04 (FREP)	--	4.14	--	0.00328	53.1	1.5	0.05	--	--	31	--	100	0	0
EKC06	--	1.9	--	0.00499	16.9	2.88	0.02	0.468	--	5.2	2.31	39.4	0	1
EKC09	3.6	7.55	--	0.0613	122	1.95	0.08	--	--	23	31.7	197	0	0
EKC11	--	2.1	--	0.00701	21.3	1.08	0.04	0.498	--	7.9	3.59	45.5	0	0
EKC13	3.5	7.16	--	0.00052	94.6	1.73	0.13	0.0419	--	22	1.9	124	0	0
EKC14	2.3	26.8	--	0.0354	127	4.99	0.06	--	--	12	0.14	155	0	0
EKC15	3.5	21.4	--	0.0033	105	29	0.09	--	--	27	0.31	185	0	0
EKC16	4.6	3.86	--	0.0011	22.4	4.07	0.02	4.72	--	11	4.79	81	0	0
EKC16 (FREP)	4.8	3.79	--	0.0012	21.4	4.05	0.03	4.76	--	11	4.66	79.8	0	0
EKC17	--	40.4	--	0.00754	109	2.23	0.05	--	--	14	3.78	141	0	0
EKC18	3.1	47.1	--	0.024	133	1.93	0.22	--	--	17	6.58	168	0	0
EKC18 (FREP)	3.2	46.7	--	0.0351	132	1.92	0.23	--	--	16	6.61	173	0	0
EKC19	3.6	51.5	--	0.0243	156	4.45	0.11	--	--	13	7.16	191	0	2
EKC21	2.6	35	--	0.00088	141	6.35	0.03	--	--	12	1.8	170	0	0
EKC21 (FREP)	2.3	33.6	--	0.00076	140	6.37	0.04	--	--	12	1.77	176	0	0
EKC22	--	10	--	0.0939	144	30.9	0.02	0.61	--	22	17.5	242	0	0
EKC24	--	3.9	--	0.0123	33.8	1.84	0.03	2.2	--	17	4.25	81.8	0	0
EKC24 (FREP)	--	3.95	--	0.0155	33.7	1.8	0.03	2.2	--	17	4.16	56.6	0	0

"--" indicates these analytes were not detected

Issaquah Creek Valley -- Round 1

Locator	Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ISS-01	0.0021	0.00569	--	14.5	--	--	0.001	63.1	0.12	--	6.52	0.104	--	--
ISS-04	0.00724	0.00487	--	22.9	--	--	--	87.9	0.081	0.00028	7.45	0.0917	--	--
ISS-04 (FREP)	0.00728	0.00476	--	23.2	--	--	--	89.1	0.094	0.0003	7.6	0.0916	--	--
ISS-05	0.00686	0.00409	--	18.1	--	--	--	67.5	--	--	5.42	0.0692	--	--
ISS-05 (FREP)	0.00673	0.00443	--	18.2	--	--	--	68.1	0.077	--	5.48	0.0683	--	--
ISS-06	--	0.00059	--	9.3	--	--	--	34.3	2.06	0.00026	2.69	0.0142	--	--
ISS-06 (FREP)	--	0.00057	--	9.35	--	--	--	34.4	0.598	--	2.68	0.0159	--	--
ISS-07	--	0.00196	--	7.54	--	--	0.0531	27.2	1.2	0.00688	2.04	0.123	--	--
ISS-08	0.0011	0.00614	--	25	0.00064	--	0.0018	110	--	0.00241	11.6	--	--	--
ISS-09	0.00274	0.00484	--	13	--	--	--	49.1	--	--	4.08	0.0283	--	--
ISS-10	0.0017	0.00255	--	14.2	--	--	0.0016	52	--	0.00032	4	0.00026	--	--
ISS-10 (FREP)	0.0018	0.00256	--	14.3	--	--	0.0017	52.3	--	0.00036	4.02	0.00028	--	--
ISS-11	--	0.00095	--	12.9	0.00052	--	0.0177	46.2	0.319	0.00023	3.43	0.017	--	--
ISS-12	--	0.0029	--	15.5	--	--	0.00231	67	--	--	6.88	0.00078	--	--
ISS-13	0.00452	0.00406	--	0.524	0.00063	--	0.00244	3.82	1.01	0.00045	0.609	0.0119	--	--
ISS-14	--	0.00255	--	11.6	0.0015	--	0.00277	58	--	--	7.07	0.00166	--	--
ISS-15	0.00977	0.0148	--	28.4	--	--	0.0011	104	--	--	8.04	0.108	--	--
ISS-15 (FREP)	0.00957	0.0144	--	28.6	--	--	0.00087	105	--	--	8.08	0.104	--	--
ISS-16	0.0019	0.00352	--	14.5	0.0015	--	0.00275	58.4	0.067	0.00023	5.37	0.00073	--	--
ISS-18	0.00338	0.00372	--	14.6	--	--	--	58.6	--	--	5.37	0.0509	--	--

"--" indicates these analytes were not detected

Issaquah Creek Valley -- Round 1

Locator	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Nitrite Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform
	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	CFU/100 ml
ISS-01	--	4.32	--	0.0162	60	2.2	0.11	--	--	24	15	90.8	0	0
ISS-04	2.4	5.03	--	0.0199	90.5	2.8	0.07	--	--	36	7.9	130	0	0
ISS-04 (FREP)	2.8	5.15	--	0.0235	91.3	2.6	0.06	--	--	36	8.2	127	0	0
ISS-05	--	6.7	--	0.0156	78.7	2.2	0.07	--	--	25	4.6	95.9	0	0
ISS-05 (FREP)	--	6.8	--	0.0259	79.1	2.1	0.06	--	--	24	4.9	107	0	0
ISS-06	--	4.38	--	0.0881	37.4	2.5	0.05	0.208	--	28	5.2	75.5	0	0
ISS-06 (FREP)	--	4.38	--	0.11	37.1	2.4	--	0.226	--	28	5.5	79.8	0	0
ISS-07	--	5.18	--	0.0202	24.6	3.8	0.03	0.714	--	24	7.2	62.6	0	0
ISS-08	--	5.61	--	0.0143	99.7	4	0.03	3.01	--	33	10	160	0	0
ISS-09	2	28.2	--	0.0014	109	3.2	0.09	--	--	35	4.4	138	0	0
ISS-10	--	9.14	--	0.0019	60.3	3.4	0.04	0.531	--	27	6.3	93.4	0	0
ISS-10 (FREP)	--	9.2	--	0.0022	60.2	4.5	0.04	0.527	--	27	6.9	95.4	0	0
ISS-11	--	6.05	--	0.00599	48	2	0.04	1.24	--	29	8.8	81.6	0	0
ISS-12	--	6.75	--	0.0018	68.3	3.1	0.06	0.527	--	29	9.6	108	0	0
ISS-13	--	96.2	--	0.0172	200	3.8	0.1	--	--	32	9.1	260	0	0
ISS-14	--	5.02	--	0.00401	58	3.3	0.04	1.02	--	27	3	97	0	0
ISS-15	5.4	12.9	--	0.0025	106	4.7	0.05	0.481	0.023	37	23	168	0	0
ISS-15 (FREP)	5.7	13	--	0.0023	106	4.8	0.06	0.488	0.023	37	23	175	0	0
ISS-16	--	6.78	--	0.0173	64.1	2.1	0.04	1.39	--	31	6.4	107	0	0
ISS-18	--	13.5	--	0.00867	85.1	1.7	0.09	--	--	23	2.7	103	0	0

"--" indicates these analytes were not detected

Redmond - Bear Creek Valley -- Round 1

Locator	Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
R-01	0.00303	0.00628	--	8.78	0.0031	--	0.00043	44.7	0.11	0.00166	5.53	0.00137	--	0.00061
R-01 (FREP)	0.00296	0.00626	--	9.15	0.00299	--	0.00044	46.3	0.12	0.0016	5.7	0.00137	--	0.00059
R-05	0.0299	0.00364	--	8.42	--	--	0.00067	31.3	--	0.00021	2.51	0.0176	0.00437	--
R-08	--	0.0031	--	7.42	--	--	0.00064	37.1	0.079	--	4.52	0.0247	0.00085	--
R-08 (FREP)	--	0.00292	--	7.23	--	--	0.00052	36.1	0.089	--	4.38	0.0238	0.00082	--
R-09	0.00279	0.00334	--	13.5	0.00219	--	0.00095	90.9	--	0.00062	13.9	0.00044	--	0.00048
R-09 (FREP)	0.00271	0.00333	--	13.2	0.00212	--	0.00094	88.6	--	0.00061	13.5	0.00044	--	0.00047
R-10	--	0.00852	--	25.9	0.00288	--	0.00445	106	--	0.0004	10.1	0.00072	--	0.0014
R-11	0.00397	0.00213	--	9.41	--	--	0.00084	45.1	0.12	0.0002	5.23	0.0752	0.00052	--
R-12	0.00447	0.00927	--	7.01	0.0187	0.0005	0.00712	43.4	1.1	0.00174	6.3	0.0522	0.00266	0.00193
R-13	0.00255	0.0108	0.0001	11.1	--	--	0.00266	70	0.91	0.00513	10.2	0.0424	0.0011	0.00062
R-14	0.00358	0.00464	--	12.4	--	--	0.00099	48.5	--	--	4.24	0.0517	0.00317	--
R-17	0.0011	0.0125	--	31.9	--	--	0.0013	153	--	0.00033	17.8	0.00559	--	0.0014
R-21	0.00278	0.0214	--	31.9	0.00409	--	0.0484	196	--	0.00212	28.3	0.0036	--	0.0012
R-30	0.0019	0.00408	--	16.3	--	--	0.0684	74.8	0.448	0.00058	8.25	0.00445	--	0.00063
R-32	0.00484	0.00808	--	15.2	--	--	0.00052	54.4	0.068	--	4	0.0592	0.0015	0.00036
R-32 (FREP)	0.00485	0.00833	--	14.6	--	--	0.00045	52.5	0.052	--	3.88	0.0609	0.0016	0.00036
R-34	0.00374	0.00531	--	11	--	--	0.0009	52.8	0.066	0.00036	6.14	0.0808	0.00089	--
R-35	0.0016	0.00836	--	19.4	--	--	0.00332	86.5	--	0.00024	9.26	--	0.00082	0.00062
R-35 (FREP)	0.0015	0.00807	--	19.2	--	--	0.00255	85.7	--	--	9.14	--	0.00077	0.00057
R-37	0.00071	0.0048	--	16.1	--	--	0.0104	89.7	--	0.00095	12	0.00314	--	0.00099

"--" indicates these analytes were not detected

Redmond - Bear Creek Valley -- Round 1

Locator	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Nitrite Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform
	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	CFU/100 ml
R-01	--	4.55	0.00642	0.077	41.9	2.01	0.03	1.61	--	22	7.8	90.8	0	0
R-01 (FREP)	--	4.68	0.0063	0.0771	41.5	1.97	--	1.71	--	22	7.58	91	0	0
R-05	2.6	42.1	--	0.00445	124	1.94	0.03	0.027	--	17	0.25	153	0	0
R-08	5.8	24.3	0.00043	--	95.2	1.73	0.1	--	--	30	--	127	0	0
R-08 (FREP)	5.6	23.5	0.00041	0.00053	95.2	1.65	0.14	--	--	30	--	132	0	0
R-09	2.7	7	0.00519	0.162	78.3	5.07	--	3.53	--	31	10.2	148	0	0
R-09 (FREP)	2.3	6.81	0.00513	0.16	77.6	4.95	--	3.61	--	31	10.2	151	0	0
R-10	--	8.19	0.0006	0.00732	96.1	7.77	--	4.91	--	20	2.39	156	0	27
R-11	--	5.36	0.0011	0.0719	51.8	1.96	0.05	0.0583	--	21	3.07	86.7	0	2
R-12	12.9	111	0.00277	0.0485	288	4.25	0.36	--	--	45	--	366	0	0
R-13	2.6	16.2	--	0.00581	64.8	3.64	--	--	--	25	14.8	118	0	--
R-14	4.3	35.4	--	0.00063	121	3.66	0.18	--	--	33	1.85	162	0	0
R-17	2.4	11.7	0.00192	0.0158	123	10	--	0.0446	--	22	38.6	215	0	0
R-21	3	9.94	0.0078	0.0969	170	10.5	--	6.65	--	31	12.6	262	0	0
R-30	--	7.9	0.0008	0.0421	79.4	3.72	--	0.291	--	22	6.15	118	0	0
R-32	2.9	23	--	0.0367	102	2.47	--	--	--	26	1.5	136	0	0
R-32 (FREP)	2.6	22.3	--	0.0335	101	2.65	--	0.02	--	26	1.52	133	0	0
R-34	--	5.17	0.00042	0.0178	57.2	2.18	--	--	--	22	6.21	92.5	0	0
R-35	3.1	13	0.00065	0.00371	86.1	11.6	--	0.643	--	21	11.9	149	0	0
R-35 (FREP)	3.4	12.8	0.00064	0.00257	86.7	11.4	--	0.645	--	21	12	143	0	0
R-37	2.1	9.22	0.0011	0.00472	89.7	5.33	--	1.32	--	24	12.1	145	0	0

"--" indicates these analytes were not detected

Vashon - Maury Island -- Round 1

Locator	Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
VAS_S-02	0.0011	0.00799	--	19.2	0.0016	--	--	116	--	--	16.6	0.00024	--	0.0013
VAS_S-03	0.0019	0.00657	--	11.8	0.00499	--	0.00507	92.9	--	--	15.4	0.00105	--	0.00191
VAS_W-02A	0.0071	0.00398	--	19.5	0.00073	--	0.001	96.5	--	--	11.6	0.00496	0.00078	0.00059
VAS_W-03	0.0013	0.0137	--	22.7	0.00078	--	0.00074	148	--	--	22.2	0.00028	0.00706	0.00039
VAS_W-04	0.0185	0.0236	--	20.4	--	--	0.00825	81.9	0.064	0.00048	7.49	0.0504	0.0059	0.00078
vas_w-04 (FREP)	0.0184	0.0248	--	20.6	--	--	0.0012	82.8	0.089	--	7.58	0.0498	0.00587	0.00068
VAS_W-06	0.0016	0.00228	--	10.8	0.0014	--	0.0135	61.8	0.25	0.013	8.46	0.00158	--	0.0004
VAS_W-07	0.0367	0.0148	--	20.9	--	--	0.00406	89.4	0.058	0.00106	9.03	0.0707	0.00584	0.00041
vas_w-07 (FREP)	0.0548	0.0179	--	20.6	0.0011	0.00028	0.0167	89	0.724	0.00451	9.09	0.0811	0.00542	0.00235
VAS_W-08	0.00393	0.0295	--	43.8	--	--	0.0019	191	0.26	--	19.9	0.193	0.00952	0.0006
VAS_W-09A	0.00054	0.00286	--	17.2	--	--	--	110	0.462	--	16.2	0.0906	0.0006	0.0004
VAS_W-10A	0.0013	0.00623	--	20.5	0.00219	--	0.0206	130	--	0.004	19.1	0.00122	--	0.00322
vas_w-10a (FREP)	0.0012	0.00603	--	20.7	0.00207	--	0.00285	132	--	0.00042	19.4	0.00086	--	0.0029
VAS_W-11	0.0015	0.0112	--	25.3	--	--	0.00205	109	0.19	--	11	0.142	0.0008	0.00035
vas_w-11 (FREP)	0.0015	0.0113	--	25.2	--	--	0.00208	108	0.17	--	11.1	0.136	0.00082	0.00038
VAS_W-12	0.00553	0.00914	--	24.3	--	--	0.0531	89.7	0.271	--	7.09	0.0805	0.00329	--
VAS_W-13	0.0012	0.00603	--	16.9	0.00233	--	0.00473	105	--	0.0017	15.2	0.00078	--	0.0014
VAS_W-14	0.0015	0.00364	--	12.5	0.00096	--	0.00045	70.5	0.16	--	9.51	0.00121	--	--
VAS_W-15	0.0016	0.00127	--	11.8	--	--	0.00282	63.2	0.057	0.00046	8.21	0.178	--	0.00043
vas_w-15 (FREP)	0.0018	0.00123	--	12	--	--	0.00464	64.4	0.065	0.00044	8.38	0.168	--	0.00045
VAS_W-16A	--	0.00401	--	9.91	0.00201	--	0.00473	58.3	0.086	--	8.14	0.00085	--	0.00068
VAS_W-17	0.00064	0.00279	--	10.7	0.0011	--	0.00325	55.9	0.12	0.00178	7.07	0.00345	--	0.0012
VAS_W-19	0.002	0.00552	--	9.01	--	--	0.00734	63.3	0.357	0.00064	9.92	0.0939	--	0.00085
vas_w-19 (FREP)	0.002	0.00536	--	8.76	--	--	0.0044	63.9	0.392	0.00104	9.64	0.0915	--	0.00081
VAS_W-20	0.00072	0.00347	--	10.2	0.00289	--	0.00207	54.3	0.21	0.00118	6.99	0.00315	--	0.00038
VAS_W-21	0.00389	0.0094	--	19.9	--	--	0.0197	89.2	0.267	0.00085	9.6	0.021	0.00058	0.0014

"--" indicates these analytes were not detected

Vashon - Maury Island -- Round 1

Locator	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Nitrite Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform
	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100 ml	CFU/100 ml
VAS_S-02	--	9.07	0.00491	0.00088	93.8	9.3	0.03	2.01	--	30	17	158	0	5
VAS_S-03	3.2	7.16	0.00617	0.0079	70.2	5.4	0.05	2.43	--	42	22	149	0	2
VAS_W-02A	3.2	6.23	0.00275	0.00665	84.3	3	0.07	0.863	--	30	23	144	0	0
VAS_W-03	--	30.8	0.00534	0.00496	187	7.6	0.11	0.332	--	26	18	229	0	0
VAS_W-04	8.4	57.1	0.00035	0.00912	213	2.7	0.08	--	--	40	--	233	0	0
vas_w-04 (FREP)	7.3	58.1	0.00033	0.0111	214	3	0.07	--	--	38	--	238	0	0
VAS_W-06	--	5.13	0.00379	0.00737	54.9	2.7	0.03	0.945	--	25	10	119	0	0
VAS_W-07	5.9	22.7	--	0.0261	131	2.1	0.07	--	--	37	4.8	141	0	0
vas_w-07 (FREP)	5.7	21.7	0.0011	2.47	134	2	0.07	--	--	37	4.6	173	0	0
VAS_W-08	8	40.4	--	0.00623	269	7.4	0.09	--	--	41	--	305	0	0
VAS_W-09A	2.7	8.41	--	0.00469	84.4	6.7	0.04	0.073	--	20	48	145	0	0
VAS_W-10A	2.7	16.9	0.003	0.0136	123	8.9	0.05	3.79	--	36	22	209	0	0
vas_w-10a (FREP)	2.3	17	0.0029	0.0032	121	8.8	0.04	3.74	--	36	19	209	0	0
VAS_W-11	3.7	9.45	--	0.00331	88.3	5.2	0.08	--	--	43	40	194	0	0
vas_w-11 (FREP)	3.4	9.36	--	0.00352	87.8	4.6	0.08	--	--	41	34	188	0	0
VAS_W-12	3.6	26.1	--	0.0208	140	3.4	0.04	--	--	26	5.6	173	0	0
VAS_W-13	2.9	6.73	0.00463	0.00319	90.7	8.9	0.02	2.05	--	30	16	152	0	0
VAS_W-14	--	6.34	0.00276	0.115	64.3	3.7	0.04	--	--	29	15	107	0	0
VAS_W-15	--	5.68	0.0008	0.0527	54.8	4.3	0.04	--	--	30	17	104	0	0
vas_w-15 (FREP)	--	5.79	0.00077	0.0642	53.8	4.4	0.04	--	--	29	14	101	0	0
VAS_W-16A	--	7.28	0.00347	0.0194	37.2	3.8	0.03	6.28	--	26	8.3	125	0	0
VAS_W-17	--	6.58	0.00157	0.0362	50.6	3	0.03	1.43	--	30	17	96.9	0	0
VAS_W-19	--	4.87	0.0017	0.0185	52	2.2	0.03	0.57	--	28	17	101	0	0
vas_w-19 (FREP)	--	4.76	0.00167	0.0168	52.6	3.1	0.03	0.582	--	26	14	100	0	0
VAS_W-20	--	5.26	0.0026	0.0785	39.4	2.8	0.02	3.04	--	24	11	94.9	0	0
VAS_W-21	3.3	7.02	--	0.0101	89.3	2.3	0.04	--	--	32	16	143	0	0

"--" indicates these analytes were not detected

East King County -- Round 2

Location		Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
EKC03		--	0.0148	--	12.9	--	--	0.00467	43.6	0.17	--	2.75	0.0418	--	--	--	2.6	0.00048
rep_EKC03		--	0.0152	--	13	--	--	0.00426	44	0.14	--	2.8	0.0417	--	--	--	2.56	0.00047
EKC04		0.0228	0.00598	--	14.6	--	0.00163	--	47.9	9.39	--	2.8	0.473	--	0.0006	--	4.47	--
EKC09		0.0124	0.0108	--	37.1	--	--	0.013	143	0.11	0.00025	12.3	0.131	0.0022	0.00055	3.5	7.4	--
EKC11		--	0.00216	--	8.72	--	--	0.00726	29.3	0.534	0.00089	1.83	0.00444	--	--	--	2.4	--
EKC13		0.0186	0.00779	--	22.6	--	--	--	83.5	0.464	0.00039	6.56	0.383	0.0014	0.00087	3.2	7	0.0011
EKC14		0.0376	0.0158	0.00018	25.1	--	--	0.0013	80.7	0.815	0.00065	4.38	0.0337	0.003	0.00071	2.7	25.3	0.00031
EKC15		0.00488	0.0152	--	27	--	--	0.00487	101	--	--	8.23	0.0987	0.0013	0.0004	3	21.2	--
EKC16		--	0.0169	--	17.2	--	--	0.00413	65	--	0.00038	5.32	0.00029	--	0.00038	8.9	5.68	0.00034
EKC17		0.0716	0.00372	--	10.3	--	--	0.00089	33.8	--	--	1.95	0.0112	0.0023	--	--	40.1	0.00161
EKC18		0.0267	0.00931	--	10.1	--	--	0.001	38	0.13	0.00128	3.13	0.0324	0.00385	0.00044	3	48.7	--
rep_EKC18		0.0261	0.00907	--	10.2	--	--	0.0017	38.5	0.11	0.00115	3.16	0.0308	0.00376	0.0004	3.6	49.4	--
EKC19		0.0469	0.0128	--	19.5	--	--	0.00079	60.1	0.16	0.00026	2.76	0.0235	0.0192	0.0005	3.4	49.5	--
EKC21		0.037	0.0235	--	23.8	--	--	0.001	79.9	0.11	0.00033	4.98	0.0248	0.00851	0.0005	2.6	34	--
EKC22		0.0021	0.00692	--	48.8	0.00065	--	0.001	215	0.299	0.0013	22.6	0.00141	--	0.00163	--	10.6	0.00083
EKC24		--	0.00176	--	8.11	--	--	0.00654	38.5	--	0.00026	4.43	0.00039	--	0.00037	--	3.76	0.00052

"--" indicates these analytes were not detected

East King County -- Round 2

Location	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform		Phenol
	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100ml	CFU/100ml		ug/L
EKC03	0.00507	21.5	2.01	0.04	5.43	9.9	4.48	59	0	0		--
rep_EKC03	0.00496	21	1.94	0.03	5.31	9.5	4.45	87	0	1		--
EKC04	0.00507	54.3	1.47	0.08	--	29	--	103	0	0		--
EKC09	0.127	121	1.77	0.21	--	29	33	172	0	0		--
EKC11	0.00856	25.8	1.44	0.03	0.815	9.5	3.67	29	0	0		--
EKC13	0.00055	91.3	1.59	0.25	0.027	28	1.91	109	0	0		--
EKC14	0.0669	123	5.25	0.13	--	15	0.25	124	0	0		--
EKC15	0.00267	105	30.1	0.19	--	38	0.3	153	0	0		0.0269
EKC16	0.0013	23.9	6.9	0.03	11.3	13	10.6	140	0	1		--
EKC17	0.00627	108	2.18	--	--	17	4.05	151	0	0		--
EKC18	0.0442	129	1.76	0.38	--	21	6.87	148	0	0		--
rep_EKC18	0.0874	129	1.75	0.43	--	21	6.85	159	0	0		--
EKC19	0.0159	147	4.74	0.18	--	14	6.64	172	0	37		0.0334
EKC21	0.0102	138	7.22	0.11	--	15	1.85	159	0	0		--
EKC22	0.0264	163	35.8	0.1	0.469	26	15.8	255	0	0		--
EKC24	0.00673	32.8	1.81	0.06	2.11	22	4.18	73	0	0		--

"--" indicates these analytes were not detected

Issaquah Creek Valley -- Round 2

Location	Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ISS-01	0.0021	0.00607	--	15	--	--	--	65.1	--	--	6.72	0.113	0.0007	--	2	4.52	--
ISS-04	0.00727	0.0048	--	22.8	--	--	--	87.7	0.073	--	7.47	0.0968	--	0.00038	2.4	5.15	--
ISS-05	0.0069	0.0044	--	18.7	--	--	--	69.8	--	--	5.59	0.0752	0.00051	0.00037	--	6.88	--
ISS-06	--	0.00058	--	9.67	--	--	--	35.6	0.755	--	2.79	0.0151	--	--	--	4.49	0.00035
ISS-07	--	0.00225	--	8.27	--	--	0.013	29.6	0.15	0.0029	2.17	0.00301	--	0.00038	--	5.51	0.00051
ISS-08	0.0011	0.00583	--	25.2	0.00062	--	0.00202	110	--	0.00215	11.5	--	--	0.00066	--	5.72	0.00253
ISS-09	0.00281	0.00503	--	12.8	--	--	--	48.2	--	--	3.97	0.0298	0.00081	--	--	28.6	--
ISS-10	0.0018	0.00273	--	14.3	--	--	0.0012	52.2	--	0.0005	3.98	--	0.00053	0.00032	--	9.18	0.001
rep_ISS-10	0.0018	0.00275	--	14.5	--	--	0.0012	52.8	--	0.00026	4.02	--	0.00053	0.00032	--	9.31	0.001
ISS-11	--	0.00087	--	12.7	0.00052	--	0.011	45.5	0.11	0.00021	3.35	0.00325	--	0.00034	--	5.94	0.00186
ISS-12	--	0.00303	--	15.3	--	--	0.00223	66.2	--	--	6.78	0.00104	--	0.00072	--	6.79	0.0011
rep_ISS-12	--	0.00297	--	15.3	--	--	0.00248	66.2	--	--	6.79	0.00081	--	0.00076	--	6.79	0.0011
ISS-13	0.00482	0.00128	--	0.543	--	--	--	2.87	0.079	0.00024	0.369	0.00476	--	--	--	93.6	0.00034
ISS-14	--	0.00272	--	11.6	0.0014	--	0.0017	57.7	0.063	--	7	0.00149	--	0.00083	--	5.11	0.0012
ISS-15	0.00964	0.0158	--	28.5	--	--	0.00089	104	--	--	8.02	0.113	--	0.00086	4.9	12.6	0.00073
ISS-16	0.0022	0.00373	--	14.7	0.0015	--	0.00731	58.8	0.87	0.00101	5.38	0.0045	--	0.00625	--	6.86	0.00089
ISS-18	0.00364	0.00352	--	14.3	--	--	--	57.4	0.062	--	5.23	0.0482	0.0013	--	--	13.6	--

"--" indicates these analytes were not detected

Issaquah Creek Valley -- Round 2

Location	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform		1,1,2-Trichloroethylene	Benzoic Acid
	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100ml	CFU/100ml		ug/L	ug/L
ISS-01	0.00312	58.9	1.93	0.06	--	22	13.1	97	0	0		--	--
ISS-04	0.0245	87.1	2.85	0.06	--	36	8.07	136	0	0		--	--
ISS-05	0.0203	76.5	2.11	0.07	--	23	5.35	102	0	0		--	--
ISS-06	0.026	34.8	3.3	0.02	0.601	27	4.94	73	0	0		0.12	--
ISS-07	0.00252	25.1	4.1	0.02	1.15	24	6.39	71	0	0		--	--
ISS-08	0.0133	96.4	4.01	0.03	2.94	33	9.17	180	0	0		--	--
ISS-09	0.0014	102	3.24	0.11	--	33	5.02	140	0	0		--	--
ISS-10	0.00074	59.9	4.07	0.05	0.496	26	5.92	95	0	0		--	--
rep_ISS-10	0.00088	59.8	3.96	0.04	0.493	28	6.12	95	0	0		--	--
ISS-11	0.00315	47.5	2.24	0.04	1.03	26	4.38	83	0	0		--	--
ISS-12	0.0025	65	3.86	0.04	0.495	31	9.12	107	0	1		--	--
rep_ISS-12	0.00251	64.3	3.79	0.03	0.486	28	9.26	109	0	0		--	--
ISS-13	0.0096	195	4.32	0.1	--	30	7.98	233	0	0		--	--
ISS-14	0.00305	56	3.87	0.04	1.18	25	3.1	86	0	0		--	--
ISS-15	0.00623	103	4.75	0.05	0.419	35	26.7	163	0	0		--	0.29
ISS-16	0.0356	60.7	2.44	0.03	1.43	29	4.43	102	0	0		--	--
ISS-18	0.0112	82.1	1.66	0.1	--	22	2.19	93	0	0		--	--

"--" indicates these analytes were not detected

Redmond - Bear Creek Valley -- Round 2

Location	Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
R-01	0.00284	0.00642	--	8.51	0.00293	--	--	43.4	--	0.00068	5.37	0.00038	--	0.00044	--	4.49	--
R-05	0.0288	0.00356	--	7.7	--	--	0.00082	28.6	--	--	2.27	0.015	0.00418	--	2.7	39.7	--
R-08	--	0.00311	--	6.86	--	--	0.0012	34.4	0.057	--	4.18	0.0228	0.00088	--	5.4	22.7	--
R-09	0.00252	0.00339	--	13.2	0.0019	--	0.0008	88.7	0.066	0.00054	13.6	0.00137	--	0.00049	2.6	6.88	--
R-10	--	0.00879	--	25.6	0.00262	--	0.00782	104	--	0.00081	9.85	0.00067	--	0.0014	--	8.11	--
rep_R-10	--	0.00919	--	25.4	0.00253	--	0.00428	104	--	0.00037	9.8	0.00067	--	0.0014	--	8.08	--
R-11	0.00453	0.00242	--	8.79	--	--	--	42.3	0.24	0.00097	4.93	0.0822	--	--	--	5.14	--
R-12	0.00395	0.00574	--	6.24	0.00094	--	0.00358	38.4	0.26	0.00047	5.55	0.0392	0.00276	0.00057	12.2	101	--
R-13	0.0023	0.0112	--	10.3	--	--	0.00322	64.8	0.88	0.00087	9.51	0.0419	0.00083	0.00054	2.1	5.16	--
R-14	0.00354	0.00462	--	12.8	--	--	0.0006	49.9	--	--	4.35	0.0468	0.00324	--	4.4	35.9	--
R-21	0.00265	0.0221	--	29.2	0.00401	--	0.0307	180	--	0.00074	26.1	0.00145	--	0.0012	2.8	9.4	--
R-30	0.0022	0.00625	--	21.7	0.00043	--	0.05	99	0.333	0.00048	10.9	0.00134	--	0.00099	--	14.5	--
R-32	0.00505	0.00949	--	14.8	--	--	0.00079	52.6	0.448	0.00025	3.79	0.0956	0.0016	0.00045	2.6	23	--
R-34	0.00364	0.006	--	12.1	--	--	--	59.1	0.1	--	7	0.0838	0.0007	--	--	5.68	--
R-35	0.0016	0.00972	--	18.7	--	--	0.0015	83.5	--	--	8.94	--	0.001	0.00068	3.4	12.6	--
R-37	0.00067	0.00515	--	15.1	--	--	0.00929	84.6	--	0.00272	11.4	0.00564	--	0.00096	--	9.13	--
rep_R-37	0.00066	0.00519	--	14.9	--	--	0.00902	83.6	--	0.00268	11.2	0.0061	--	0.001	--	9.01	--

"--" indicates these analytes were not detected

Redmond - Bear Creek Valley -- Round 2

Location	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform		Atrazine	Chloroform	Tetrachloroethylene
	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100ml	CFU/100ml		ug/L	ug/L	ug/L
R-01	0.0558	41.3	2.03	0.06	1.66	28	7.89	90	0	0		--	--	--
R-05	0.00507	121	1.92	0.08	0.04	21	0.39	138	0	0		--	--	--
R-08	0.0011	94.9	1.77	0.13	--	38	--	120	0	0		--	--	--
R-09	0.15	78.7	5.4	0.05	3.43	38	10.5	158	0	0		--	--	--
R-10	0.00516	101	6.76	0.03	4.5	25	2.36	153	0	8		--	--	--
rep_R-10	0.00531	100	6.89	0.02	4.55	25	2.38	162	0	13		--	--	--
R-11	0.0618	51.7	2.02	0.1	0.05	26	3.26	75	0	0		--	--	--
R-12	0.00804	291	4.34	0.37	--	54	--	372	0	0		--	--	--
R-13	0.00347	65.6	3.71	0.05	--	30	15.6	131	0	0		--	--	--
R-14	0.00087	120	3.87	0.2	--	41	1.85	173	0	0		--	--	--
R-21	0.0719	168	10.8	0.03	6.22	39	12.8	261	0	0		--	--	--
R-30	0.0236	104	4.51	0.04	--	25	15.5	160	0	0		0.0513	--	--
R-32	0.0798	98.1	2.45	0.09	--	32	1.38	138	0	0		--	--	--
R-34	0.00848	59	2.54	0.06	0.094	28	6.74	111	0	0		--	--	--
R-35	0.0016	93.1	8.98	0.06	1.09	27	13.2	144	0	4		--	--	--
R-37	0.00353	89.3	5.28	0.05	1.32	30	12.2	148	0	0		--	0.368	0.13
rep_R-37	0.00332	88.9	5.42	0.05	1.3	30	12.4	126	0	0		--	0.362	0.11

"--" indicates these analytes were not detected

Vashon - Maury Island -- Round 2

Location	Arsenic, Total, ICP-MS	Barium, Total, ICP-MS	Cadmium, Total, ICP-MS	Calcium, Total, ICP	Chromium, Total, ICP-MS	Cobalt, Total, ICP-MS	Copper, Total, ICP-MS	Hardness, Calc	Iron, Total, ICP	Lead, Total, ICP-MS	Magnesium, Total, ICP	Manganese, Total, ICP-MS	Molybdenum, Total, ICP-MS	Nickel, Total, ICP-MS	Potassium, Total, ICP	Sodium, Total, ICP	Vanadium, Total, ICP-MS
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
VAS_S-02	0.00093	0.00832	--	17.8	0.0015	--	--	107	--	--	15.2	0.00092	--	0.00152	--	8.48	0.00471
VAS_S-03	0.0018	0.00676	--	11.1	0.00413	--	0.00701	85.8	--	--	14.1	0.0004	--	0.00193	2.5	6.59	0.00547
VAS_W-02A	0.00766	0.00411	--	17.8	0.00056	--	0.00071	90.9	0.525	0.00067	11.3	0.00939	0.00083	0.00081	3	6.22	0.00285
VAS_W-03	0.0011	0.0132	--	21.2	0.00072	--	0.00231	137	--	--	20.5	0.00029	0.00697	0.00062	5.8	29	0.00475
VAS_W-04	0.0188	0.0241	--	20.4	--	--	0.00442	81.5	0.077	0.00038	7.38	0.0514	0.00604	0.0009	7.5	56.7	0.00032
rep_vas_W-04	0.0186	0.0236	--	21.1	--	--	0.0029	84	0.076	0.00038	7.61	0.0492	0.00582	0.00079	7.6	58.6	--
VAS_W-06	0.001	0.0024	--	9.45	0.0012	--	0.0013	53.4	0.094	0.00036	7.24	0.0017	--	0.00043	--	4.68	--
VAS_W-07	0.037	0.0175	--	20.7	0.00053	0.00022	0.00219	88.6	0.736	0.00076	8.97	0.0773	0.00524	0.00201	4.8	21.6	0.00072
rep_vas_W-07	0.0388	0.0187	--	21.7	0.00088	0.00033	0.00305	93.1	1.07	0.00082	9.46	0.0842	0.00512	0.00257	4.9	22.6	0.0011
VAS_W-08	0.0024	0.0301	--	44.1	--	--	0.0033	191	0.507	0.0006	19.7	0.195	0.00974	0.0012	7.3	37.6	--
VAS_W-09A	0.0011	0.00287	--	17.4	--	--	--	110	1.85	0.00031	16.1	0.087	0.00052	0.00047	2.5	8.39	0.00046
VAS_W-12	0.00584	0.00954	--	23.4	--	--	0.0442	85.9	0.536	--	6.7	0.085	0.00338	0.00045	3.2	24.7	--
VAS_W-13	0.0012	0.00551	--	16.1	0.00212	--	0.00046	97.8	--	0.00036	14	0.00119	--	0.0013	--	6.55	0.00434
VAS_W-14	0.0015	0.00413	--	11.6	0.0012	--	0.00083	65.1	0.717	0.00077	8.75	0.00122	--	--	--	6.07	0.00292
VAS_W-15	0.0014	0.00125	--	11	--	--	0.00052	58.9	--	--	7.62	0.177	--	0.00042	--	5.42	0.00072
VAS_W-16A	0.00052	0.00385	--	8.91	0.0019	--	0.00697	52	0.13	0.00025	7.23	0.00161	--	0.0007	--	6.65	0.00321
VAS_W-17	0.0005	0.00291	--	10.3	0.0011	--	0.00222	53.4	0.1	0.00086	6.71	0.00241	--	0.0013	--	6.42	0.0014
VAS_W-18	0.00314	0.0124	--	36.4	0.0014	--	0.00829	133	9.52	0.00365	10.4	1.13	--	0.0011	2.2	6.65	--
VAS_W-20	0.00064	0.00353	--	8.84	0.00309	--	0.00391	46.3	--	--	5.88	0.00151	--	0.00043	--	4.74	--
VAS_W-21	0.00376	0.00871	--	19.7	--	--	0.00092	87.6	0.24	--	9.31	0.019	0.00056	0.00042	2.7	7.2	--

"--" indicates these analytes were not detected

Vashon - Maury Island -- Round 2

Location	Zinc, Total, ICP-MS	Alkalinity	Chloride	Fluoride	Nitrate Nitrogen	Silica	Sulfate	Total Dissolved Solids	Fecal Coliform	Total Coliform		Benzoic Acid	Phenanthrene	Phenol
	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100ml	CFU/100ml		ug/L	ug/L	ug/L
VAS_S-02	0.00078	91.7	10.4	0.05	2.08	5.7	14.2	154	0	1		--	--	0.118
VAS_S-03	0.0115	68.8	6.37	0.08	2.44	5.7	17.7	147	0	0		0.26	--	--
VAS_W-02A	0.0186	81	3.77	0.08	0.619	31	19.6	142	0	0		--	--	--
VAS_W-03	0.00481	183	7.7	0.12	0.345	27	14.8	226	0	22		--	--	--
VAS_W-04	0.016	208	3.68	0.1	--	43	--	260	0	0		0.25	--	--
rep_vas_W-04	0.0144	207	3.77	0.09	--	43	--	256	0	0		0.28	--	--
VAS_W-06	0.00374	50.8	2.92	0.04	1.01	30	8.84	96	0	0		--	--	0.0247
VAS_W-07	1.18	132	2.78	0.1	--	38	4.21	166	0	0		0.25	--	--
rep_vas_W-07	1.45	131	2.81	0.1	--	41	4.23	173	0	0		--	--	--
VAS_W-08	0.0118	267	8.69	0.1	--	43	--	302	0	0		0.28	--	--
VAS_W-09A	0.055	82	7.06	0.06	--	20	36.4	152	0	0		--	--	--
VAS_W-12	0.0141	138	3.97	0.07	--	28	4.15	167	0	0		--	--	0.0738
VAS_W-13	0.00073	80.5	8.97	0.03	1.88	35	12.4	140	0	0		--	0.0065	--
VAS_W-14	0.224	60	4.26	0.06	--	28	12.3	103	0	0		--	--	0.0288
VAS_W-15	0.0454	53.5	4.55	0.06	--	32	13.1	106	0	0		--	--	0.0379
VAS_W-16A	0.022	35.7	4.04	0.04	5.59	27	6.58	97	0	0		--	--	--
VAS_W-17	0.028	50.2	3.69	0.05	1.49	31	7.08	93	0	0		--	--	0.0225
VAS_W-18	0.0825	144	5.85	0.07	--	67	1.65	241	0	0		--	--	0.0182
VAS_W-20	0.0604	37.6	3.77	0.03	2.88	27	8.9	183	0	0		--	--	0.0222
VAS_W-21	0.00081	88.5	3.58	0.07	--	34	10.1	136	0	0		0.32	--	--

"--" indicates these analytes were not detected