Oregon Department of Environmental Quality

A Strategy for Monitoring Oregon's Waters

2005

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Table of Contents

INTRODUCTION

Role of Monitoring in Water Quality Management

Water monitoring is the systematic collection and evaluation of data about the chemical, physical, and biological quality of the State's waters, and assesses how external changes, both natural and anthropogenic, affect that quality. This monitoring strategy identifies various assessment needs and forms a basis for setting resource priorities to ensure their best use in achieving strategic water quality management goals. This strategy establishes the expectations and objectives for the Watershed Assessment Program.

Monitoring and assessment is a fundamental need of the Water Quality Program and an integral component of protecting human health and the environment. A well designed monitoring and assessment program defines water quality problems, characterizes existing and emerging problems, determines the magnitude and geographical extent of water conditions, provides the basis for designing and operating pollution prevention and abatement programs, evaluates the effectiveness and compliance of water quality programs, and identifies trends in water quality over time.

A 2000 report by the US Government Accounting Office (GAO) described the need for water monitoring and assessment programs accordingly:

> "EPA [Environmental Protection Agency] and States need comprehensive water quality monitoring and assessment information on environmental conditions and changes over time to help set levels of protection in water quality standards and to identify problem areas that are emerging or that need additional regulatory and non-regulatory actions to support water quality management decisions such as TMDLs [Total Maximum Daily Loads], NPDES [National Pollutant Discharge Elimination System] permits, enforcement, and non-point source management. This information also informs EPA and State decision makers, the Congress, the public, and other stakeholders of the progress that the Agency and State partners are making in protecting human health and the environment. Without this information, it is difficult for EPA and the States to set priorities, evaluate the success of programs and activities, and report on accomplishments in a credible and informed way."

Ultimately, monitoring and assessment inform the public and policy makers, and provide the foundation for wise and effective water quality management.

Legal Authorities and Requirements for Monitoring

The Department of Environmental Quality (DEQ) is authorized and in certain cases mandated to conduct water quality monitoring under Oregon Revised Statutes (ORS).

- ORS 468.05: (1) (b) and ORS 468.05 (1) authorize the department to conduct monitoring.
- ORS 468B.110 (4): Requires the department to establish guidelines describing how the department and commission will determine whether water quality standards in waters affected by non-point sources are being met.
- ORS 468B.035: Authorizes the department to implement the Clean Water Act.
- ORS 468B.160 (3): Requires the department to conduct statewide programs to identify and characterize groundwater quality.
- ORS468B.162 (4): Requires the department submit a report to the legislature on January 1 of each odd numbered year on the status of groundwater in Oregon.
- ORS468B.190: Requires the department conduct a groundwater monitoring and assessment program based on vulnerability to contamination that determines status, long term trends and emerging problems.

The Department also implements the requirements of the Clean Water Act. Clean Water Act requirements related to monitoring include:

- Section106 (d): " Administrator shall not make any grants under this section to any state which has not provided or is not carrying out as a part of the program-(1) The establishment and operation of appropriate devices, methods, systems, and procedures necessary to monitor, and to compile and analyze data on (including classification according to eutrophic condition) the quality of navigable water and to the extent practicable, groundwaters including biological monitoring; and provisions for annually updating such data and including it in the report required under Section 305 of this Act."
- Section 303(d) (1) (A) & (B): Requires each state to identify waters within its boundaries for which effluent limits and controls of thermal discharges required by section 301are not stringent enough to meet water quality standards and to assure protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife.
- Section 305 (b)(1): Requires each state submit a biennial report by April 1 on even numbered years that includes a description of the water quality of <u>all</u> navigable waters in the state, an analysis of the extent to which they provide for shellfish, fish, wildlife and recreation, the extent to which the elimination of pollutants has provided for the above and recommendations for additional actions necessary to do so, the economic and social costs to do so, and a description of the extent of non-point source pollutants and recommended actions to address non-point sources including costs.

- Section 314: Requires the establishment of a clean lakes program including an assessment of the status and trends in water quality in publicly owned lakes and list of impaired lakes and the pollutant sources in those lakes.
- Section 406: Requires the establishment of a coastal recreation water monitoring and notification program.

Past, Present, and Future of Oregon's Water Monitoring Program

Oregon has a long history of assessing and reporting on the conditions of Oregon's waters beginning in 1938 when the Oregon State Sanitary Authority was established as a result of a citizen initiative. In 1969 the name was changed to the Oregon Department of Environmental Quality creating the current agency assigned the protection and preservation of the Oregon's land, water and air. Over the ensuing decades monitoring objectives, methods, and resources have periodically changed in response to shifting water pollution problems, new regulatory programs, improved knowledge of water pollution problems and methods for assessing them, and fluctuations – both up and down – in funding for monitoring and assessment activities. A brief overview of major changes in the water program that have affected monitoring include:

- 1938 – 1970's: The main focus of both the Sanitary Authority and DEQ in the early decades of work was on assessing and controlling major point sources of pollution. Sewage from cities and towns and chemical waste from factories and businesses were the obvious and major sources of water pollution. Water monitoring focused on the documentation of water quality from these point sources and their control through the construction of waste water treatment facilities. In addition a network of ambient water quality monitoring sites was established on major rivers throughout the state to determine water quality status and compliance with standards, as well as to document trends in water quality.
- Late1970's to mid 1980's: As point source pollution problems were addressed there was a growing understanding that many other pollution problems were the result of broad land use practices and urban development. Logging, farming, and the expansion of highways, parking lots and housing developments in response to population growth, all have the potential to degrade water quality. Such wide spread activities do not produce pollution problems at discrete points or at regular frequencies, and are thus referred to as "non-point" sources of pollution. DEQ began to develop biological and habitat assessment methods to help in assessing non-point source pollution, while still maintaining its network of ambient water monitoring sites. DEQ also began statewide sampling and analysis for bioaccumulative toxic chemicals in fish tissue and sediment.
- Mid 1980's to mid 1990s: During this time there was increasing attention to groundwater contamination from both industrial and non-point sources. Hazardous

waste site investigations were documenting groundwater contamination in urban and industrial areas. A statewide study of agricultural chemicals in groundwater conducted in 1985-86 revealed widespread contamination of groundwater with nitrates, particularly in agricultural areas and contamination with pesticides in certain areas. This led to extensive assessment of groundwater quality until funding was cut in the late 1990s. In addition improved analytical capabilities and data assessment resulted in new attention to toxic chemical contamination of water. During the late 1980's and early 1990s considerable work was done on assessing bioaccumulative toxic chemicals, including dioxins, furans, PCBs, and chlorinated pesticides in the Willamette and Columbia rivers. From the early 1990's to the present mercury has received the most attention as a bioaccumulative toxin. Finally, citizen law suits forced the implementation of the Total Maximum Daily Load (TMDL) requirements in the Clean Water Act. TMDLs have been developed in Oregon by constructing a mathematical model that simulates improvements in water quality resulting from reductions of pollutant loads. These models require extensive data on the sources and loads of pollutants in water quality limited streams for the development of TMDL models. Much of the monitoring currently conducted is to provide that data.

- Mid 1990's to present: TMDL modeling and development continues to be a significant monitoring need for the agency. In addition, between 1996 and 1998, several salmon and steelhead populations in Oregon – and throughout the Pacific Northwest – were listed as threatened under the federal Endangered Species Act (ESA). This created another shift in information needed for assessing the condition of rivers and streams, especially where listed species occur. In 1997 the Oregon Plan for Salmon and Watersheds was adopted by the State to protect and recover threatened salmonids. This plan established an interagency monitoring team to coordinate environmental monitoring efforts of all state natural resource agencies. It also established a monitoring design based on probabilistic random sampling to assess the majority of wadeable stream miles within large geographic areas.

Since the Oregon State Sanitary Authority began collecting water quality data in 1938, the number and complexity of water quality programs has grown significantly. The result has been an increased demand on the monitoring and assessment program: more types of data are collected, monitoring designs must address multiple needs, data quality must be maintained, and data must be compiled and managed in a useable format.

Goals of Monitoring Strategy

A variety of different issues have emerged in the water program over the last ten years. There has been the recognition that non-point source pollution must be addressed as well as point sources. The TMDL program has expanded into a major effort that includes DEQ personnel and public interest groups across the entire State. The ESA listing of salmonid populations has created the need for broader assessments of the condition of rivers and streams. Biological assessments of aquatic assemblages and stream habitat, in addition to traditional water chemistry data, are now recognized as essential components of water quality assessment. And finally, contamination of waters from toxic chemicals, in both surface and groundwater, must be understood in order to protect human health and the environment.

The goal of this strategy document is to describe a comprehensive statewide water monitoring and assessment approach that will effectively address these complex data needs, provide high quality credible data that is accessible to DEQ and other users when needed, and ensure that data becomes useable information that can help management make informed decisions. Finally, since resources limit the extent of any monitoring program, the strategy will be used to set priorities and identify resource gaps.

This strategy is comprehensive in scope and addresses monitoring issues for all waters of the state: rivers and streams, estuaries, lakes, wetlands, and groundwater. It also recognizes that current resources for monitoring and assessment are insufficient to implement a program that adequately addresses all program needs for all waters. Therefore, this strategy document is intended to be used as a tool for setting monitoring priorities within the agency and identifying funding needs to fully implement the watershed assessment program. Last, some of the most important information about water quality and the effectiveness of state and federal programs comes from the consistent application of monitoring activities over long periods of time (decades). Nevertheless, given the dynamic nature of water issues and monitoring needs, it is the intent that this document will be periodically reviewed and revised as needed to maintain and improve the relevancy of monitoring data collected by the agency.

ELEMENTS OF A WATER MONITORING PROGRAM

DEQ's watershed assessment program includes several key elements that must function together for a successful monitoring program. These elements include:

- Clear monitoring objectives
- Monitoring designs that effectively address objectives
- Appropriate indicators for a comprehensive water quality assessment
- Effective quality control and quality assurance procedures including training
- Effective data management system in place
- Appropriate data analysis and assessment methods
- Timely and effective reports

In 2003 EPA published the document, "Elements of a State Water Monitoring and Assessment Program." EPA expects states to implement all elements outlined in the document for a comprehensive monitoring and assessment program within a ten-year period. The elements described by EPA are essentially the same as those already outlined by DEQ. A summary of EPA's ten elements is provided below.

1. The State needs a comprehensive watershed assessment strategy that addresses all State waters, including all waterbody types (lakes, wetlands, estuaries, rivers, etc.).
2. Objectives of the watershed assessment program need to be consistent with the Clean Water Act (CWA) and address all the data requirements of the CWA.
3. The monitoring strategy needs to describe the design and rationale for selecting monitoring sites.
4. The strategy should describe what parameters the State will use for assessing water quality. Parameters should include physical/habitat, chemical/toxicological, and biological/ecological endpoints as appropriate to assess attainment of water quality standards throughout the State.
5. The strategy needs to include quality assurance objectives and quality management plans that ensure the quality of data collected and reported.
6. State monitoring and assessment programs should also address data management, and provide for an accessible electronic data system for water chemistry, fish tissue, toxicity, sediment chemistry, habitat, and biological data.
7. The methodology used for data analysis and assessment should also be addressed and describe the monitoring strategy.
8. The watershed assessment program needs to provide timely reporting of data results and lists as described under Sections 305(b), 303(d), and 314 of the CWA and Section 406 of the Beaches Act.
9. The monitoring strategy should be periodically reviewed by the State in conjunction with EPA. This audit of the monitoring program will determine how well each of the elements

is addressed and determine what changes or additions are needed to the monitoring program.

10. Finally, the strategy should describe current and future resource needs to fully implement the State's monitoring program. This should address, funding, staffing, training, laboratory resources, and needed improvements.

The ten elements outlined above provide broad directions for State water quality monitoring programs. It is also necessary to look closely at the monitoring needs of specific water quality programs within Oregon DEQ and those of the agency as a whole. If the information needs of the agency are not met, DEQ will not have the knowledge needed to make informed decisions about the implementation and success of its programs. The primary water quality programs and their assessment needs within DEQ include:

- Permit program (includes NPDES, WPCF (Water Pollution Control Facilities), 401 permits, etc.): Effluent and mixing zone data to assess permit compliance, far field data to assess effectiveness and data to update permit limits when necessary.
- Water Quality Standards: Data on water quality and beneficial use impairment needed to evaluate and refine water quality standards to ensure the protection of designated beneficial uses.
- 305(b) Report: Data needed to report on the status and trends of the quality of all waters throughout the state.
- 303(d) List: Data needed to identify water bodies not meeting water quality standards.
- TMDL program: Data on sources and loads of pollutants that is needed to develop and verify models for setting appropriate loading limits in streams that exceed water quality standards. In addition data is needed to assess implementation and effectiveness of TMDLs over time.
- 319 Nonpoint Source program: Data that can document the effectiveness of restoration efforts in improving water quality or biological integrity.
- Groundwater program: Need data on current status and emerging issues to protect current and future beneficial uses of groundwater and to protect public health.

In addition to these internal agency programs DEQ also provides water quality data for uses outside the agency. These include:

- Oregon Progress Board Benchmark Performance Report: Using a variety of established benchmarks Oregon reports on the status of the benchmarks every two years. Statewide water quality data using the Oregon Water Quality Index is the current benchmark for assessing water quality.
- Oregon Plan for Salmon and Watersheds (OPSW): Beginning in 1997 the OPSW funded several state agencies, including DEQ, to work together on a comprehensive monitoring strategy to assess threatened fish populations and the environmental factors that affect their survival and recovery. Originally targeting coastal coho populations, in 1998, an

executive order from the Governor expanded the OPSW statewide, though it was never funded at a level to cover the entire state. Since 1998 DEQ has been monitoring streams in the Coast Range, Willamette Valley, and Lower Columbia ecoregions as part of this interagency monitoring and assessment program.

- Volunteer monitoring coordination and assistance: DEQ has one position funded to help coordinate and assist volunteer groups – primarily watershed councils – develop and implement effective water quality monitoring and assessment programs.

Water quality data are required to effectively implement each of the above programs. Sometimes the data needs between programs overlap, while at other times they do not. The permit program, for example, typically requires site specific data to evaluate the impact of point source discharges, while TMDLs require data that can characterize water quality for specific parameters along an entire stream length or watershed. Providing data for programs like 319 or 305(b) require data at a basin and statewide scale. The fact that different programs require data collected at different scales, at different frequencies, for different parameters requires multiple monitoring designs and assessment approaches.

WATER MONITORING STRATEGY

The following strategy outlines a comprehensive plan to implement a complete statewide monitoring and assessment program. While comprehensive in scope, this plan represents the "minimum" monitoring effort needed to implement a statewide water monitoring program with all the required elements for all waters of the state.

DEQ's statewide monitoring strategy is presented in three parts: Part 1 presents the key monitoring objectives for a statewide watershed assessment program. Part 2 describes the monitoring design approaches – current and proposed – that meet the objectives of the monitoring and assessment program, and provides specific information about each part of the proposed monitoring strategy, including issues related to data management, data analysis and reporting. Part 3 describes the agencies monitoring priorities, current funding for monitoring, and future funding needs to fully implement a statewide monitoring strategy.

PART 1 – MONITORING OBJECTIVES

Clear objectives are required to implement an effective monitoring and assessment program. Therefore, the first step in developing this monitoring strategy is defining a clear set of objectives. The objectives of DEQ's watershed assessment program can be placed into three broad monitoring categories:

1. Status and trend monitoring
2. Compliance monitoring for standards and permits
3. Effectiveness monitoring of water quality pollution management programs

In addition the objectives are designed to address the primary requirements of the Clean Water Act including section 305(b) reporting, section 303(d) listing of impaired waters, section 314 clean lakes program; and section 406 (beach monitoring), plus address State water quality program needs, as described above. The strategy is designed to ultimately meet these objectives for all waters of the state (rivers, streams, lakes, wetlands, estuaries and groundwater). Eight key monitoring and assessment objectives have been identified:

1) <u>Assess the Status or Condition of Oregon's Waters</u> – This objective focuses on periodic state-wide and basin-wide assessments of the water-quality status (relative to water quality standards and the attainment of beneficial uses) of Oregon's surface waters, as required by Section 305(b) of the CWA. These assessments will support the development of the Section 303(d) List of Impaired Waters and will help identify causes and sources of those impairments. This objective will ultimately be met by establishing a rotating basin sampling design that includes a combination of targeted sites and probabilistic or random sites, and includes the assessment of chemical, physical and biological indicators.

2) Determine Water Quality Trends – This objective will evaluate monotonic water quality trends on major river systems in Oregon at fixed-site monitoring locations using some of the targeted stations used for status monitoring described above, and assess long-term step trends in populations of smaller streams and rivers and estuaries based on probabilistic monitoring results where sufficient data exists.

3) Implement Pollution Control Strategies – This objective is to identify sources of pollution and to develop and implement measures for controlling them that include, but are not limited to, the derivation of TMDLs through allocation of pollutant loads to point and nonpoint sources, the assessment and issuance of NPDES wastewater discharge permits by conducting mixing zone studies to determine mixing zone compliance and the need for additional pollution control measures, and by using water quality data to help prioritize stream restoration activities and funding.

4) Measure Program or Project Effectiveness – This objective is to evaluate the effectiveness of water quality management projects or programs. This may involve measuring the results of individual pollution control practices at the local level, such as the effectiveness of implementing TMDLs and Best Management Practices (BMP) for the control of nonpoint pollution, assessing the effect of permited point sources, or evaluating the effectiveness of regional basin-wide control measures for improving water quality implemented by DEQ, other state and federal agencies, and local citizen groups.

5) Improve the protection of public health and the environment by reducing the risk of exposure to toxic chemicals in surface and groundwater – Although toxic chemicals are incorporated into the other monitoring objectives, there are issues that are unique to a toxic chemical monitoring strategy and would be addressed by:

- identifying and monitoring high risk groundwater areas including private drinking water wells;
- establishing a statewide network for assessing fish tissue contamination;
- monitoring for currently used and released toxic chemicals in surface water and groundwater.

6) Involve other agency and community partners in water quality monitoring and protection. – This will be accomplished by:

- providing training to other agencies, communities and local watershed groups in water quality monitoring and assessment techniques;
- making effective use of the water quality data collected by other agencies and local watershed councils or groups;

- using monitoring data to identify local water quality problems and evaluate effectiveness of changes in management practices;
- using monitoring data and results to help set priorities for restoration projects and funding to watershed organizations that are capable of doing implementation projects.

7) Use information obtained through the monitoring and assessment program to make informed management decisions. – This will be done by:
   - providing a larger base of data to characterize the extent of water quality problems and setting priorities for the development of control measures;
   - supporting the evaluation of program effectiveness;
   - using monitoring data to help idenfity new or emerging water quality issues and help develop water quality policies and standards;
   - using monitoring data, in combination with historical data, to set statewide priorities to address toxic chemicals in surface and ground water;
   - production of timely reports that describe and interpret monitoring results including major sources of stress and impairment and success of management programs in improving water quality.

8) Make monitoring information available to other programs within the Department, other state agencies, and local watershed groups for use in their work. – This objective is to ensure that an effective data management system is in place, and that water quality data are routinely reported in a useble format.

DEQ has also made a commitment to coordinate all phases of the water program (permits, TMDLs, monitoring, etc.) using a "watershed cycle." Water conditions in a watershed reflect natural landscape conditions (e.g. geology, soils, and elevation), and human activities (e.g. road density, land use, point sources, and population density) within that watershed. Because water quality is directly linked to natural and human factors within each watershed, coordinating water quality program activities within watersheds will help identify the key issues in individual watersheds and better focus available resources on these issues.

PART 2: MONITORING STRATEGY DESIGN – EXISTING AND PROPOSED

Strategy Overview

DEQ proposes to use two basic monitoring designs to address the above monitoring objectives. One is a random site selection or probabilistic survey design. In a probabilistic design data represents the entire population being surveyed – all wadeable streams in the Willamette Basin, for example. This approach provides an unbiased evaluation of water quality conditions across small to large geographic areas (watersheds, basins, ecoregions, and state). Because the data are not biased towards certain types of pollution or sources of pollution, the extent of stressors affecting water quality across basins, ecoregions or the state, can be quite accurately characterized. This design, however, does not provide sufficient information to characterize individual members of that population, such as a particular stream, and requires considerable data collection to satisfy statistical requirements. This approach is most cost effective when the targeted population is too large to census all members.

The second approach is a targeted site design. This approach is effective where the objective is to characterize a site or specific waterbody, such as the Willamette River below Willamette Falls, or an individual well. It can be used to identify waters not meeting standards, determine sources and loads of pollutants for TMDL development, or measure temporal trends at a specific site or spatial trends along a stream. Targeted sampling is often used to help understand processes controlling water quality or when the interest is a specific waterbody.

Both designs are important for understanding status and trends, and assessing the effectiveness of water quality programs. For effectiveness evaluation, for example, targeted sampling can provide information about the effectiveness of specific projects at the project site scale. To understand how multiple projects effect overall regional water quality conditions a probabilistic design is needed.

In addition to using a combination of targeted and probabilistic designs this strategy proposes a rotating basin approach to assess waters across the state. The Oregon Watershed Enhancement Board (OWEB) has divided Oregon's river basins into 15 major basins (Figure 1) based on the USGS 3rd field Hydrologic Unit Classification (HUC) level (OWEB 2003). Using this basin delineation, DEQ proposes to implement a rotating basin design by assessing waters in three, 3rd field HUCs, per year. This will result in complete coverage of the state every five years. The selection of basins and schedule for sampling will be based on water quality program priorities so that data from specific basins can be incorporated into other assessment needs (e.g. TMDL and non-point source programs) to the

highest degree possible. With some exceptions, these 15 basins will provide the primary scale at which both targeted and probabilistic water quality information is collected, assessed and reported. Exceptions include activities with priority driven schedules such as TMDL development, specific permit assessments, groundwater studies in high risk areas, and other special projects.

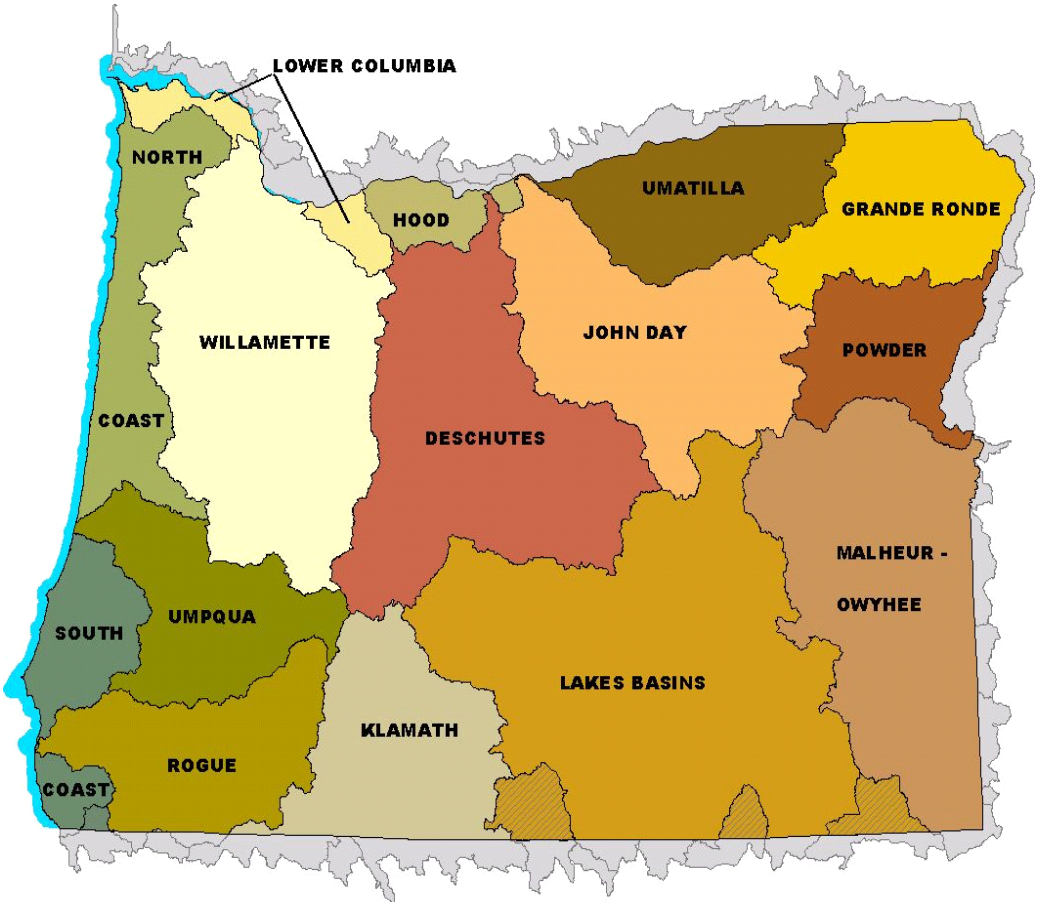

Figure 1. Fifteen major basins in Oregon based on 3rd field hydrologic unit classifications (HUCs). Note that some HUCs cross drainage boundaries (e.g. North and South Coast HUCs).

Strategy Components

This monitoring strategy proposes a combination of fixed site and probabilistically derived sampling networks to meet state monitoring and assessment goals and objectives. These monitoring approaches incorporate a number of different design components such as the assessment of designated uses, fixed-station networks, intensive and screening-level targeted monitoring, and probabilistic site selection. Furthermore, these designs encompass both rotating basin monitoring cycles as well as non-rotating priority-driven schedules.

The five-year rotating basin approach will address the Clean Water Act (CWA) objective related to assessing the status of designated uses and other CWA goals. Requirements for the monitoring program designed to support watershed assessments, reflecting CWA mandates, are that it be statewide in scale, comprehensive (all water bodies of the State are assessed), and repeated at regular intervals. Another requirement is that the program lead to improvements in the federal 305(b) assessment process, by increasing the number of stream miles and lake acres assessed and reducing the historical bias toward problem areas. This expanded coverage will be achieved by supplementing the existing fixed-site large river monitoring program with a probabilistic sampling design aimed at rivers and wadeable streams.

Specific components of the strategy are described below for the following waters of the State: Rivers and streams; estuaries; coastal beaches; lakes; wetlands; and groundwater.

1. Rivers and Streams

Probabilistic Design:

A probabilistic or random survey follows the same approach used to conduct public opinion polls by randomly selecting people within the population to interview. In this case a defined group of waters are randomly selected and surveyed for specific indicators or parameters using a consistent set of protocols. By using a probabilistic survey design water quality conditions within a region (basin, ecoregion, or statewide) can be predicted with a known level of statistical confidence providing estimates of status and eventually trends of known reliability.

A probabilistic design is best used when the population of interest is too large to use a census approach. For example, while the goal is to assess all waters of the state, it would be nearly impossible to do so without using probabilistic based sampling. A probabilistic design can provide statistically representative data for all waters of the state without having

to assess all waters proposed. Initially probabilistic surveys will assess streams and rivers and estuaries. Additional waters, primarily lakes and wetlands, may be added in the future as resources allow. Specific objectives addressed by this approach include:

- Assess the status of the physical, chemical and biological integrity of streams and rivers at a basin, ecoregion, and statewide scale. Detecting trends with a probabilistic design, while possible, takes longer than routine sampling at fixed sites.
- Identify what proportion of the surveyed population of waters are impaired (violate water quality standards and/or do not fully support all beneficial uses),
- Identify the relationship between various stressors and the extent and degree of impairment.
- Provide information for setting and refining water quality standards. The unbiased, random data collected across a specific region (basin or ecoregion) provides a useful data set for evaluating water quality standards.
- Assess the effectiveness of DEQ's water quality programs and other agency programs designed to protect and restore water quality. Overtime, the physical, chemical and biological condition information from probabilistic surveys will provide a useful measure of the effectiveness of not only DEQ's programs, but will help evaluate how the cumulative actions of numerous programs affect water quality.

A probabilistic design is proposed for a general assessment of the physical, chemical and biological condition of streams and rivers by major basin as described below.

A) Probabilistic Survey of Streams & Rivers (new proposed program)

Using the rotating basin approach a probabilistic assessment of streams and rivers will sample 50 random sites within three, 3rd-field HUCs per year (150 sites/year). A new set of random sites will be selected and sampled within each basin once every five years. This will provide an evaluation of overall stream conditions within each basin and provide complete coverage of streams across the entire State every five years. Sites will be selected from all perennial streams (large rivers to small wadeable streams) and sampled for parameters that include chemical, physical and biological indicators (see "Indicators for Monitoring and Assessment" section for details).

Fixed-site and Targeted Design:

A targeted sampling design is effective for answering specific questions about specific waters. Targeted monitoring can be conducted at regular sites on a continuous basis ("fixed station" monitoring); at selected sites on an as needed basis to answer specific questions (intensive surveys); on a temporary or seasonal basis (e.g. summer sampling at bathing beaches); or on an emergency basis, such as after a spill. A census is a type of a targeted

design where all members of the population are surveyed. The large river network sampling is an attempt to implement a census approach for the major rivers in the state. The largest amount of water quality data in Oregon currently exists from fixed station large river monitoring sites, which allows for the determination of water quality trends for most major rivers in Oregon.

Current monitoring activities that rely on a targeted sampling design include large river monitoring, TMDL development monitoring, water quality permit monitoring, toxic chemical monitoring, and groundwater studies. The specific objectives of these current activities include the following:

- Assess the status of the chemical and physical integrity at major river sites across the state.
- Evaluate trends in the physical and chemical integrity of major rivers across the state.
- Identify waters not meeting water quality standards
- Provide information for setting and refining water quality standards.
- Collect data needed to protect human health.
- Collect data needed to develop TMDLs, monitor their effectiveness, and implement permit programs.
- Assess the effectiveness of DEQ's water quality programs and other agency programs designed to protect and restore water quality by looking at long-term trends in water quality.

(Note that current resources are not adequate to meet all the above objectives)

A targeted approach is proposed for monitoring five components of the water program: large river network, reference sites, TMDLs, permits, and toxic chemicals.

A) Large River Network (currently existing program)

A fixed station network of 151 sites located on more than 50 rivers across the state currently makes up the large river monitoring network. These sites cover 4th order and larger rivers; there is one site for approximately every 56 miles of 4th order and larger river in the state. Sites were selected to represent all major rivers in the state and provide statewide geographical representation. Sites are primarily "integrator" sites, meaning they reflect the integrated water quality effects from point and nonpoint source activities as well as the natural geological and hydrological factors for the watershed. Larger river basins have multiple sites, which may be based on tributaries, land use changes, topographical changes, ecoregions, point sources, and nonpoint sources.

Sampling frequency is based on resources, priorities, and statistical needs for trending, including determining central tendency and data distribution characteristics. Most sites are visited six times per year (every other month). Water samples are collected from bridges at

selected sites and analyzed for approximately 20 chemical constituents including: pH, dissolved oxygen (concentration and % saturation), specific conductance, alkalinity, turbidity, total solids, nutrients (nitrogen and phosphorus analytes), temperature, bacteria (*E. coli*), and chlorophyll (chlorophyll a and pheophytin a). Results are reported for individual parameters and summarized with the Oregon Water Quality Index (OWQI), which provides a simple and concise water quality assessment for general recreational uses. As part of the new strategy implementation an assessment of fixed ambient sites will be made to determine if the current number of sites should be continued and whether a combination of fixed sites and random sites could be combined to maximize both status and trend detection.

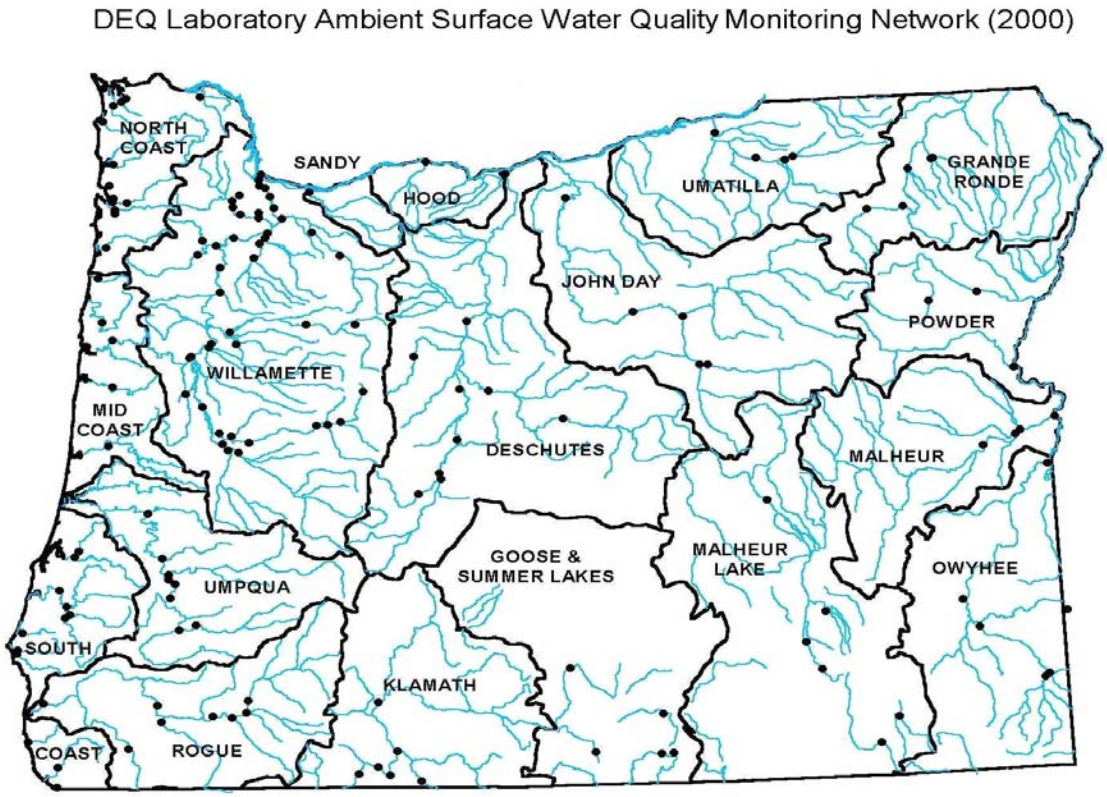

Figure 2. Fixed-site locations for large river network across Oregon.

B) Reference Site Monitoring (new proposed program)

A network of targeted reference sites is an important component of the biological monitoring and assessment program at DEQ, and also provides useful data for evaluating regional conditions relative to water quality standards. Reference sites represent streams or stream segments with minimal human disturbance. Because reference sites only occur at specific locations within watersheds or basins across the state, a targeted sampling approach is an effective strategy. Some sites selected through the probabilistic surveys will also qualify as reference sites, and will be added to the reference site data base as appropriate. Close

evaluation and site screening is necessary to make sure the reference sites selected are actually the best available within certain regions and stream types (Drake 2004).

Reference site data are primarily used in developing and maintaining biological assessment models. These models are used to assess the condition of biological communities and calculate biotic condition index scores (Davis and Simon 1995). The models also help identify environmental factors affecting the biological communities. To make sure assessment models are up-to-date, reference sites need to be periodically resampled and assessed. Therefore, reference sites within each of the fifteen, 3rd field HUCs will be sampled at the same time random sites are sampled as part of the rotating basin probabilistic surveys.

C) TMDL Monitoring (currently existing program)

Waterbodies that are identified through the 303(d) process as being impaired are addressed through the development and implementation of a Total Maximum Daily Load (TMDL). A TMDL is a determination of the total amount of a pollutant the waterbody can assimilate and still meet water quality standards. The TMDL allocates the pollutant load among point sources, nonpoint sources, background levels, reserve capacity and a margin of safety.

Oregon's 303(d) list and TMDL process was the subject of lawsuits brought by environmental groups in the 1990s. Under a consent decree signed in 2000, EPA has agreed to a timeline within which Oregon will complete all applicable TMDLs for waterbodies listed on the 1998 303(d) list (1,153 TMDLs) by the end of 2010. This schedule is further memorialized in a Memorandum of Agreement between DEQ and EPA. The schedule sets interim benchmarks for completing the TMDLs by 2010. DEQ is currently ahead of the annual schedule for completion of TMDLs by 2010.

Monitoring for TMDL development is designed to provide the necessary data to determine and calibrate the loading models used to set the maximum daily loads for the pollutant or pollutants above water quality standards. This generally involves fairly intensive monitoring at targeted sites at a 4th field HUC scale. Data gathered varies depending on the 303d listed parameters, but often involves sampling stream hydrology (flow, time of travel, groundwater effects, etc.), chemistry (both conventional and toxic chemical using longitudinal surveys, storm sampling, source studies, etc.), temperature (continuous temperature data and shade and channel morphology), and sometimes biology (fish, macroinvertebrates or algae). The actual location of TMDL monitoring sites and selected parameters varies from year to year based on a long-term schedule to complete TMDLs throughout the state (Figure 3).

In addition specific permit effluent limits on TMDL streams are based upon wasteload allocations established through the TMDL process. The primary role of monitoring in this

process is to provide the data on sources and loads of pollutants for the development and verification of the models on which the TMDLs are based. Approximately five FTE are currently (2005) allocated to this work. Annual monitoring plans are developed in cooperation with Regional and Headquarters TMDL staff. Monitoring needs are determined along with resource requirements, priorities are established, and resources are allocated based on those priorities.

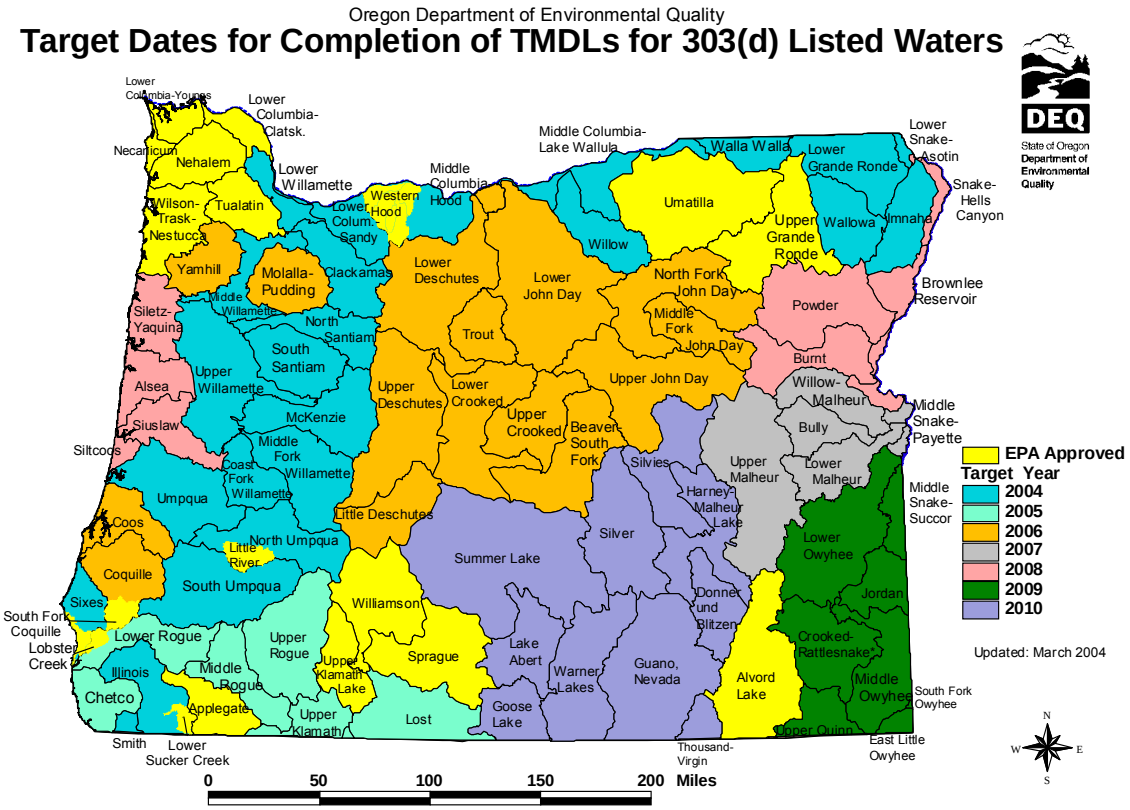

Figure 3. Current TMDL completion schedule by basin.

D) Permit Monitoring (new proposed program)

The permit program currently relies on data collected from the ambient river monitoring program, and instream information collected during TMDL development, as well as data submitted by permittees. At one time most mixing zone studies were conducted by DEQ. As a result of budget reductions those studies were eliminated. This decision has been revisited, and some resources have been restored to conduct mixing zone studies (~15 studies per year). Currently compliance with permit requirements for effluent limits is primarily determined through self monitoring by the permittees. The primary role of

Laboratory resources has been focused on conducting quality assurance audits at permittee analytical facilities and for analyzing split samples collected by Regional staff.

The proposed strategy would increase the number of mixing zone studies completed per year from approximately 15 to 25 or 30. Mixing zone studies assess the effect of point source discharges on ambient receiving streams and help determine if permittees comply with permit requirements. Mixing zone studies may be required to be conducted by the permittee through the permit or by DEQ, as is common for smaller permittees such as small municipalities.

The proposed strategy would also add needed information on toxic chemicals for the permit program. Data are needed for toxicity and toxic chemical concentrations in the ambient receiving waters and in the effluent. This information can then be used to determine if limits for certain toxic chemicals need to be included in permits.

E) Toxics Monitoring (new proposed program)

Understanding the risks to human health and the environment from toxic chemicals released into Oregon's waters requires a statewide toxic chemical monitoring program. Historically, fish tissue, sediment, and water column monitoring for toxic chemicals were conducted on a limited basis statewide. However, because of budget cuts over the past decade, toxic chemical monitoring has been focused in small areas with a known or highly suspected risk of toxic chemical exposure. The objectives for toxics monitoring are:

- Establish a targeted, statewide approach for assessing fish tissue contamination and potential sources of bioaccumulating toxic chemicals including mercury, organochlorines, polychlorinated byphenyls (PCBs), flame retardants and dioxins and furans;
- Establish land use and sector-based monitoring for currently used and released toxic chemicals;
- Provide local water quality data to engage local communities in voluntary pollution prevention efforts;
- Partner with local stakeholders to study local water conditions, and where needed, encourage changes in management practices to improve water quality; and
- Identify high risk groundwater areas including monitoring private drinking water wells for safety (described below in section 6, Groundwater Monitoring).

As proposed, completion and evaluation of statewide toxic chemical data will take several years because resources will need to be rotated throughout the state over time. The strategy will, however, use early data to identify and prioritize later work.

Rationale and Approach:

Bioaccumulative compounds (including polybromated diphenyl ethers (PBDEs) and limited dioxin/furan analysis)

This monitoring program will provide data on the bio-accumulative toxic chemicals in fish tissue near likely sources of contamination to evaluate possible health risks to Oregonians from fish consumption. Existing fish tissue data in Oregon is limited, making this an important public health concern.

The classes of bio-accumulative substances detected most frequently in fish tissue collected from Oregon waters are chlorinated pesticides, PCBs, and mercury (Hg). Concentrations of PBDEs have been shown to be rapidly increasing in sediments and biota in the Columbia basin and nationwide, although little data have been collected in Oregon (Rayne et al. 2003). The laboratory has recently added the four major PBDE congeners to its standard PCB analysis, allowing simultaneous evaluation of these compounds at little additional cost. Available data on dioxins and furans in the state is very limited due to the expense of the analyses. However, because of high toxicity, known sources in Oregon, and the strong tendency of these chemicals to bioaccumulate, dioxin/furan analysis would be conducted at selective locations.

To assess risks to human health from fish consumption DEQ will evaluate fish tissue concentrations in resident fish at 26 sites per year. Three edible resident fish species and six samples per species per site would be collected above and below potential sources. Point and non-point sources would be selected to be representative of different industry and land use sectors to gather data that would help prioritize monitoring work in upcoming biennia.

Evaluating potential source contributions

While fish tissue data will deliver important information about possible risk to human consumers, the data are less effective at identifying potential sources of toxic chemicals. Gathering data that can be used to broadly identify point and non-point sources is essential to developing effective strategies to reduce inputs and improve environmental conditions, whether through pollution prevention activities and voluntary partnerships with local stakeholders or through regulatory means.

For this purpose semi-permeable membrane devices would be deployed at 10 sites per year to measure low-level bioaccumulative toxic chemicals in the water column. Sampling would occur above and below selected major permitted point sources and non-point source areas, three times yearly. This sampling method integrates samples over 28 day sampling periods. Data by industrial sector and land use from 2005-07 sampling would be used to prioritize site selection for future sampling.

Currently used and released chemicals

Pesticides, pharmaceuticals, personal care products, and steroids have been detected in ground and surface waters in Oregon and are increasingly being detected nationwide in complex mixtures (Colpin et al. 2002; USGS, 1999). They may exert adverse effects through a broad array of different mechanisms. While the risks of some of these compounds have been well-studied, little is known about the toxicity of some other individual chemicals, or of chemical mixtures.

Pharmaceuticals, personal care products, pesticides and other chemicals released from consumer products are most likely to enter waterways from residential and commercial sewage discharges, and may be associated with sewage treatment effluent. Other currently used and released chemicals from industrial and non-point sources can also cause harm to humans and animals by disrupting hormone function. Because very little water quality data on these toxic chemicals have been collected in Oregon, risks to human health or the environment are unknown. This monitoring program would provide in-stream evaluation of 34 sources per biennium, covering major municipal dischargers, major industrial dischargers and nonpoint sources, including livestock operations. Data collected in 2005-07 could be used to evaluate whether these compounds are detectable at levels of concern in Oregon waters.

Non-point source Toxic Reduction Partnerships

In two successful pilot projects in Hood River and The Dalles, DEQ has demonstrated that voluntary, collaborative partnerships with local stakeholders can deliver environmental results. Building on this success, additional sampling is proposed for 10 watersheds per biennium, with site selection based on associations between certain land uses, sources, exposure, and toxicity from currently used and released chemicals. Expanded pesticide monitoring would include most currently used chemicals, including fungicides, herbicides and insect growth regulators.

Sites within each watershed would be identified to delineate smaller drainages and sampled repeatedly over time periods when chemicals could be entering local waterways. Initial data would be used to identify water quality issues associated with land uses. If problems exist that pose risks to humans or the environment, subsequent monitoring would be used to evaluate effectiveness of voluntary changes in local land use management practices.

Effects-based monitoring

Humans, wildlife, and aquatic life are exposed to complex mixtures of chemicals that, in combination, may cause adverse effects. However, most toxic chemical monitoring is focused on chemical by chemical regulation due to certain sections within the Clean Water

Act (CWA). But the CWA does contain language for maintaining biological integrity and the use of biological endpoints for regulating water quality. In Oregon and nationally, recent work has used Effects Based Monitoring (EBM) for improved regulation of toxic chemicals (Schmitt, 2002; USEPA 2001). In EBM, biological endpoints are used for assessing toxic chemical effects on human health and aquatic life by measuring the responses to low level exposures of complex mixtures of chemicals. This approach has been used successfully for identifying effects that might otherwise have gone unnoticed using chemical by chemical methods.

The proposed EBM approach would use a combination of field and laboratory methods to measure the effects of complex mixtures of chemicals on growth, reproduction, development, and the nervous system in relation to human health, wildlife, and aquatic life. Molecular, biochemical, and physiological methods would be used for measuring these potential effects. Ten sites would be evaluated each biennium, based on monitoring data showing where complex mixtures of toxic chemicals occur at concentrations of concern. The data gathered would be used to more accurately evaluate risks to humans and ESA listed species from real world mixtures of toxic chemicals.

2) Estuary Monitoring (currently existing program)

The US EPA's National Coastal Assessment surveys the condition of the Nation's coastal resources by creating an integrated, comprehensive monitoring program among the coastal states. To answer broad-scale questions on environmental conditions, EPA's Environmental Monitoring and Assessment Program (EMAP) and its partners have collected estuarine and coastal data from thousands of stations along the coasts of the continental United States.

Since 1999 DEQ has sampled nearly 350 coastal and estuarine sites, including the Columbia River from Astoria to Bonneville. EPA currently funds Oregon DEQ to sample 25 random sites per year in Oregon estuaries, which provides an assessment based on 50 random sites every two years. Estuarine conditions are assessed using biological indicators such as benthic community structure, fish community analysis, and the incidence of disease or other pathologies in fish. Stressors are evaluated by assessing water quality parameters (dissolved oxygen, pH, suspended sediment, nutrients, chlorophyll a), sediment contamination (metals, PAH, PCBs, pesticides) and toxicity (amphipod bioassay), and the presence of contaminants in fish tissue (metals, PCBs, pesticides). These stressor indicators are used to interpret the most likely cause for observed poor condition in biological indicators. The funding for this program ends after 2006, and further monitoring will depend on renewed funding.

3) Beach Monitoring (currently existing program)

The Oregon Coastal Beach Monitoring Program is a joint project between DEQ and the Oregon Department of Human Services (DHS). The DHS administers the Beaches Environmental Assessment and Coastal Health Act (BEACH Grant) funds from the EPA. Their duties include risk assessment, public outreach, data analysis and reporting, data storage in STORET, issuing and withdrawing beach advisories, and assisting with water monitoring and sample analysis. DEQ conducts beach monitoring through an inter-agency agreement with DHS. The DEQ's role covers monitoring network design, sample collection and analysis, sample and data tracking in DEQ's Laboratory Information Management System (LIMS), data storage and verification in DEQ's LASAR database, maintaining hard-copy data records, transferring data to DHS, and preparing and maintaining quality assurance plans.

Water samples are collected to assess bacterial contamination at coastal beaches, and water contact advisories are issued when necessary to protect public health. The EPA's National Beach Guidance describes the following required monitoring elements:

- Primary objective to protect public health.
- Monitor the maximum number of beaches.
- Consider existing data, if available.
- Have opportunity for public review.
- Use an Adaptive Sampling Approach to accommodate demands for new information as the need arises.

DEQ currently monitors water for *enterococcus* bacteria at 20 beaches on a weekly to monthly schedule depending on the time of year and level of public use. An annual Sampling and Analysis Plan establishes a comprehensive sampling site list. The beach monitoring program will continue as currently implemented as long as funding through EPA continues.

4) Lake Monitoring (new proposed program)

There is no routine lake monitoring program currently active in Oregon. Some lakes have been identified as water quality impaired and require a TMDL. These lakes will be assessed as part of the TMDL development process. A statewide lake monitoring program is proposed below, and consists of three tiers that would be implemented in phases as funding allows.

Importance and purpose of a lake monitoring program:
Lakes have historically been identified by DEQ as a lower priority for monitoring than rivers because point source discharges are not allowed in lakes. With the agency's early emphasis on controlling and monitoring the effects from point sources, lakes could logically be seen to be at a lower risk. Lakes, however, act as natural sinks for contaminants in runoff from the surrounding land, and therefore may be at an even higher risk than rivers from nonpoint sources, especially as development and urbanization around lakes increases. Lakes also receive heavy recreational use, which exposes people directly to lake water. Toxic algae blooms in lakes have received more attention in recent years with 19 lakes receiving or being tracked for health advisories. Advisories may include warnings against ingesting water, swimming or bathing, or inhaling water droplets, and may also include information about treating water to reduce or eliminate toxins. Eating fish caught from popular sport fisheries on numerous lakes exposes people (and wildlife) to potential contaminants in fish tissue. Finally, the use of lake water as a drinking water source has increased as residential development has expanded around many lakes. As a result of direct exposure to lake water from drinking water and recreational use as well as exposure to fish tissue from fish caught in lakes, monitoring lake water quality is needed to ensure protection of human health and the surrounding environment.

Tiered approach to lake monitoring:
DEQ proposes a three tiered approach to lake monitoring, with tier 1 the highest priority for implementation followed by tiers 2 and 3. Activities for implementing each tier are described below.

Tier 1 –
Tier 1 monitoring would consist of a targeted lake monitoring design within the rotating basin approach. The objective is to quantify water quality conditions in lakes with known or suspected water quality problems and document whether water quality criteria are violated.

This would be implemented by identifying high risk lakes in each 3rd field HUC basin according to the rotating basin schedule. Risk would be based on information about: known water quality problems; land use activities in the area surrounding lakes that present high water quality risks (e.g. mining); high level of human exposure from recreation, drinking water use, and/or fish consumption; and lakes with unusually high water quality that need protection. In addition two or three lakes with minimal human activity or disturbance in the watershed would be selected in each basin to provide background information for comparison with other lakes. Once the targeted set of lakes has been identified a specific sampling scheme would be developed based on the issues of concern. Lakes with documented violations of water quality criteria would be added to the States 303(d) list and TMDLs scheduled.

The current Integrated Report on Water Quality Status (305b report) lists approximately 65 lakes and reservoirs as being of potential concern and needing additional data. This does not include the 37 lakes that are on the 303(d) list or have TMDLs completed. The number of lakes that could be sampled per basin will depend on the level of funding available.

Tier 2 –
Tier 2 monitoring would use Landsat satellite images to characterize baseline information on chlorophyll and turbidity levels for all lakes and reservoirs in the state greater than 5 acres. Every 16 days Landsat satellites retake images of the same sections of earth in large swaths or blocks. Twenty-two blocks cover the entire state of Oregon. By purchasing these images and interpreting the results, all lakes in Oregon over 5 acres could be assessed for potential algal bloom activity and turbidity. In addition hyperspectral imaging could be used to evaluate macrophyte populations. This information would be used to prioritize lakes with nutrient or other water quality problems. To accurately evaluate satellite images a subset of lakes would be selected to ground-truth satellite images with actual lake data on chlorophyll levels.

To address seasonal variability, images from three seasons (spring, summer, and fall) could be purchased and evaluated. It would also be possible to review archived images from previous years to determine the needed sampling frequency and to evaluate potential changes in algal bloom activity over time. This approach would provide a cost effective method to identify and prioritize lakes that need further water quality evaluation. This Tier could be tied into a redevelopment of the Citizen Lake Watch Program, which was a volunteer monitoring program coordinated by the Center for Lakes and Reservoirs at Portland State University in conjunction with DEQ. It is currently inactive due to the loss of the program's funding.

Tier 3 –
The third tier or phase of the proposed lake monitoring program would use sediment cores to characterize long-term trends in lake conditions based on changes in diatom assemblage composition. This method allows development of an historical picture of lake conditions and the ability to assess how lake conditions change over time. Based on the type of shifts in the diatom community, akinetes, pigments, geologic markers, etc., the types of stressors affecting a lake can also be assessed (e.g. historic phosphorus levels can be inferred from diatom communities by developing ecoregional transfer functions). This information would document significant changes and help develop appropriate management strategies. The number of lakes that could be assessed using this method would depend on data needs and funding levels. Each sediment core assessment costs approximately 10 to 30 thousand dollars (the lower cost covers laboratory analyses for nutrients, lead 210, diatoms, akinetes

and characterization of the core for 20 subsamples of a sediment core; the higher end covers collection, data interpretation and additional analyses). A prioritized list of lakes would be developed for potential sediment core analysis.

5) Wetlands

In Oregon the Department of State Lands (DSL) has the responsibility for maintaining and protecting wetlands. The DSL Wetlands Program promotes the protection and management of Oregon's wetland resources, and is responsible for implementing the wetland program elements contained in the 1989 Wetlands Conservation Act. The DSL wetlands staff helps local governments with wetland inventories and planning and helps property owners determine if wetland permits are needed. They also provide wetland delineation expertise (guidance and report review) to local governments, consultants and agencies. In addition DSL wetland staff coordinates research and develops tools to improve the Removal-Fill Permit Program. The program has close ties with local wetland planning conducted by cities, providing both technical and planning assistance. The DSL provides information on wetland identification, wetland functions, wetland regulations, and wetland planning through publications, workshops, and presentations to various groups.

6) Groundwater Monitoring (combined existing and new proposed program)

In 1989, the Oregon Legislative Assembly passed a comprehensive set of laws known as the Groundwater Protection Act. These laws established the state goal to prevent groundwater contamination. A major component of the Groundwater Protection Act was the establishment of programs to assess groundwater status, identify areas with contamination and determine long term trends. From 1989 through the mid nineties DEQ implemented the Statewide Ambient Groundwater Monitoring Program. A number of studies were conducted under this program, which targeted areas where groundwater was vulnerable to nonpoint source contamination. Forty-five groundwater studies were conducted and contaminated groundwater was found in 35 of the assessments. Funding was cut in the late 1990's and currently there are no new or follow-up groundwater assessments being conducted other than trend monitoring in three Groundwater Management areas.

Monitoring Design:
The state has used two primary methods to conduct groundwater assessments. One method evaluates individual residential drinking wells. The Department of Human Services Drinking Water Program oversees this effort, and includes mandatory real estate transaction testing. For those properties using a water well to provide drinking water, the mandatory tests include nitrate and bacteria.

The second method involves more intensive groundwater investigation. DEQ conducted these investigations, as described above in the Ambient Statewide Groundwater Monitoring Program. In addition to assembling a well network representative of the area's groundwater quality, DEQ also conducted a brief hydrogeological and land use evaluation. The groundwater quality parameters DEQ analyzed included the following: Metals, nutrients, physical parameters, volatile organic compounds, & pesticides.

The new strategy proposes DEQ conduct the following three kinds of groundwater assessments:

1. Reinstate the Statewide Ambient Groundwater Monitoring Program
2. Continue monitoring in the three Groundwater Management Areas
3. Implement a long term trending network.

Figure 5 below shows the following:

- Locations of areas sampled to assess ambient groundwater quality conditions,
- Locations of the three Groundwater Management Areas (GWMAs), and
- Locations of sensitive aquifers.

Note that virtually all areas assessed for groundwater quality conditions coincide with the locations of sensitive aquifers. These are the near-surface water table aquifers, most susceptible to contamination from anthropogenic activities.

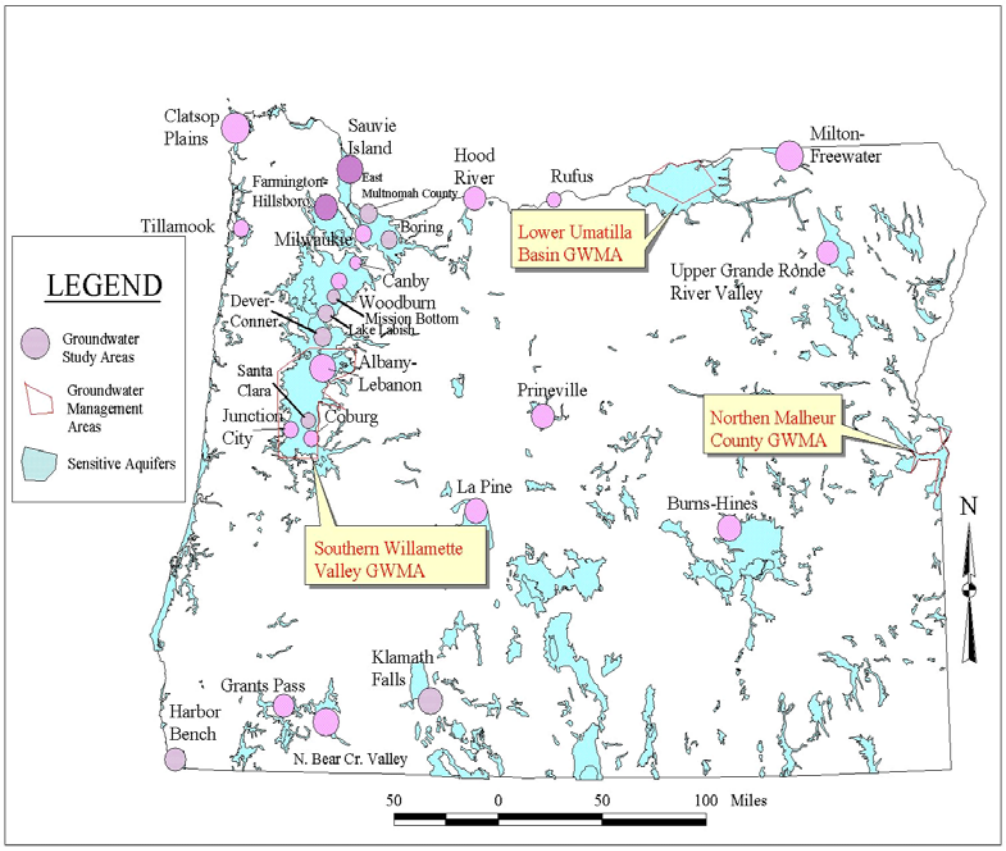

Figure 5. Groundwater sampling areas and sensitive aquifers

Summary: Table 1 below summarizes Oregon's water quality monitoring objectives and the monitoring design elements to address them based on current existing activities and new proposed monitoring activities.

Table 1. Summary of Monitoring Objectives and Design Elements

MONITORING GOALS/OBJECTIVES	MONITORING DESIGN ELEMENTS	
	Currently Existing Activities	New Proposed Activities
1) Assess the status and condition of Oregon's waters.	• Fixed-site large river monitoring network of 150 sites statewide. • Probabilistic sampling network for estuaries – 25 sites per year. • Probabilistic design for sampling 1st to 3rd order streams for inverts, fish, habitat, water quality in Coastal Coho ESU - 30 sites per year	• Probabilistic sampling network for streams and rivers based on a 5-year rotating basin approach – 150 sites per year. • Targeted sampling network for lakes based on a 5-year rotating basin approach. • Statewide targeted ambient groundwater monitoring network.
2) Determine water quality trends	• Fixed-site large river monitoring network, trends determined for specific sites using monotonic trending. • Probabilistic sampling network for estuaries: trends determined for populations using step trending (when data is sufficient).	• Basin-wide probabilistic monitoring results for rivers, streams, and lakes: trends determined for populations using step trending. • Groundwater trend monitoring network.
3) Implement pollution control strategies (TMDLs and Permits)	• Targeted monitoring to support TMDL program. • Targeted monitoring above and below permitted point sources (~ 15-20 surveys per year).	• Increase number of permitted point sources assessed per year to 25-30.
4) Measure program or project effectiveness	◆ Fixed-site large river monitoring network. ◆ Probabilistic sampling network for estuaries. ◆ McCoy Creek (Grand Ronde Basin) channel restoration effectiveness study	◆ Project specific, targeted monitoring. ◆ Basin-wide probabilistic monitoring results for rivers, streams, and lakes. ◆ Groundwater status and trend network.
5) Improve the protection of public health and the environment by reducing the risk of exposure to toxic chemicals in surface and groundwater.	◆ Targeted sampling for non-persistent pesticides in areas of application.	• Targeted groundwater monitoring for contaminated drinking water wells. • Targeted monitoring to assess fish tissue contamination in high risk areas. • Targeted monitoring to assess currently used and released toxic chemicals in streams and rivers.
6) Involve other agency and community partners in water quality monitoring and protection.	◆ Maintain current volunteer monitoring program.	◆ Improve the accessibility and use of water quality data collected by other agencies and volunteer groups.

MONITORING GOALS/OBJECTIVES	MONITORING DESIGN ELEMENTS	
7) Use information obtained through monitoring to make better mangement decisions.	◆ Update 303(d) list on two-year cycle. ◆ Continue to use mixing zone survey results to evaluate permit effectiveness.	◆ Use data to evaluate program effectiveness ◆ Produce timely and effective reports for the agency and the public describing water quality conditions, trends, and stressors.
8) Make monitoring informatin available to other programs within the Department, other agencies and local watershed groups.	◆ Continue 305(b) report, State of the Environment report, and specific project reports.	◆ Implement an effective database and data management system for all water quality information ◆ Provide documentation on data available and how to access data in database ◆ Produce timely and effective reports describing water quality conditions, trends, and stressors.

Indicators for Water Monitoring and Assessment

EPA guidance calls for the State monitoring program to include "a core set of baseline indicators selected to represent each applicable designated use, plus supplementary indicators selected according to site-specific or project-specific decision criteria." These indicators or variables (e.g., water quality parameters) include physical/habitat, chemical/toxicological, and biological/ecological endpoints that impart information pertaining to the integrity of the water resource, and provide the information-base for making water quality-related assessment and management decisions, such as determining the impairment status of the resource. There is a hierarchy of indicators for environmental assessment as follows:

1) Response Indicators - Measures of integrated or cumulative reactions to exposure and stress, such as biological community indices.

2) Exposure Indicators - Measures of environmental variables that suggest a degree of exposure to stressors, such as water-column pollutant levels or ambient toxicity.

3) Stressor Indicators - Activities that affect the aquatic environment, such as pollutant discharges and changes in land-use and habitat.

4) Administrative Indicators - Regulatory actions by the EPA, the State, and local entities and responses by the regulated community.

Each indicator type in this hierarchy represents a step closer to the direct measure of the integrity of the resource than does the category below it. For example, reliance on administrative and stressor indicators is presumptive in that actual instream pollutant concentrations are estimated based on knowledge of the magnitude and quality characteristics of upstream discharges, or because conditions are assumed to improve following regulatory action. Exposure indicators, such as pollutant concentrations that can be compared to numerical criteria, provide more reliable evidence of instream conditions but still do not account for site-specific factors influencing the biological response to those pollutant concentrations. Therefore, the site-specific application of biological response indicators, such as macroinvertebrate or fish community analyses, allows for greater confidence in the final water resource assessment. By focusing more in the future on indicators that reflect the actual condition of the resource, the 305(b)/303(d) process can be strengthened and attention shifted toward solving the most important environmental problems.

In general, monitoring programs focus on measuring exposure, response and, to a lesser degree, stressor indicators. Administrative indicators, which are tracked by counting the number of permits issued or enforcement actions taken, are typically not the subject of environmental monitoring programs.

The following table provides a breakdown of indicators used to assess and manage the aquatic life, water contact recreation, fish consumption, and drinking water uses. Not all indicators will be assessed for all projects and the specific indicators used will depend on the objectives and purpose of each project.

Table 2. Indicators for Water Quality Assessments

Water Use	**Indicators** (Specific indicators used will vary with monitoring component and its objectives)		
	Response	Exposure	Stressor
Aquatic Life	◆ Macroinvertebrate assemblage* ◆ Fish assemblage* ◆ Periphyton/Phytoplankton assemblage* ◆ Fish kills	◆ Dissolved oxygen ◆ pH ◆ Nutrients ◆ Chlorophyll ◆ Temperature ◆ Turbidity ◆ Suspended solids ◆ Toxic pollutants ◆ Sediment chemistry	◆ Habitat quality** ◆ Land-use & % impervious cover ◆ Pollutant loadings ◆ Flow ◆ Non-native species
Recreation	◆ Transparency ◆ Algal blooms, chlorophyll ◆ Objectionable scum, sheens, debris, deposits	◆ Pathogens (e.g., E. coli) ◆ Sediment quality ◆ Color/Turbidity ◆ pH	◆ Land-use & point source discharges ◆ Flow & water level

Fish/Shellfish Consumption	◆ Fish kills or abnormalities	Fish tissue contaminants: ◆ Mercury ◆ PCBs ◆ Pesticides ◆ Other contaminants of concern ◆ Pathogens	◆ Land-use & point source discharges
Drinking Water		◆ Primary drinking water standards: e-coli, organic compounds & inorganic constituents ◆ Secondary drinking water standards or other health-based advisories: color, iron, toxic chemicals.	

* Historically chemical and physical indicators were emphasized; however, biological monitoring and assessment has assumed an important role in the Oregon monitoring program, especially for assessing beneficial use support for aquatic life.

** Habitat quality includes measures of: Geomorphology (slope, bank stability, channel morphology); substrate (sediment type, embededness); and riparian zone (shoreline vegetation, canopy).

Ultimately, indicators of watershed condition should support an understanding of resource management policies and management programs that will lead to more effective use, protection, and restoration of Oregon's natural resources. Monitoring should be able to answer the two most basic questions:

1. What is the condition of our waters?
2. Do our actions result in improved environmental conditions?

To help establish a common set of watershed indicators the Oregon Watershed Enhancement Board (OWEB) commissioned the Oregon State University (OSU) Institute for Natural Resources to identify a set of environmental indicators and their measurement methodology to quantitatively measure the status and trends in watershed condition and fish recovery throughout the state. The final report titled, *Indicators of Basin Condition for the Oregon Plan for Salmon and Watersheds* was completed in 2005 (Dent et al. 2005).

The report identified five environmental values (Aquatic communities, Aquatic and riparian ecosystems, Terrestrial ecosystems, Estuarine ecosystems, and Ecosystem biodiversity) and sixteen indicators associated with these values (Table 3). Five of the fifteen indicators were identified as highest priority: anadromous fish distribution and abundance; coldwater indexes of biological integrity for fish and macroinvertebrates; water quality index; area, distribution, and types of riparian and wetland vegetation; and change in land use and land cover. The original direction given for this project was to develop indicators that could be used to assess conditions at a watershed scale as defined by the 15 OWEB defined basins in the state.

Much of the data needed for the suggested indicators would be collected by implementing the monitoring strategy described above.

Table 3. Proposed Environmental Condition Indicators for Assessing Watershed Condition in Oregon.

Environmental Indicators of Basin Condition * = ranked as a high priority by Dent et al. 2005.	
Aquatic and Riparian Ecosystems	1. *Anadromous fish abundance, distribution and life histories
	2. *Cold water Index of Biotic Integrity for fish and for macroinvertebrates. (Also, with these same data we can report native and non-native species numbers and distributions for Indicator #15)
	3. *Water Quality Index (WQI) (miles or % of streams with rating of poor, fair, or good WQI)
	4. *Area, distribution, and types, of riparian and wetland vegetation
	5. Riparian function index based on vegetation and site capability (e.g. large wood recruitment, shade, and nutrient input) and Wetland function index based on hydrogeomorphic (HGM) typing
	6. Condition of physical aquatic habitat and estuarine habitat
	7. Access to freshwater and estuarine habitat (Miles of habitat accessible or limited-further analyze by habitat quality)
	8. Frequency with which instream water rights are being met
Terrestrial Ecosystems	9. Area, distribution, configuration, and types of cover for established ecological classes
	10. *Change in land use and land cover
Estuarine Ecosystems	11. Area, distribution, type, and change in area of tidal and submerged wetlands
	12. Index of Biotic Integrity for estuaries
Ecosystem Biodiversity	13. Number of native plant and animal species and distribution over time (departure from potential)
	14. At-risk species (aquatic, estuarine, and terrestrial; plant and animal)
	15. Percent of non-native invasive species (focus on subset of known species)

Regional Monitoring and Coordination Efforts

Besides DEQ, numerous other natural resource agencies collect watershed condition and water quality data in Oregon and throughout the Pacific Northwest. At both the state and federal level there is increasing awareness of the importance of coordinating monitoring efforts and effectively sharing monitoring results and data.

At the State level the Oregon Plan Monitoring Team has provided interagency coordination for implementation of the Oregon Plan monitoring strategy. The monitoring team includes a member from each state natural resource agency as well as members from federal land management agencies. The monitoring team generally meets monthly and is coordinated by a staff person from the Oregon Watershed Enhancement Board (OWEB). The Oregon Plan Monitoring Strategy identifies three key outcomes for the monitoring program and specific questions and monitoring strategies. The overall monitoring goals are to:

1. Determine the status and trends of fish populations, stream habitat, and water quality in Evolutionarily Significant Units (ESUs) within the State.
2. Evaluate the effectiveness of restoration and land management programs in Oregon.
3. Provide needed environmental data to policy makers in the state so more effective management decisions can be made.

Appendix A provides a summary of the Oregon Plan monitoring strategy components.

DEQ's monitoring budget for implementing the Oregon Plan monitoring strategy has been cut due to state agency budget reductions from 6 FTE in 2000 to 2.7 FTE in 2005. These reductions have significantly reduced DEQ's ability to continue the Oregon Plan monitoring program as originally implemented. Fully implementing the proposed probabilistic stream and river program described in this strategy would provide a statewide basin assessment compatible with the goals of the Oregon Plan, but would not provide the level of assessment often desired at smaller watershed or landuse scales.

The DEQ still maintains a volunteer monitoring coordinator position. This position works with watershed councils and other volunteer monitoring groups throughout the state, providing training, technical assistance, and oversight of volunteer data submitted to DEQ. This position provides a critical link to non-agency groups in the State collecting water quality data.

Besides State efforts to coordinate monitoring, the Pacific Northwest Aquatic Monitoring Program (PNAMP) is a regional (Oregon, Washington, and California) effort to improve the coordination and use of aquatic monitoring information collected by state and federal agencies. Standardizing indicators plus sampling and analysis protocols, as well as

understanding how different protocols affect results, are some of the goals of this group. Appendix B summarizes the key actions identified by PNAMP to improve monitoring coordination.

Given the limited monitoring resources, DEQ recognizes that using data collected by other agencies and monitoring groups is necessary in the effort to provide statewide water quality assessments. Evaluating data quality and overcoming data management issues are critical steps in making more effective use of other data sources. DEQ has been directly involved in developing techniques that link multiple data bases in real time to improve data sharing between agencies and other groups. While still in the development phase this could provide one important step towards the use of data from multiple sources.

Quality Control and Quality Assurance Procedures

The DEQ Laboratory implements a full quality assurance program with internal and external review elements. Details of Oregon DEQ quality assurance program may be found in the following documents: *DEQ Quality Management Plan (DEQ 2004a), DEQ Laboratory Quality Manual (DEQ 2004b), DEQ Field Sampling Reference Guide (DEQ 1998)*, *and Watershed Assessment Section Mode of Operations Manual (DEQ 2004c).*

Data Management

All data collected by DEQ's Watershed Assessment Section are entered into the agency database (LIMS/LASAR) and verified after entry for errors. Biological and habitat data are currently maintained in a separate Access database, however plans are in place to migrate that data into LIMS/LASAR. Oregon DEQ has not entered data into STORET since the close of the Legacy STORET system. Oregon DEQ is working with EPA STORET to develop a new method of sending data to STORET using the National Environmental Information Exchange Network. Current plans have data flowing to EPA STORET by 2006. DEQ provides data at no cost or a minimal fee to the public, other agencies, industry, consultants, educators and others. Data are provided to the internet through the Oregon DEQ Website, as well as through the Pacific Northwest Water Quality Data Exchange.

Data Analysis and Assessment Methods

Department staff use the water quality monitoring data for a variety of purposes. Some of the routine uses are identified below.

- Ambient river monitoring data are used to develop a water quality index score for every site. The water quality index scores are then used to rank sites, identify spatial and temporal variability, and communicate water quality conditions to the public. Ten-year trending analysis based upon the water quality index is conducted for all ambient network sites. Trend data are used to measure progress and are a primary environmental indicator for the Performance Partnership Agreement with EPA and the Oregon Progress Board Benchmarks Program.

- Regional probabilistic survey data are assessed following procedures established by EPA's Environmental Monitoring and Assessment Program (EMAP). Site weights for each regional assessment are determined based on sampling intensity and reasons for sites not being sampled (e.g. permission denial or inaccessible). Results are reported as a "percent of stream miles" for the region being assessed. In addition environmental stressors are evaluated using a relative risk assessment methodology developed by John VanSickle at Oregon State University, and with a biological stressor assessment method using taxa sensitivities to temperature and fine sediment (Huff et al. 2005).

- All data are evaluated every two years to determine the extent to which stream reaches meet water quality standards and types of impairment. This evaluation is a major part of the preparation of the 303(d) list.

- Much of the data collected is used by regional watershed specialists and TMDL modelers to develop and assign waste load allocations. As the agency moves to a watershed based permitting approach NPDES permit writers evaluate water quality data for receiving streams prior to issuing new or renewed permits.

- Toxic chemical data will be used to describe the level of toxic chemicals in groundwater, surface water and fish tissue, and evaluate the risk of exposure to humans and the environment.

Reporting

Water quality data are used to produce a wide variety of reports. Some are routine reports such as the 305b Water Quality Assessment report, which is submitted to EPA every two years, or the Oregon Benchmarks reported to the Oregon legislature every two years. Other reports are project specific and are not produced on a regular schedule. Many of these reports are produced by DEQ staff in regional offices or headquarters. Examples of project reports include:

- TMDL reports

- Basin reports (example: Coastal Coho ESU Assessment report and Deschutes Basin REMAP Report)
- Mixing zone survey reports
- Special project reports (example: Grande Ronde stream restoration effectiveness study)

As the agency moves into a rotating basin and watershed cycle, basin reports will be written that summarize data from probabilistic and targeted data collected from each of the 15 major basins as they are completed. These reports will describe the status of water quality conditions, identify major water quality problems, assess trends in water quality, and, to the degree possible, assess management activity effectiveness in each basin.

DEQ also plans to improve its ability to use water quality data from volunteer groups and other agencies when assessing basin conditions and identifying important water quality issues. To improve the use of outside data, more effort will need to be placed into assessing data quality and data management.

Table 4 below summarizes the proposed statewide monitoring strategy components, the indicators measured, and existing versus proposed level of effort.

Table 4. Summary of Monitoring Strategy Components

Monitoring Program Component	Design Approach	Indicators Measured					Number of sites sampled per year		
		Fish	Algae	Inverts	Hab	Chem	Existing	Proposed	Visits/ Year/Site
Streams & Rivers	Probabilistic site selection: 5-year Rotating Basin	Opt.	Opt.	Yes	Yes	Yes	14 – 100	150	1
Large river surface water sites	Fixed site selection; statewide network	No	Opt.	Opt.	No	Yes	151	151	6
Reference sites: wadeable streams	Combination of fixed site and probabilistic site selection; 5-year rotating basin	Yes	Opt.	Yes	Yes	Yes	0 – 30	60	1
Toxic Chemicals	Targeted monitoring of waters from areas with potential toxic sources Site selection coordinated with 5-year rotating basin	No	No	No	No	Water Column	0	35	3
Toxic Chemicals	Fish Tissue: Targeted site selection; priority basins/watersheds	Tissue	No	No	No	Yes	0	26	1
Toxic Chemical	Non-point source toxic reduction partnerships through targeted watersheds.	Yes		Opt		Yes	5	5	3

		Indicators Measured					Number of sites sampled per year		
TMDL Monitoring	Targeted site selection; priority basins and watersheds	Opt.	Opt.	Opt.	Opt.	Yes	200 – 400	200-400	Varies
Permit Monitoring	Targeted site selection	Opt.	Opt.	Opt.	Opt.	Yes	15	30	1-3
Beach Monitoring	Targeted sites	No	No	No	No	Yes	20	20	12-25
Estuary Monitoring	Probabilistic site selection	Yes	Yes	Yes	Yes	Yes	25	25	1
Lake Monitoring	Tier 1: Targeted Lake monitoring	Opt	Opt	Opt	Opt	Yes	0	9	1-3
Lake Monitoring	Tier 2: Landsat Satellite Imagery	No	Aerial	No	No	No	0	NA	NA
Lake Monitoring	Tier 3: Sediment Cores	No	Yes	No	No	No	0	2-3	1
Groundwater	Targeted site selection; priority basins/watersheds	No	No	No	No	Yes	80	160	1-6

PART 3: MONITORING STRATEGY IMPLEMENTATION, PRIORITIES, AND FUNDING REQUIREMENTS

Use of the Monitoring Strategy

How this document is used by DEQ and others involved in monitoring Oregon's waters will influence how well the conditions of Oregon's waters are understood and protected. This section describes how DEQ plans to implement and use this document to improve water quality data collection and use.

There are several ways this strategy may be used by DEQ and others outside the agency. First, this document will identify how and why DEQ uses current monitoring funds. While DEQ has an active water-monitoring program, it falls well short of the monitoring needs and objectives for all waters of the state. The plan for spending current monitoring dollars is discussed in detail in the "Monitoring Priorities and Implementation of Monitoring Strategy" section below. Second, in addition to explaining how current funds will be used, by identifying the priorities for unfunded work, the strategy will provide clear direction for pursuing and using additional funding for monitoring if and when it becomes available. Third, identifying what DEQ is not monitoring will also help identify what data DEQ should look for from other agencies and groups within the state that collect data from Oregon's waters. This should help focus where and what type of data others collect to help accomplish common objectives between a variety of agencies and interest groups. Finally, debating and discussing monitoring needs and priorities should not end with completion of this strategy document. As new or different water issues emerge different priorities will surface as well. This document can provide the starting point for future discussions and decisions about how best to spend DEQ's water monitoring resources. We propose revisiting and reviewing this plan annually.

Funding for Water Monitoring

DEQ's water-monitoring program depends on several sources of funding. In recent years a significant portion of monitoring dollars have come from federal and state grants that have specific goals and objectives. Because these grants were awarded for specific projects, the dollars cannot be used to support different monitoring activities. Such restricted funds are referred to as "non-fungible" dollars. Currently, out of 17 FTE directly used for ongoing water monitoring work at DEQ, 7.5 FTE (44%) are funded by non-fungible dollars. The remaining 9.5 FTE are supported by dollars that have the flexibility to be used for a variety of monitoring activities and can be shifted from one activity to another as needed. These funds are referred to as "fungible" dollars. **Only monitoring activities supported by fungible dollars are directly affected by the priority setting process.**

Monitoring Priorities and Implementation of Monitoring Strategy

Because there is insufficient funding to implement all monitoring activities outlined in this strategy, each monitoring component of the strategy has been ranked and prioritized as a high, medium, or low monitoring need. Thus, available fungible resources can be targeted at those monitoring activities with a high priority, although current funding is not adequate to fund all monitoring needs identified as high priority. To develop the priority list for monitoring activities both internal (DEQ) and external users of water quality data were considered. Internally staff meetings were held at all DEQ regional offices to discuss the monitoring strategy and get input from staff reflecting different water programs (e.g. TMDLs, permits, and groundwater). In addition a survey was conducted of DEQ water quality program managers, which ranked their priorities for water monitoring. External input considered the monitoring objectives of the Oregon Plan Monitoring Team, which includes members from state and federal natural resource agencies, and the data needs of other groups such as watershed councils.

One of the goals in the development of this strategy was to determine if current monitoring activities could be reduced or dropped to free up resources for implementing higher priority unfunded activities. Both fungible and non-fungible activities were evaluated. There are costs associated with conducting non-fungible activities, which are typically not adequately covered by funding sources and are picked up by the agency at large. Current monitoring activities covered by fungible dollars were ranked as the highest priorities so no significant funding shifts are proposed at this time. Activities supported by non-fungible dollars were determined to be of sufficient value to be continued. Non-fungible supported monitoring activities should be reevaluated on a regular basis as new information on their costs and value becomes available.

It became clear that developing consensus for how monitoring activities should be prioritized across the many different users of water quality data would not be possible. Different users often ranked the same monitoring activity at opposite ends of the scale. If any generalizations could be made it might be that DEQ staff and managers (internal users) generally felt that monitoring activities that supported pollution control programs (TMDLs and permits) were a high priority, while external users felt that activities providing regional status and trend data were a high priority. These results were not unexpected and reflect the need for a broad monitoring program with multiple objectives and designs. With this in mind the following table characterizes the current funding priorities for each component of the monitoring strategy.

Monitoring Program Summary Table

Monitoring Component	Design Approach	Program Use	FTE Proposed/ (FTE Existing)	Fun-gible	Priority	Funding Currently Available
*Data Management & Analysis	NA	Needed for all components of monitoring program. Will support watershed scoping and work with internal and external water quality data.	2.0/ (0)	Yes	High	No
Large River Ambient Sites	**Proposed:** Fixed Sites: ~150 sites on major streams statewide. Add biological sampling where possible **Existing:** Same – No biological sampling	Long-term data for trending at fixed sites across the state. Used to identify standards violations, develop TMDLs, and evaluate program effectiveness. Add biological sampling where possible.	4.0/ (3.5)	Yes	High	Yes
Streams & Rivers (Oregon Plan)	**Proposed:** Probabilistic (random) samples at a 3rd field HUC scale (basin) using a rotating basin approach. 150 sites/year across three basins plus continued sampling in Coastal ESU. **Existing:** Continue probabilistic sampling in Coastal ESU.	Provide statistically valid status assessment of streams and rivers at a 3rd field HUC scale. Identify major wq stressors and help evaluate overall land management effectiveness. Rotating basin program will provide statewide coverage every 5 years.	10.0/ (3.0)	No	Proposed: High Existing: Medium	Proposed: No Existing: Yes

* Improving data management & analysis was consistently listed as a high priority among DEQ staff and outside users of DEQ data. Even though data management is a critical part of a successful monitoring program, it is often under-funded when planning monitoring activities. Currently, funding for additional staff for data management/analysis is not available; however, we can improve data management by allocating additional time for existing staff to work on data management & analysis. This may result in some reduction in the amount of data collected, but it will ultimately make all data more accessible and usable.

Monitoring Component	Design Approach	Program Use	FTE Proposed/ (FTE Existing)	Fun-gible	Priority	Funding Currently Available
Watershed Scoping Assessments	**Proposed:** Sample targeted sites for indicators and at locations based on local concerns. Three third order HUCs per year- state coverage five years **Existing:** None	Watershed cycle scoping, determine compliance with standards in un-assessed waters, fill data gaps, and set priorities.	4.0/ (0)	Yes	High	No
TMDL Development	**Proposed:** Increase lab staff to complete TMDL development monitoring & free regional staff for other work. **Existing:** Maintain current level of staff for TMDL development.	Develop TMDLs for 303(d) listed streams and meet current TMDL schedule.	7.0/ (4.0)	Yes	Proposed: Low Existing: High	Proposed: No Existing: Yes
Groundwater	**Proposed:** Targeted sites in current GWMAs plus screening private wells in areas with risk of contamination. **Existing:** Targeted trending sites in established GWMAs	Identify areas of groundwater contamination to protect public health and beneficial uses of groundwater, determine trends in GWMAs.	4.0/ (1.5)	Yes	Proposed: High Existing: High	Proposed: No Existing: Yes

Monitoring Component	Design Approach	Program Use	FTE Proposed/ (FTE Existing)	Fun-gible	Priority	Funding Currently Available
TMDL Effectiveness	**Proposed:** Targeted and/or probabilistic sites sampled within TMDL watersheds over time to detect trends in water quality. **Existing:** None	Use to determine success of TMDL actions in improving water quality and protecting beneficial uses.	4.0/ (0)	Yes	High	Proposed: No
Permit Evaluation	**Proposed:** Increase number of permits evaluated yearly by sampling above and below outfalls and mixing zones using chemical and biological indicators, and do split sampling with permittees for QA. **Existing:** Sample above and below outfalls and mixing zones using chemical and biological indicators.	Used to determine compliance with permit conditions and reasonable potential analysis.	3.0/ (0.5)	Yes	Proposed: Medium Existing: High	Proposed: No Existing: Yes
Volunteer Monitoring Coordination	**Proposed:** Provide support for Watershed Councils and other non-profits for water monitoring including equipment, training, project planning, and data management. **Existing:** Same	Improve data quality collected by outside groups and increase the data accessibility for local and statewide assessments	1.5/ (1.0)	No	Proposed: Medium Existing: High	Proposed: No Existing: Yes

Monitoring Component	Design Approach	Program Use	FTE Proposed/ (FTE Existing)	Fun-gible	Priority	Funding Currently Available
Toxics: Water Column	**Proposed:** Targeted monitoring of waters from areas with potential toxic sources. **Existing:** Targeted sampling for non-persistent pesticides in areas of application.	Determine compliance with water quality standards, identify toxic threats to humans and biota, and develop toxic reduction partnerships with stakeholders	7.0/ (0.5)	No	Proposed: Medium Existing: Medium	Proposed: No Existing: Yes
Toxics: Fish Tissue	**Proposed:** Targeted monitoring of fish frequently caught for human consumption and in areas of potential toxic sources **Existing:** None	Identify potential health risks for fish consumption and advise public.	9.0/ (0.0)	Yes	Proposed: High	No
Lakes	**Proposed:** Targeted monitoring of lakes of special interest for water quality and biological indicators. Select lakes based on rotating basin approach. **Existing:** None	Determine general status and compliance with water quality standards and protect beneficial uses.	4.5/ (0)	Yes	Proposed: Medium	No

Monitoring Component	Design Approach	Program Use	FTE Proposed/ (FTE Existing)	Fun-gible	Priority	Funding Currently Available
Estuaries	**Proposed:** Continue current probabilistic sampling of Oregon estuaries and analyze data and produce reports. **Existing:** Probabilistic samples from estuary sites. Includes fish tissue, water and sediment chemistry and benthic biota. 25 sites per year.	Characterize water quality and toxics in fish and sediments, biological condition and stressors to biology in Oregon estuaries.	3.0/ (2.0)	No	Proposed: Low Existing: Medium	Proposed: No Existing: Yes (through 06 only)
Non-point Source (NPS) Effectiveness	**Proposed:** Select certain NPS projects for DEQ conducted effectiveness monitoring. **Existing:** Long term assessment of stream restoration project in Grande Ronde Basin using biological, physical, and chemical indicators.	Determine effectiveness of different types of 319 funded restoration projects	2.0/ (0.5)	No	Proposed: Low Existing: Low	Proposed: No Existing: Yes
Beach Monitoring	**Proposed:** Continue routine sampling of Oregon's coastal beaches for Enterococcus bacteria. **Existing:** Same	Advise public if bacteria levels exceed public health criteria for water contact.	1.0/ (1.0)	No	Low	Yes

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Based on the priorities above the final list of monitoring activities that DEQ will implement with current funding is listed below. Monitoring work based on fungible and non-fungible dollars are listed separately, since non-fungible dollars can only be used for the specifically funded work regardless of its priority. Note that some monitoring activities supported by non-fungible dollars have a low priority relative to other monitoring work. The information from these activities, however, is still considered valuable, and because these funds cannot be shifted to other work, they will be continued as long as their grant funding continues.

Monitoring Program Implementation Plan (Fungible dollars): DEQ currently has 9.5 FTE available for monitoring work supported by fungible dollars.

Monitoring Activity	Activity Summary	FTE
Large River Ambient Sites	Maintain network of 150 fixed sites located on major rivers across the state. Sites will be sampled every other month for water chemistry and assessed for status and trends. Biological samples (primarily macroinvertebrates) will potentially be added to sites where water conditions allow such sampling. Macroinvertebrate samples would be collected once per year during the summer low-flow period.	3.5
TMDL Development	Maintain current level of staff for TMDL development monitoring work. This will provide the data needed to develop TMDLs on 303(d) listed streams around the state. It does not provide resources for TMDL implementation or effectiveness evaluation.	4.0
Permit Evaluations	Continue current level of effort (~ 15 permits per year) for mixing zone surveys using chemical and biological indicators.	0.5
Groundwater	Continue groundwater assessment in current Groundwater Management Areas (GWMAs) using a targeted site monitoring approach. It will not fund broader screening of private wells around the state.	1.5

Monitoring Program Implementation Plan (Non-fungible dollars): Continuation of all programs listed below is contingent upon continued funding from specific sources.

Monitoring Activity	Activity Summary	FTE
Stream & River Condition Assessment by Basin (Oregon Plan)	Use a probabilistic or random sampling design for stream and river condition assessments with a rotating basin approach that will sample approx. 50 random sites in three, 3rd field HUCs (basins) per year (150 sites/yr total). Samples will include chemical, physical and biological indicators. Results will provide statistically valid basin assessments (and a statewide assessment every 5 years) for overall stream conditions, identify key water quality stressors, and evaluate beneficial use support.	10 Contingent upon new funding
Volunteer Monitoring Coordination	Provide support for Watershed Councils and other non-profits for water monitoring including equipment, training, project planning, and data management.	1
Estuary Condition Assessment	Annual sampling of probabilistic sample sites from Oregon's estuaries. Indicators include fish tissue, water and sediment chemistry, and benthic biota. 25 sites sampled per year.	2.0 Federal funding confirmed only through 2006
Beach Monitoring	Routine sampling of Oregon's coastal beaches for Enterococcus bacteria. Results are used to advise public if bacteria levels exceed public health criteria for water contact.	1.0 Requires annual renewal of federal grant
Non-point Source (NPS) Effectiveness	Long term assessment of stream restoration project in Grande Ronde Basin using biological, physical, and chemical indicators.	0.5 Requires annual renewal of 319 dollars
Toxics: Water Column	Targeted sampling for non-persistent pesticides in areas of application	0.5

DEQ's currently unfunded monitoring activities, listed from highest to lowest priority for future implementation, are summarized in the table below. The FTE listed represents what would be needed for full implementation. A specific schedule for implementation is

not provided as future funding cannot be predicted at this time. The priorities listed here, however, establish how future money would be used if and when it becomes available.

Monitoring Activity	Activity Summary	FTE Required
Data Management & Analysis	These positions will support management and analysis of water quality data collected by DEQ and outside agencies and programs. They will also support watershed scoping activities as part of the geographic approach being implemented by DEQ.	2.0
Expanded Groundwater Monitoring	Select targeted sites for screening private wells in areas with risk of contamination, and continue sampling trending sites in current GWMAs.	4
Watershed Scoping Assessments	Targeted monitoring in three HUCS per year to support implementation of watershed cycle in identifying problems and setting priorities	4
TMDL Effectiveness Assessment	Select targeted and/or probabilistic sites within specific TMDL watersheds and sample over time to detect trends in water quality and assess effectiveness of implemented management activities and TMDL program.	4
Toxics: Fish Tissue	Select targeted monitoring sites for sampling fish frequently caught for human consumption and in areas of potential toxic sources. Use results to identify potential health risks for fish consumption and advise public.	9
Lakes	Targeted monitoring of lakes of special interest for water quality and biological indicators. Select lakes based on the rotating basin approach.	4.5 for all 3 phases
Toxics: Water Column	Select targeted monitoring sites in waters from areas with potential toxic sources. Data will help determine compliance with water quality standards, identify toxic threats to humans and biota, and develop toxic reduction partnerships with stakeholders.	7
Expanded Permit Evaluations	Increase number of permits evaluated yearly (25-30 instead of 15-20) by sampling above and below outfalls and mixing zones using chemical and biological indicators, and do split sampling with permittees as a quality assurance (QA) check.	3
Non-point Source (NPS) Effectiveness	Select certain NPS projects for DEQ conducted effectiveness monitoring. Combine these results with probabilistic basin site results to determine effectiveness of different types of NPS funded restoration projects.	2

Besides identifying current and future monitoring priorities, implementation of this monitoring strategy will require detailed decisions about how the actual monitoring work will be conducted (e.g. exact timing of sampling, final selection of specific indicators for each type of sample, selection of rotating basin sequence, etc.). Decisions will also need to be made for improving data use and coordination between other agencies and monitoring groups, improving data management and reporting, and finding additional funding to support currently unfunded but needed monitoring activities. The following steps have been identified to ensure these and other actions in the strategy are implemented.

- ► Form a team of monitoring and regional staff to set up specific plans for implementing the rotating basin approach. This will include selection of basins and their sampling sequence, identification of random sites within each basin, detailed description of indicators and protocols to be sampled at each site, and scheduling details for planning work, field work, sample analysis, data analysis and reporting.

- ► Identify personnel to work with Technical Services on data management problems and solutions, and develop a schedule for implementation.

- ► Begin discussions with other agencies and monitoring groups to identify currently existing water quality data, type of data, data quality, and data format. Work with Technical Services to manage data from outside sources.

- ► Continue discussion with DEQ regional staff on key water quality data needs including sampling scale, indicators, and timing issues.

- ► Develop a prioritized list of reporting goals, including objectives and scale of reports, data analysis and interpretation procedures and schedules for completion.

INFORMATION ON THE WEB

Oregon DEQ Water Program website:
http://www.deq.state.or.us/wq/

Oregon DEQ Quality Management Plan:
http://www.deq.state.or.us/about/QualityManagement/DEQ03-LAB-0006-QMP.pdf

Oregon DEQ Laboratory Division website:
http://www.deq.state.or.us/lab/lab.htm

DEQ Watershed Assessment Mode of Operations Manual:
http://www.deq.state.or.us/lab/qa/DEQ03-LAB-0036-SOP.pdf

DEQ Volunteer Monitoring Resources and Information:
http://www.deq.state.or.us/lab/wqm/volunteermonitoringresources.htm

DEQ, Water Quality Program, Required Data Elements Policy:
http://www.deq.state.or.us/lab/QA/Required%20Data%20Elements.pdf

Oregon Watershed Enhancement Board (OWEB) Monitoring Strategy:
http://www.oweb.state.or.us/OWEB/docs/pubs/MonitoringStrategy.pdf

Environmental Indicators for the Oregon Plan for Salmon and Watersheds:
http://www.oweb.state.or.us/OWEB/docs/pubs/OPSW_EnvIndicators.pdf

Oregon Revised Statutes for Water Quality (ORS Chapter 468B)
http://landru.leg.state.or.us/ors/468b.html

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US Geological Survey. 1999. The Quality of our nation's waters. Nutrients and Pesticides, Circular 1225, 82 p.

Appendix A

Oregon Plan Monitoring Strategy Summary

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Oregon Plan for Salmon and Watersheds Monitoring Framework

Outcomes	Questions	Strategies	Sample Data Types/Information
Outcome One: Provide a scientific assessment of watershed conditions and salmon populations. Identify the appropriate indicators of population and watershed condition, the appropriate scales of inquiry, and the appropriate level of precision needed.	**What is the condition of aquatic habitat and watershed systems?** 1. What is the condition of salmon populations at the ESU, Sub-Basin and watershed scale? 2. What is the status and what are the trends in aquatic habitats, water quality, and stream flow? 3. What are the critical factors that limit watershed function and salmon productivity? 4. What constitutes detectable and meaningful changes in habitat condition and populations?	1. Assess general status and trends for physical habitat, salmon populations, and biotic conditions in Oregon sub-basins and ESU regions at appropriate scales. 2. Monitor habitat capacity, salmon survival and productivity, and biotic processes in selected watersheds within each sub-basin or ESU region. 3. Analyze habitat trends and salmon populations in the context of local or regional effects, landscape influences, and ocean productivity.	Landscape Characterization: Riparian Condition: canopy composition, site potential, Habitat Condition: channel morphology, fish passage. Salmon: abundance, geographic distribution, life history, diversity, and productivity Biotic Condition: invertebrate communities, toxics. Water quality: temperature, DO, pH, sediment, bacteria Stream flow: duration, peak flow events, minimum flows
Outcome Two: Provide an evaluation of Oregon Plan restoration actions and conservation measures Evaluate the relative importance of restoration activities as a contribution to watershed health. Develop analytical models to evaluate changes produced by the Oregon Plan to target conditions and recovery goals.	**What is the benefit of Oregon Plan restoration projects, management practices, and conservation programs relative to adverse impacts and natural ecosystem variability?** 5. What changes are occurring in watersheds that improve stream habitat quality? 6 What are the management practices and programs that enhance or restore watershed functions and salmon populations? 7. What habitat changes and biotic responses result from these projects, practices, and programs? 8. What are the impacts of land use and land management practices on watersheds?	4. Document implementation of restoration projects, conservation activities, and agency programs. 5. Evaluate the local effectiveness of restoration efforts by monitoring representative samples of specific project, activity, and program types. 6. Evaluate the combined effectiveness of restoration efforts by monitoring habitat and population response in a structured sample of watersheds.	Broad Scale Indicators :--land use/land cover, road density --wetland change --ocean productivity cycles Instream, riparian, road, and upland project type, number and location. Habitat and biotic indicators of project effectiveness. Compliance rates and effectiveness measures of policy guidelines and rules (i.e. Forest Practices Act Monitoring) Component and cumulative analysis of restoration actions and management program benefits

Outcomes	Questions	Strategies	Sample Data Types/Information
Outcome Three: Provide useful information to policymakers, agencies, and the public through efficient and coordinated monitoring Oregon Plan partners coordinate to implement efficient monitoring, employ scientific assessments, and report results in ways that promote adaptive responses and informed participation.	**Does the Monitoring Program provide information and analysis for adaptive review of restoration actions, management practices, and Oregon Plan policies?** 9. Is there sufficient support and guidance for local efforts so that monitoring evaluates restoration effectiveness and contributes to broader scale assessments? 10. Does the Oregon Plan coordinate effectively with state, federal, and tribal assessment and monitoring activities? 11. What is the level of public understanding and acceptance of and participation in the Oregon Plan? 12. Is monitoring information used adaptively to guide actions and to meet Oregon Plan reporting requirements? 13. Does the monitoring help evaluate progress toward environmental benchmarks and salmon recovery goals?	7. Standardize monitoring designs, assessment protocols, and methods to manage and analyze data. 8. Coordinate and support interagency monitoring programs and public-private monitoring partnerships. 9. Integrate information from multiple sources to produce data products and reports that assess restoration efforts and evaluate progress toward recovery goals.	Comprehensive documentation of who is monitoring what and where, and what methods are used. (agencies, Tribes, watershed councils, SWCD's, landowners, other organizations) Assessment of natural resource data management throughout the Pacific Northwest. Whole stream or watershed surveys, synoptic assessments of salmon populations and water quality, and other OWEB funded and cooperative monitoring. Complimentary Program Data: • NW Forest Plan Aquatic and Riparian Monitoring • Clean Water Act - DEQ TMDL implementation • Ag Water Quality 1010 Plans

Appendix B

Pacific Northwest Aquatic Monitoring Program (PNAMP) for Regional Monitoring Coordination

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Pacific Northwest Aquatic Monitoring Program (PNAMP) Action Plan

	Key Element/Recommendation	Timeline	Cost
Coordination Structure			
1.	Implement proposed PNAMP coordination structure to include: an Executive Network, a Steering Committee, Technical Groups, and a Coordinator jointly funded by PNAMP participants.	March 2004	$155K
2.	Agencies contribute in kind participation.	Continuous	($246K)
Watershed Condition – HABITAT			$15K/yr
1.	Develop a spatially balanced survey design and integrated sampling strategy that allows the aggregation of data at multiple landscape levels over the PNAMP area to which participants will tier their watershed condition surveys.	2004-06	
2.	Identify a core set of attributes and protocols that state, federal, and tribal monitoring programs will use for assessing status and trends in watershed condition.	2004-06	
3.	Identify and implement a process for developing/refining common GIS layers.	2004-06	
Effectiveness Monitoring – HABITAT & FISH			$15K/yr
1.	Develop a short list of high level indicators of salmon recovery and watershed health at a 3rd field level that can be aggregated to state and regional levels.	June 2004	
2.	Develop a regionally acceptable standard for obtaining statistically valid samples of habitat restoration projects to say with certainty that the projects sampled represent the effectiveness of the project category as a whole.	2005	
3.	Develop a list of habitat restoration project categories that if designed and constructed using documented BMP criteria are considered effective.		
4.	Identify attributes and protocols that state, federal, and tribal monitoring programs will use for assessing project effectiveness.	September 2004	
5.	Strategically place intensively monitored watersheds throughout the Pacific Northwest to monitor and evaluate cause and affect relationships between habitat changes and fish abundance.	2005	
Fish Population Monitoring – ABUNDANCE & HARVEST			$15K/yr
1.	Identify field sampling attributes and protocols that state, federal, and tribal monitoring programs will use for assessing status and trends in fish abundance, other biological indicators, and harvest.	August 2004	
Data Coordination			$15K/yr
1.	Complete detailed assessment of the data management coordination needs of PNAMP work groups and the PNAMP group as a whole	Begin February 2004	$30-55K
2.	Complete the PNAMP needs assessment including a gap analysis to determine what data management needs can be met by existing programs and what needs can be met with PNAMP coordination	Begin May 2004	Same as above
3.	Develop a PNAMP Data Management Coordination Plan including deliverables, timetable and budget.	Begin June 2004	tbd