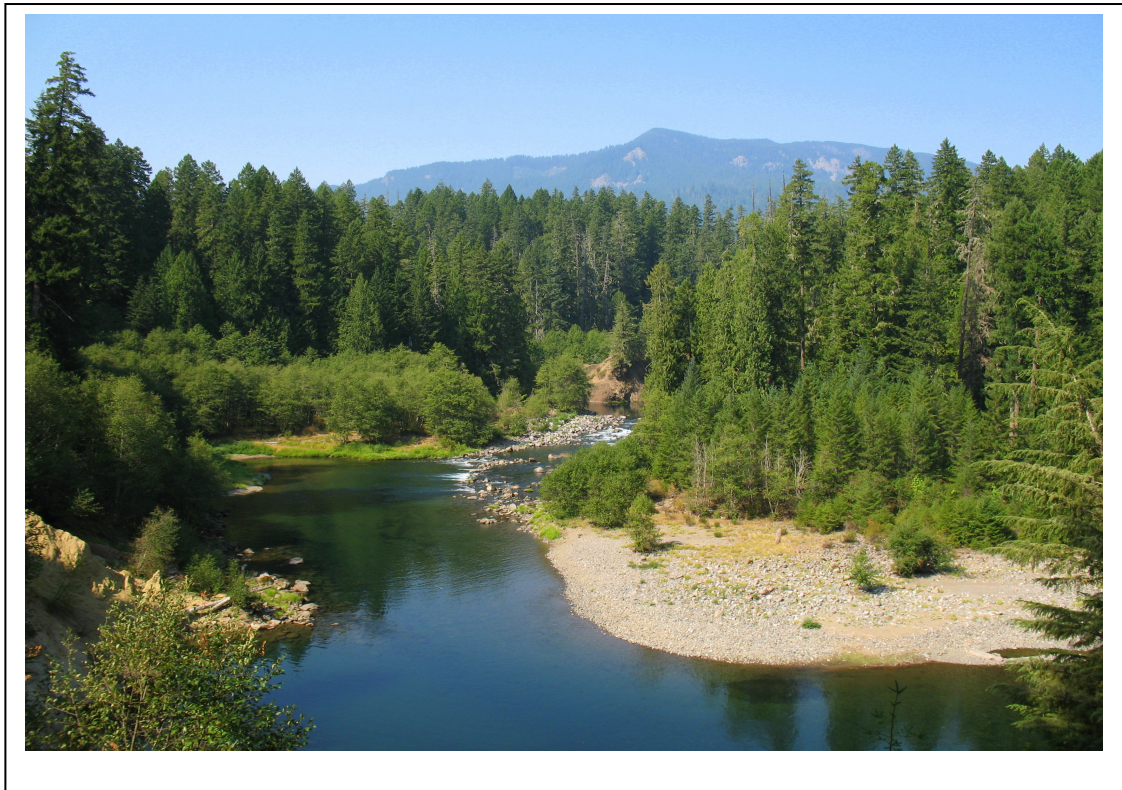


The Clackamas River Water Providers

Drinking Water Protection Plan

For the Clackamas River

Serving
Clackamas River Water
City of Estacada
City of Lake Oswego
North Clackamas County Water Commission
South Fork Water Board
Sunrise Water Authority



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Glossary

ASR – Aquifer Storage and Recovery

AST - Above ground storage tanks

Basin - The watershed of a major river system.

Best Management Practices (BMPs) - Structural and nonstructural techniques that store or treat stormwater runoff to reduce flooding, remove pollutants, and provide other amenities. BMPs can include structural controls such as grass swales or level spreaders, nonstructural controls such as buffer protection, or operation and maintenance procedures.

BGA – Blue Green Algae

BLM – Bureau of Land Management

Biochemical Oxygen Demand (BOD) - A measure of the amount of oxygen consumed by the decomposition of biological matter or chemical reactions in the water column. Most NPDES discharge permits include a limit on the amount of BOD that may be discharged.

Buffer - An area adjacent to a shoreline, wetland, or stream where development is restricted or prohibited.

CAFOs- Confined Animal Feeding Operations

CCSWCD – Clackamas County Soil and Water Conservation District

Clackamas River Basin Council (CRBC) – watershed council for the Clackamas Basin

Clackamas River Water Providers (CRWP) – A coalition of municipal water providers that get their drinking water from the Clackamas River and who are working together on water resource issues.

DBPs – Disinfection by Products

Degradation - The lowering of the physical, chemical, or biological quality of a water body caused by pollution or other sources of stress.

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DEQ – Oregon Department of Environmental Quality

Dissolved Oxygen (DO) - A measure of the amount of oxygen available for biochemical activity in a given amount of water. Adequate levels of DO are needed to support aquatic life. Low DO concentrations can result from inadequate waste treatment.

DOGAMI - Oregon Department of Geology and Mineral Industries

Drinking Water Protection Area - A geographic area above drinking water intake structures that provide adequate response time to protect the integrity of the public water system should a spill or release occur at any crossing or discharge point to the stream.

Effluent - The treated liquid discharged from a wastewater treatment plant.

EPA - United States Environmental Protection Agency

EWEB – Eugene Water and Electric Board

Fecal Coliform Bacteria - A group of microorganisms found in the intestinal tracts of warm-blooded animals. Often used as indicators of the sanitary quality of water.

FEMA – Federal Emergency Management Agency

FERC – Federal Energy Regulatory Commission

Hydrologic Unit (HU) - A watershed area defined by a national uniform hydrologic unit system that is sponsored by the Water Resources Council. This system divides the country into 21 regions, 222 sub-regions, 352 accounting units, and 2,149 cataloging units.

GIS – Geographic Information Systems

IPM – Integrated Pest Management

Impaired - The term that applies to a water body that has a use-support rating of partially supporting (PS) or not supporting (NS) its uses.

Impervious Area (Impervious Cover) - Impermeable surfaces, such as pavement or rooftops, that prevent the infiltration of water into the soil.

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Indicators - Measurable quantities of chemicals (i.e., elements or compounds) or biota (i.e., organisms, species, or communities) that can be used to evaluate the relationship between pollutant sources and their impact on environmental conditions.

Loading - Mass rate of addition of pollutants to a water body (for example, kg/year)

Low Impact Development - The use of small-scale and non-structural site design techniques that store, infiltrate, evaporate, and/or detain stormwater runoff in an effort to mimic the predevelopment hydrology of a site and minimize the impacts of development on water quality and water resources.

Macroinvertebrates - Aquatic organisms, visible to the naked eye (macro) and lacking a backbone (invertebrate). Examples include, but are not limited to, aquatic insect larvae, mollusks and various types of worms. Some of these organisms, especially the aquatic insect larvae, are used to assess water quality.

NCCWC – North Clackamas County Water Commission

Non-degradation - A management target that sets as its goal to avoid any further degradation of a water body. Non-degradation targets do not necessarily mean improving the water quality of a water body.

Nonpoint Source Pollution - Diffuse sources of water pollution in a drainage area associated with runoff of rainfall or snowmelt or irrigation. The quality and rate of runoff of NPS pollution is strongly dependent on the type of land cover and land use from which the rainfall runoff flows.

NPDES - National Pollutant Discharge Elimination System

NRCS – Natural Resources Conservation Service

Nutrients - Substances that are necessary for the growth of all living things (i.e., carbon, nitrogen, and oxygen).

ODA – Oregon Department of Agriculture

ODOF – Oregon Department of Forestry

ODOT – Oregon Department of Transportation

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OHV – Off highway vehicle

OWEB - Oregon Watershed Enhancement Board

PCBs - Polychlorinated biphenyls. PCB production was banned by the United States Congress in 1979 and by the Stockholm Convention on Persistent Organic Pollutants in 2001.

PPCPs – Pharmaceuticals and Personnel Care Products

PSP – Pesticide Stewardship Partnership

PGE - Portland General Electric

PSU – Portland State University

QA/QC - Quality Assurance/Quality Control

Regional Water Supply Plan - was adopted in 1996 by most of the Portland metro area water providers, and is coordinated by the Regional Water Providers Consortium. The Plan provides a comprehensive, integrated framework of technical information, resource strategies and implementation actions to meet the water supply needs of the Portland metropolitan area to the year 2050.

Reservoir - Any holding area, natural or artificial, used to store, regulate, or control water.

Riparian Area - A land area directly influenced by a body of water. Riparian areas usually have visible vegetation or other physical characteristics showing this water influence. Stream banks, lake borders, and marshes are typical riparian areas.

RM - River mile

Runoff (Stormwater Runoff) - The rainfall and/or irrigation that does not evaporate or infiltrate the ground but instead flows across land and into water bodies.

Sedimentation - Soil particles suspended in stormwater. These particles (for example, sediment, algae, and dead organisms) can settle in stream beds and disrupt the natural flow of the stream or degrade aquatic habitat.

SFWB – South Fork Water Board

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Source Water Assessment - An assessment is a study and report, unique to each water system, that provides basic information about where the drinking water comes from, and what could pose a threat to drinking water quality. This information is used to determine how susceptible the water system is to contamination.

SOCs – Synthetic Organic Chemicals

Stressor - Any physical, chemical, or biological entity that can induce an adverse response.

Sub-basin - A designated sub-unit or subwatershed area of a major river basin. Sub-basin typically encompasses the watersheds of a significant stream or lake within a river basin.

303(d) list - Section 303(d) of the Clean Water Act requires states to develop a list of waters not meeting water quality standards or having impaired uses. Listed waters must be prioritized, and a management strategy or total maximum daily load (TMDL) must subsequently be developed for all listed waters.

Total Maximum Daily Load (TMDL) - The maximum amount of pollutant loading that a water body, segment can receive and still support water quality standards/designated uses.

Total Organic Carbon (TOC) - Concentration of all organic (carbon-containing) chemicals.

Toxic Substance - Poisonous matter (either chemical or natural) that causes sickness, disease and/or death to plants or animals.

Tributary - A stream that flows into a larger stream, river, or other water body.

TSS - Total Suspended Solids

UGB- Urban Growth Boundary

USDA – United States Department of Agriculture

USEPA - United States Environmental Protection Agency

USFS – United States Forest Service

USGS – United States Geological Survey

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UST – Underground storage tanks

VOCs - Volatile organic compounds

Watershed - The region, or land area, draining into a body of water (such as a stream, river, pond, lake, or sound). A watershed may vary in size from several acres for a small stream to thousands of square miles for a major river system (the Clackamas River watershed is 940 square miles). The watershed of a major river system is referred to as a basin or river basin.

WES – Water Environment Services

Wetland - An area of land that is regularly wet or flooded, such as a marsh or swamp.

WPCF – Water Pollution Control Facility

WWTP - Wastewater treatment plant

Executive Summary

The Clackamas River is a drinking water source for over 300,000 people in Clackamas County and is identified in the Regional Water Supply Plan¹ as a source to meet future water demand. There are five municipal surface water intakes on the Clackamas River represented by the Clackamas River Water Providers (CRWP): City of Estacada, Clackamas River Water, North Clackamas County Water Commission (Sunrise Water Authority, Oak Lodge Water District and the City of Gladstone) South Fork Water Board (Oregon City and West Linn), and City of Lake Oswego. In addition the Timber Lake Job Corp has a small drinking water system that uses surface water diverted at Lake Harriet as an emergency source and there are numerous public and private wells in the watershed using the groundwater resource.

The purpose of this document is to provide the CRWP with a road map of potential strategies and programs to implement over the next decade to preserve the Clackamas River as a high quality drinking water source and to minimize future drinking water treatment costs. This document is intended to provide guidance to the CRWP but it should be recognized that as we learn more about the watershed and as drinking water regulations change over time, the priorities of the programs and strategies identified in this plan may shift and change.

Who We Are

The water providers in the Clackamas River Basin have been working together on various water resource issues for more than a decade. In July of 2005 an Intergovernmental Agreement for Joint Funding for Watershed Activities in the Clackamas Basin was signed between water providers and Clackamas County Water Environment Services to formalize collaborative work on watershed and water quality related projects. During the summer of 2007 strides were made to expand these efforts to include water conservation and broader water resource issues with the signing of the Intergovernmental Agreement creating the Clackamas River Water Providers (CRWP).

The organization is made up of representatives from City of Estacada, City of Lake Oswego, Clackamas River Water, the North Clackamas County Water Commission, South Fork Water Board, and Sunrise Water Authority and currently includes two staff people, a Water Resource Manager and a Water Conservation Program Coordinator. The purpose of the organization is to fund and coordinate efforts regarding water source water protection and water conservation.

¹ Regional Water Supply Plan Update, December 2004

Plan Goals and Objectives

The overall concept of source protection is to have the ability to measure the balance between watershed health and human use over time and implement actions that maintain a healthy balance for production of exceptional water quality. This requires not only being aware of all the different human activities going on, and their risks to drinking water, within the watershed but also understanding the limits of what the river can handle and still maintain a high level of water quality.

The Water Providers have two primary goals for establishing a source water protection program for the Clackamas River. They are to:

1. Identify, prevent, minimize and mitigate activities that have known or potentially harmful impacts on drinking water quality so that the Clackamas River can be preserved as a high quality drinking water source that meets human future needs and minimizes drinking water treatment costs;
2. Promote public awareness and stewardship of healthy watershed ecology in collaboration with other stakeholders.

This Plan will lay out a number of implementation strategies that the CRWP can use as a map and/or work plan and will prioritize where staff time, resources, and funding should be focused.

Priority Issues in the Watershed for Drinking Water

In 2002-03 the Department of Environmental Quality and Department of Human Services with the assistance of the Clackamas Basin Watershed Council and the water providers completed four source water assessments on the Clackamas River for the USFS Timber Lake JCC, the City of Estacada, a joint assessment for South Fork Water Board, the North Clackamas County Water Commission and Clackamas River Water, and a fourth for the City of Lake Oswego. The purpose of these assessments was to identify surface water areas that supply public drinking water, identify sensitive areas, and potential contaminant sources that could adversely impact that source of water.

Over 1,200 potential contaminant sources were identified in the Clackamas River Source Water Assessments. These potential contaminants that were identified were ranked by risks (low, moderate, higher) and fell into 15 broad categories which are described in detail in the Plan.

Regulatory Authority

The CRWP has no regulatory authority over activities, other than its own, with-in the Clackamas River watershed. There are multiple federal, state, and local authorities that do have existing and proposed rules, regulations, and programs that can protect water quality. Most agencies have a primary focus other than drinking water quality, and typically fall into two categories: 1) control or

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managing the use of the resource, or 2) protection of the environment. Most of these protective measures tend to focus in general on protecting or restoring water quality for fish and wildlife, with secondary benefits of protecting drinking water quality. The CRWP can support existing protective requirements, and positively affect proposed protections for the Clackamas River.

What Management Strategies does the Plan Recommend?

The overall drinking water protection strategy includes eight elements which outline management measures, programs, and strategies to accomplish the goal of addressing the various threats to water quality and to ensure the long-term viability of the Clackamas River as a drinking water source. Each of these elements, are address in a separate section of the Plan. For each of these source protection elements or subprograms, the following details are discussed a) objectives and purpose; b) program description and scope; c) existing activities or programs; d) partnerships and CRWP's role and relationship with partners; e) estimated costs; f) potential funding sources and requirements/limitations of funding sources. A summary of each element/subprogram is below.

1. **Basin Analysis: Studies, GIS, Modeling and Water Quality Monitoring Sub-program.** To better understand the Clackamas River watershed and the potential drinking water threats, there are four elements in this subprogram that the CRWP need to consider. They include additional studies, use of GIS to map land use and potential threats, pollutant load modeling, and developing a comprehensive water quality monitoring program. Each is discussed in more detail in this chapter.
2. **Education and Research Assistance Sub-program.** The objective of this subprogram is to encourage and promote the education of students, research issues related to watershed health, and protection of the Clackamas River as a valuable resource. Programs under this subprogram will also help to promote future professional interest in watershed topics.
3. **Point Source Evaluation and Mitigation Sub-program.** The objective of the point source subprogram is to inventory, track, evaluate, and monitor point sources (water quality and other permits) of potential pollution to understand these potential threats and work with regulatory agencies, facilities, and permittees to reduce these potential threats to drinking water.
4. **Nonpoint Source Evaluation and Mitigation Sub-program.** The objective of the nonpoint source subprogram is to inventory, track, evaluate, and monitor nonpoint sources of potential pollution. Stormwater runoff from urban and rural areas, and from agricultural and forestry activities is the biggest contributor to nonpoint source pollution in the Clackamas watershed. Programs identified in this subprogram will identify ways to work with other stakeholders to reduce non-point source pollution.

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5. **Disaster Preparedness and Response Sub-program.** The purpose of the disaster preparedness and response subprogram is for the CRWP to recognize and be prepared for events that may have a low probability of occurring, but if they happen may cause extensive problems for the CRWP member's drinking water source.
6. **Public Outreach and Information Sharing Sub-program.** The objective of the public outreach and information sharing subprogram is to widely disseminate data and information collected as part of the source protection program to CRWP water customers, Clackamas River watershed residents, and other stakeholders. The overarching goal is for the watershed community to help protect the water quality of the Clackamas River and be engaged in implementing this Plan.
7. **Watershed Land Use Tracking and Management Sub-program.** The objectives of the land use tracking and management subprogram are to gain a thorough understanding of current land use activities and zoning regulations in the watershed; to develop a mechanism for tracking land use activities; and, become an active participant in shaping land use and zoning policy in the watershed to protect the Clackamas River as a drinking water source.
8. **Land Acquisition Sub-program.** The objective of the land acquisition subprogram is to target critical properties in the Clackamas River watershed for purchase or conservation easement in order to protect the watershed over the long term as a high quality source of drinking water.

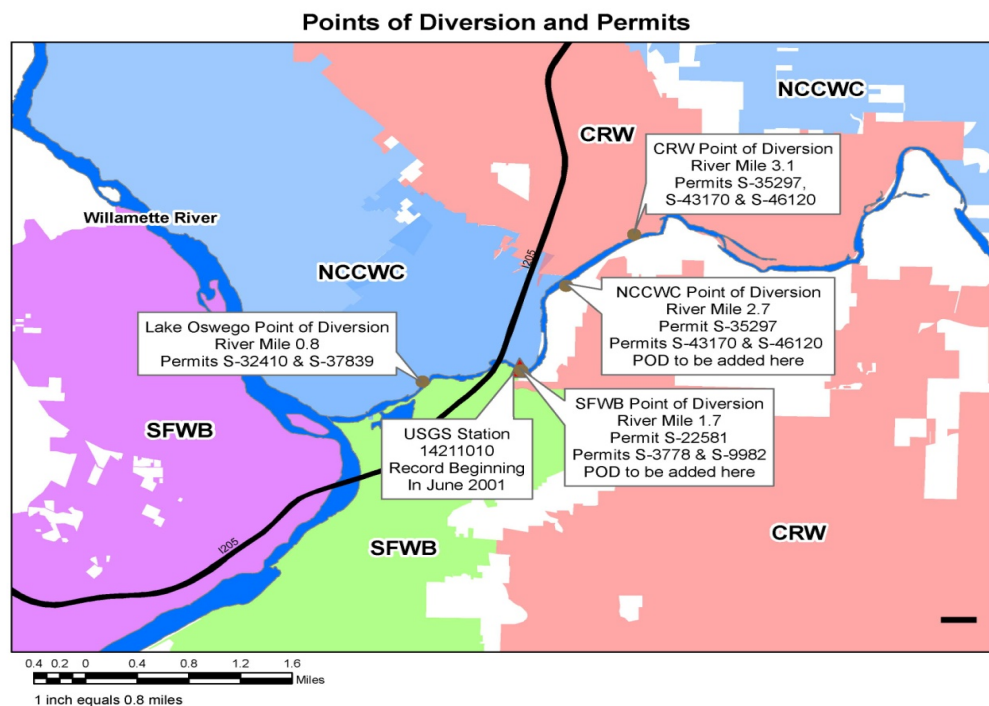
Next Steps

A separate Implementation Plan will be developed to implement the strategies and programs outlined in this Plan. There are more strategies and programs outlined in the Drinking Water Protection Plan than the CRWP will be able to accomplish under current staffing and funding levels. The purpose of the Implementation Plan is to discuss what criteria was used to prioritize the programs and strategies outlined in the eight elements of the Drinking Water Protection Plan. In addition, the Implementation Plan will propose 5 and 10 year implementation schedule and an estimated budget for Plan implementation. The implementation schedule and estimated budget will help guide the CRWP's annual workplan and budget process but will be flexible enough to allow for changes as drinking water rules and regulation change and as more watershed data is collected that could shift program priorities.

Drinking Water Protection Plan

Forward

The Clackamas River is a drinking water source for over 300,000 people in Clackamas County and is identified in the Regional Water Supply Plan² as a source to meet future water demand. There are five municipal surface water intakes on the Clackamas River represented by the Clackamas River Water Providers (CRWP): City of Estacada, Clackamas River Water, North Clackamas County Water Commission (Sunrise Water Authority, Oak Lodge Water District and the City of Gladstone) South Fork Water Board (Oregon City and West Linn), and City of Lake Oswego. In addition the Timber Lake Job Corp has a small drinking water system that uses surface water diverted at Lake Harriet as an emergency source and there are numerous public and private wells in the watershed using the groundwater resource. Below is a map of the of the water provider intakes in lower basin. It does not include Estacada or the Timber Lake Job Corp.



² Regional Water Supply Plan Update, December 2004

The purpose of this document is to provide the CRWP with a road map of potential strategies and programs to implement over the next decade to preserve the Clackamas River as a high quality drinking water source and to minimize future drinking water treatment costs. This document is intended to provide guidance to the CRWP but it should be recognized that as we learn more about the watershed and as drinking water regulations change over time, the priorities of the programs and strategies identified in this plan may shift and change. Each year during the development of its annual budget and workplan the CRWP will examine the long term strategies and implementation plan and determine if those priorities listed are still relevant to the ultimate goals of the organization.

As we take action to protect our drinking water we also act as stewards of the watershed protecting fish and wildlife as well as the health of our customers. By using a proactive approach to addressing water quality issues and potential drinking water impacts we strive to use the Clackamas River on the most sustainable basis possible keeping water treatment requirements at a minimum low and ensure optimum water quality for our communities. It should be noted that this plan only addresses the Clackamas River as a surface water source and does not address wellhead protection for those CRWP members that also have groundwater sources.

Background

The water providers in the Clackamas River Basin have been working together on various water resource issues for more than a decade. In July of 2005 an Intergovernmental Agreement for Joint Funding for Watershed Activities in the Clackamas Basin was signed between water providers and Clackamas County Water Environment Services to formalize collaborative work on watershed and water quality related projects. During the summer of 2007 strides were made to expand these efforts to include water conservation and broader water resource issues with the signing of the Intergovernmental Agreement creating the Clackamas River Water Providers (CRWP).

The organization is made up of representatives from City of Estacada, City of Lake Oswego, Clackamas River Water, the North Clackamas County Water Commission, South Fork Water Board, and Sunrise Water Authority and currently includes two staff people, a Water Resource Manager and a Water Conservation Program Coordinator. The purpose of the organization is to fund and coordinate efforts regarding water resource planning and management, water quality, water conservation and the development of the Clackamas River on a sustainable basis.

These joint efforts to date have included spending over \$1million dollars during the past ten years on watershed related projects. This has included funding to complete watershed assessments in the Clackamas River basin, models of the lower river basin flows, installation of water quality

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monitoring stations, algal and pesticide studies, and other water quality related projects. These projects have been conducted in partnership with a variety of organizations including Portland State University, US Geological Service, and the Clackamas River Basin Council.

By working together the CRWP is able to jointly fund projects and studies that benefit all the providers but which would be beyond the scope of the individual organizations. It allows us to foster closer relationships with each other as intra-basin water suppliers, and to speak in one voice when working with other stakeholders in the basin such as PGE.

It also allows us to realize the economies of scale by sharing in the costs of staff to manage and coordinate programs that benefit all our member agencies. This Drinking Water Protection Plan will help outline ways we can continue to work together to conserve and protect our natural resources to ensure clean, affordable, drinking water for years to come.

Plan Goals and Objectives

As the primary supply of drinking water for the communities served by the CRWP systems, it is essential to protect the Clackamas River from degradation. The purpose of this plan is to address the various threats to water quality and the long-term viability of the Clackamas River as a drinking water source. The overall concept of source protection is to have the ability to measure the balance between watershed health and human use over time and implement actions that maintain a healthy balance for production of exceptional water quality. This requires not only being aware of all the different human activities going on and their risks to drinking water within the watershed, but also understanding the limits of what the river can handle and still maintain a high level of water quality.

The Water Providers have two primary goals for establishing a source water protection program for the Clackamas River:

3. Identify, prevent, minimize and mitigate activities that have known or potentially harmful impacts on drinking water quality so that the Clackamas River can be preserved as a high quality drinking water source that meets human future needs and minimizes drinking water treatment costs;
4. Promote public awareness and stewardship of healthy watershed ecology in collaboration with other stakeholders.

To achieve these goals the CRWP will need to be an active participant in the watershed and promote activities that reduce potential contaminants including nutrients, bacteria, pesticides, volatile organic compounds (VOC's), pharmaceuticals and personal care products (PCP's), fine

sediments, and other byproducts associated with urban, agricultural, forest, land development, and road uses that could impact the quality of the treated drinking water. To accomplish these goals and objectives, the CRWP will need to:

1. Take a leadership role in the protection of the Clackamas River.
2. Promote the CRWP's mission of interagency water provider cooperation through implementation of these source water protection mitigation strategies and programs outlined in this plan.
3. Seek and develop partnerships with agencies, landowners, stakeholders, and academia to solicit feedback and to identify opportunities to develop long term relationships so that water quality objectives, data and information can be shared.
4. Collaborate with partners/stakeholders to maximize opportunities to develop and implement long term solutions for the protection of drinking water supplies, as well as the enhancement of water quality for fish and wildlife.
5. Conduct additional sub-basin analysis through studies, Geographic Information Systems (GIS) analysis, pollution load modeling, and water quality monitoring to help prioritize or reprioritize Best Management Practices (BMPs) and mitigation strategies.
6. Promote public education, awareness and cooperation in the watershed that support voluntary watershed protection activities.
7. Provide funding and resources to implement mitigation strategies and programs identified in this Plan, recognizing that grants and other outside resources will be needed.
8. Identify and monitor high quality lands which contribute to improved water quality and preserve their function.

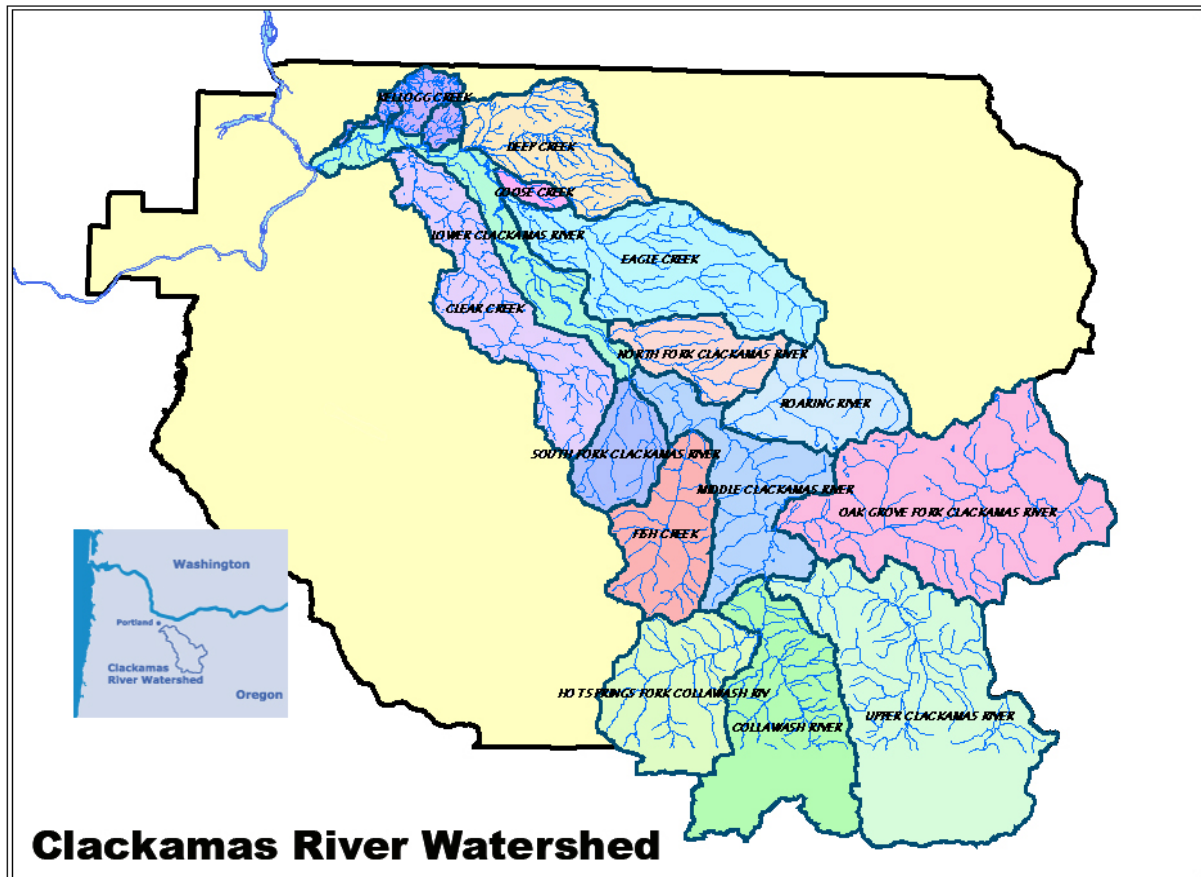
This Plan will lay out a number of implementation strategies that the CRWP can use as a map and/or work plan and will prioritize where staff time, resources, and funding should be focused.

Characteristics of the Watershed

The Clackamas River watershed is located in Clackamas and Marion Counties, Oregon, southeast of the Portland Metropolitan area. The Clackamas River is the last major tributary to the Willamette River, entering the Willamette at approximately river mile (RM) 25 downstream of Willamette Falls. Portions of the cities of Sandy, Gladstone, Oregon City, Estacada, Happy Valley, Damascus, are located within the watershed. Important transportation routes passing through the

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Basin include State Highways 211, 212, 213, and 224; US Highway 26, Interstate Highway 205, and the north-south mainline of the Union Pacific Railroad.



The Clackamas River begins on the slopes of Olallie Butte, a High Cascade volcano. The river flows 82.7 miles from its headwaters (elevation 6,000 ft) to its confluence with the Willamette River near Gladstone and Oregon City (elevation 12 ft) and is made up of 16 sub-watersheds.

The watershed drains more than 940 sq miles, or 600,700 acres. The watershed crosses two counties and includes federal land, state land, and private land. About 72% of the watershed is publicly owned, 3% is tribally owned, and 25% is privately owned.

The Clackamas watershed can roughly be divided in half. Nearly all the upper watershed is within the Mt. Hood National Forest and managed by the USFS. In contrast, most of the lower reaches flow through agricultural and densely populated areas. The area in between the national forest and the lower watershed include parcels of land owned by private timber companies and the BLM. The estimated population within the watershed in 1995 was 63,702 and is a little higher than that today.

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In addition to being a drinking water source for over 300,000 people in Clackamas County, the watershed supports naturally spawning anadromous fish including Chinook, and Coho salmon, as well as steelhead trout. It also provides important habitat for many wildlife species, both game and non-game, and supports recreational activities such as fishing, boating, and camping.

PGE operates three hydroelectric dams on the Clackamas River mainstem: Faraday (just east of Estacada), River Mill (west of Estacada), and North Fork (upstream from Faraday). These dams all have adult fish passage facilities. Faraday and River Mill also have juvenile fish bypass facilities. The Oak Grove Fork of the Clackamas River has two dams: Lake Harriet (23 miles east of Estacada) and Timothy Lake.

In 1988 Congress incorporated approximately 50 miles of the Clackamas River into the Federal Wild and Scenic River System. Four sections of the River are also designated as State Scenic Waterways. The purpose of these designations is to protect these segments' outstandingly remarkable values while maintaining and enhancing the natural integrity of the river.

For more information about the physical and biological characteristics of the Clackamas River Watershed see the *Clackamas Basin Summary Watershed Overview*, prepared for the Clackamas River Basin Council in 2005. Or go to CRBC's website at <http://www.clackamasriver.org/projects/basinPlanning/index.htm>

Identified Drinking Water Risks – DEQ Source Water Assessment

In 2002-03 the Department of Environmental Quality and Department of Human Services with the assistance of the Clackamas Basin Watershed Council and the water providers completed four source water assessments on the Clackamas River for the USFS Timber Lake JCC, the City of Estacada, a joint assessment for South Fork Water Board, the North Clackamas County Water Commission and Clackamas River Water, and a fourth for the City of Lake Oswego. The purpose of these assessments was to identify surface water areas that supply public drinking water, identify sensitive areas, and potential contaminant sources that could adversely impact that source of water.

The City of Estacada's and the Job Corp drinking water intake is located in the upper part of the Clackamas River watershed while the other four water provider's drinking water intakes are located in the lower part of the river. For this reason the drinking water protection areas for all the water providers combined cover a majority of the watershed. These protection areas extend up river from drinking water intakes and are designated as areas where increased protection measures should be focused to give water providers adequate response time in order to protect the integrity of the public water system should a spill or contaminant be discharged in the river. Average travel times down

river (from River Mill Dam to confluence with the Willamette River) are seven to eight hours³ at flows around 800-900 cfs, and about four hours at flows of 15,000 cfs.

Over 1,200 potential contaminant sources were identified in the Clackamas River Source Water Assessments. These potential contaminants identified were ranked by risks (low, moderate, higher) and fell into the following categories:

- Above Ground/Underground Storage Tanks
- Agricultural Activities – pesticides, fertilizers, animal waste management
- Dams/Powerhouses/Upstream Reservoirs
- Fish Hatcheries
- Forest Practices – clearcuts, landslides, pesticides
- Industrial and Commercial Facilities
- Landfill/Dumps/Illegal Dumping/Junk yards
- Recreation – official and unofficial campgrounds, boats, river recreation, golf courses, parks
- Resource Extraction - mines/gravel pits
- Road Vegetation Management
- Storm Sewer Outfalls
- Transportation
- Urbanization – non-point source runoff
- Septic Systems Failures
- Wastewater Treatment Plants

Below is a description of each of the potential drinking water risks listed above:

Above Ground/Underground Storage Tanks (Moderate Risk)

Spills leaks, or improper handling of stored material in above ground storage tanks (AST) may contribute to contamination. Underground storage tanks (UST) are used for the storage of petroleum and other substances. UST systems represent a threat to water quality due to deterioration of the tank, improper installation, or pipe/connection failures. In addition, active UST and AST sites represent potential sources of surface water contamination through spills and overfills during product delivery.

³ Stream Velocity and Dispersion Characteristics Determined by Dye-Tracer Studies on Selected Stream Reaches in the Willamette River Basin, Oregon; U.S. GEOLOGICAL SURVEY Water-Resources Investigations Report 95-4078, Prepared in cooperation with OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY, 1995

Agriculture (Higher Risk)

Potential non-point source pollutants include sediments, nutrients, pathogens, oxygen-depleting organics, and pesticides from irrigation and non-irrigated crop areas, animal grazing areas, boarding stables, farm machinery repair shops, and chemical mixing/storing/handling areas. Many different chemicals are used on the various commercial crops found in the Clackamas River watershed.

Nurseries (Higher Risk)

There are a number of nurseries in the lower part of the Clackamas watershed. Nurseries contribute to nonpoint source pollution, primarily by nutrients, toxic chemicals, PCP's, antibiotics and medications, and sediment. Container nurseries, in particular, tend to use relatively large amounts of fertilizers, insecticides, and fungicides.

CAFOs and Animal Management (Higher Risk)

There are three permitted Confined Animal Feed Operations (CAFOs) within the Clackamas River watershed. Both permitted and non-permitted CAFO facilities are a concern due to nitrate, bacteria, and other potential pollutants resulting from large numbers of animals in one location. Improper storage and management of animal waste, in addition to pharmaceutical use to keep animals healthy, may also impact drinking water. Concentrated livestock operations may contribute to soil erosion and sedimentation issues.

Dams/Powerhouses/Upstream Reservoirs (Low – Moderate Risk)

PGE has three large dams on the mainstem of the Clackamas River. Dams and powerhouse operations typically involve the use of fuels, paints, solvents, polychlorinated biphenyls (PCB's), and coolants/lubricants. During major storm events, reservoirs may contribute to prolonged turbidity. Construction, fluctuating water levels, and heavy waterside use can increase erosion and turbidity. Spills, leaks, or handling of chemicals and other materials during transportation, use, storage, and disposal may impact drinking water quality. Dams on the Clackamas have also been shown to warm the water downriver. Recreational uses of the reservoirs are discussed in a separate section below.

Fish Hatcheries (Higher Risk)

There are two fish hatcheries located in the Clackamas River Watershed. The Eagle Creek National Fish Hatchery is operated by the US Fish and Wildlife Service and located in the Eagle Creek Tributary. The second hatchery is the Milo McIver Hatchery, located in Milo McIver State Park is operated by the Oregon Department of Fish and Wildlife. Fish hatchery effluent containing

nutrients, biochemical oxygen demand (BOD), and pharmaceuticals (antibiotics)⁴ have the potential to adversely impact water quality.

Forestry Practices (Moderate - Higher Risk)

Forestry practices include activities related to growing and harvesting timber. Pollutants typically associated with forest practices include nutrients, sediments, organics, and increased temperature. Erosion and subsequent sedimentation result from timber harvest, road construction, stream crossings, and high intensity fires. Increased water temperature results from removal of riparian vegetation that shades streams. Cutting and yarding of trees may contribute to increased erosion, resulting in turbidity and chemical changes in river water quality. Over application and/or improper handling of pesticides and fertilizers may also contribute to contamination.

Effects may be minimal since land uses in the upper basin on National Forest land is primarily related to timber thinning with minimal road construction. Private and urban forestry activities should be analyzed for their potential impacts. Potential nitrogen sources are associated with harvest, prescribed burning, fertilization, and other processes. Phosphorus is associated with natural geologic sources in the upper basin, which can be increased by accelerated erosion.

Industrial and Commercial Facilities (Moderate - Higher Risk)

A variety of businesses including auto service stations, repair shops, dry cleaners, beauty salons, print shops, medical facilities, logging and construction companies, parking lots and retail malls, machines shops, and sand and gravel operations represent other potential nonpoint stormwater sources of pollutants. Many of these are located along Hwy 212/224 corridor.

Landfill/Dumps/Illegal Dumping/Junk Yards (Higher Risk)

Illegal trash and debris containing chemicals and hazardous materials can contaminate ground water and surface water. This includes residential accumulations that have the potential to contaminate groundwater with toxics. Improper handling of fluids and components at these sites can result in polluted stormwater runoff, infiltration into groundwater, and subsequent environmental damage. Contamination can also result from stored metals and other hazardous materials because these sites are typically located outdoors where they are exposed to the elements.

⁴ Occurrence of Antibiotics in Water from Fish Hatcheries <http://ks.water.usgs.gov/pubs/fact-sheets/fs.120-02.html>

Permitted Discharges (Moderate – Higher Risk)

Point source discharges on the Clackamas River upstream from the Clackamas River Water Providers water intakes have been identified primarily from a database of water quality permit holders from DEQ. Facilities with water quality permits, from which permitted discharge and/or runoff could potentially impact the Clackamas River upstream of drinking water intakes, are listed in Appendix C. Biosolids management and recycled water applications associated with these kinds of permits should also be looked at as potential risk.

Recreation (Low – Moderate Risk)

The Clackamas watershed is used for a variety of different recreational activities. Recreational activities such as boating, floating, hiking, camping, hunting, biking, Off Highway Vehicle (OHV) use, and fishing can contribute nonpoint source pollutants to the river. Potential pollutants associated with outdoor recreation activities include untreated or partially treated human waste, petroleum products, PCPs, detergents, solvents, paints, and non-degradable litter. Heavy use may contribute to streambank erosion causing turbidity. Fuel spills and emissions from boats (especially the older two-cycle engines) may also contribute to hydrocarbon contamination. Emissions refer to hydrocarbon emissions/pollution emitted by gasoline engines. This is mostly an issue associated with the two-cycle engines that are smaller, older and cause more pollution. The larger 4-cycle engines are generally more efficient. Pesticides and fertilizers from golf courses and parks can also lead to degraded river water quality.

Resource Extraction- mines/gravel pits (Low Risk)

Several gravel quarries and mines are found within the Clackamas watershed area. Gravel mining is associated with increased sedimentation, petroleum hydrocarbons, and metals. Spills, leaks, or improper handling of chemical waste generated in mining operations or from heavy equipment may impact river water quality.

Roadside Vegetation Management (Moderate – Higher Risk)

Untreated road runoff finds its way into the river via roadside ditches and streams. Potential pollutants include sediments, petroleum products, metals, and herbicides. Over application and/or improper handling of pesticides and/or fertilizers may impact water quality. Oregon State Law mandates that state agencies shall implement integrated pest management (IPM) practices when engaged in pest control. The USGS Scientific Investigations Report 2008–5027⁵ identifies roads

⁵ U.S. GEOLOGICAL SURVEY Scientific Investigations Report 2008–5027; Pesticide Occurrence and Distribution in the Lower Clackamas River Basin, Oregon, 2000–2005

and roadside maintenance as potential sources of the pesticides previously identified to be present in the river water.

Storm Sewer Outfalls (Higher Risk)

Urbanization is characterized by many types of impervious surfaces, including building roof tops, driveways, sidewalks, parking lots, and highways. Sediment and chemicals may accumulate on these surfaces and be washed off into storm drains or ditches during heavy rainfall. Numerous potential sources of contamination, due to runoff and/or accidental spillage/release may be created in any area where surface runoff reaches the Clackamas River. These point sources have the potential to carry gas, oil, and grease products, as well as heavy metals, pesticides, herbicides, nutrients, and other toxic chemicals and in many but not all areas are regulated by MS4 permits. Human and animal pathogens are other likely contaminants.

Transportation (Higher Risk)

Several major transportation corridors and bridges are located within the Clackamas River basin watershed. Truck movement on Hwy 212 to Boring and on Hwy 224 to Estacada includes shipments of a wide variety of materials, but gasoline and diesel are probably by far the most common products. Road building, maintenance, and use may increase erosion and slope failure causing turbidity. Vehicle use increases the risk of leaks or spills of fuel and other chemicals. Transport of hazardous materials over the I-205 bridge and the railroad bridge is a particular concern for the City of Lake Oswego. The railroad tracks near Cow Creek are a concern for the NCCWC, SFWB, and Lake Oswego treatment plants.

Urbanization (Moderate – Higher Risk)

Stormwater runoff from urban areas represent both a water quantity and water quality problem. Development and construction are two major contributors of non-point source pollution. Improper use, storage, and disposal of household chemicals, fertilizers, and pesticides may impact the river water quality. Spills, leaks, or improper handling of automotive chemicals and batteries may also contribute to contamination. High density housing areas and rural homesteads with septic systems are also potential contamination sources. Over watering (irrigation) in urban areas is also a conduit for phosphorus, fertilizers, and pesticides to enter the river. Increased runoff is associated with areas where urbanization has converted open-space land to impervious surfaces. In the Clackamas River watershed the Damascus/Boring area is currently experiencing the heaviest pressure for residential development.

Pollutants found in surface water runoff in urbanized watersheds include sediments, nutrients, pathogens, metals, petroleum products, and toxic chemicals. Metals such as copper, lead, nickel, and zinc have been shown to exceed federal water quality criteria in many urbanized basins in western Oregon (DEQ, 1992) See also Storm Sewer Outfalls on page 26.

Septic System Failures (Moderate Risk)

Nonpoint source pollution originating from septic systems is attributed to failing or malfunctioning systems. Sewage disposal systems typically consist of a septic tank and a drain field. A system failure can occur when effluent exceeds the absorbent capacity of the soils. This results in a sludge backup in the plumbing and/or the release of partially treated effluent onto the ground surface. Other causes for system failures include poor soil conditions, inadequate design, inadequate construction, and lack of maintenance of the system. Note that risk is primarily from direct runoff of partially treated effluent where the drain field or treatment system has failed or an indirect release in areas where impacted groundwater recharges surface water.

Potential pollutants sources from failing tanks include nitrate contamination, nutrients, toxic chemicals, organics, pathogens, and PCPs.

Wastewater Treatment Plants (Moderate – Higher Risk)

PCPs that go through the wastewater treatment process are emerging contaminants of concern. Wastewater biosolid and recycled water application areas may impact surface water through direct runoff or if impacted groundwater recharges surface water. Another separate, but related risk, are sewer lines that are in close proximity to the river or are located in highly permeable soils adjacent to the river (such as the sewer line going over the Clackamas near High Rocks, on its way to the Tri Cities plant). These sewage lines should be considered a high priority for evaluation of potential leakage, and as a preventive measure should be a high priority for regular inspection and maintenance.

Summary of Risks

Based on DEQ/DHS's Source Water Assessments and the work done by Eugene Water & Electric Board (EWEB) in the McKenzie River watershed, which has a very similar make up as the Clackamas River watershed, the highest risks to river water quality is stormwater runoff characterized below as:

- urban storm sewer discharges,
- stormwater runoff impacts from increased development (conversion of farm and forest land to urbanized development),
- commercial and industrial facilities potential spills and stormwater runoff,
- stormwater runoff from agricultural practices,

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- roadside vegetation management,
- potential domestic wastewater discharges from wastewater treatment plants and septic systems, and
- hazardous material spills from commercial and industrial areas, transportation activities along HWY 212/224 , the railroad line, and the numerous road bridges that cross the Clackamas River and its tributaries.

Water Quality and Water Quantity Assessment (2005)

In 2005 a Water Quality and Quantity Assessment was completed by the Watershed Professional Network. This document was compiled to summarize and synthesize the relevant information needed for the Clackamas Basin Action Plan.

The Assessment above focuses on five sets of water quality indicators, 1) Nutrients, 2) Bacteria, 3) Pesticides, 4) Water Temperature, and 5) Sediment. The report ranks the lower basin tributaries based on potential impacts (lowest to highest) of these five indicators. Each water quality indicator was given a rank based on concentration, or percent exceedance, then color coded on individual maps. Although not all of these indicators are considered to be water quality risks, this Assessment can help with prioritizing which mitigation strategies the CRWP desires to utilize.

View both of these documents by going to the Clackamas River Basin Council's website at: <http://www.clackamasriver.org/projects/basinPlanning/index.htm>.

Regulatory Authority

CRWP has no regulatory authority over activities, other than its own, with-in the Clackamas River watershed. There are multiple federal, state, and local authorities that do have existing and proposed rules, regulations, and programs that can protect water quality. Most agencies have a primary focus other than drinking water quality, and typically fall into two categories: 1) control or managing the use of the resource, or 2) protection of the environment. Most of these protective measures tend to focus in general on protecting or restoring water quality for fish and wildlife, with secondary benefits of protecting drinking water quality. CRWP can support existing protective requirements, and positively affect proposed protections for the Clackamas River, by doing the following:

1. Support regulatory efforts: promote protection of water quality and specifically address drinking water quality.

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2. Track Changes in Regulations: monitor existing rules/regulations for changes and/or amendments that could impact drinking water quality.
3. Advocate for more protections for the source of our drinking water or prioritizing existing resources toward the drinking water resource and public health goals.
4. Set pollution goals or targets: work with regulators and partners, including Clackamas County Water Environment Services, the Oregon Department of Agriculture, US Forest Service, Oregon Department of Transportation, Department of Environmental Quality, Oregon Department of Health and Human Services, and Oregon Department of Forestry.
5. Draw attention to and support the 3 Basin Rule: the 3-B Rule originally addressed only surface water discharges in three sub-basins of the Willamette River: Clackamas, McKenzie and North Santiam. The rule was substantially rewritten in 1994 and was adopted by the Environmental Quality Commission on February 16, 1995. The reworked version includes regulations for Water Pollution Control Facilities (WPCF) permits as well as NPDES permits. The purpose of this rule is to protect large surface water sources that are also drinking water sources. The CRWP should monitor this rule to ensure no changes are made that could negatively impact the water quality in the Clackamas River.
6. Coordinate with the TMDL Implementation Plan partners regarding streams listed as water quality limited on the 303(d) list.
7. Track and influence land use changes at City and County level such as comprehensive plan development or changes in riparian ordinances, septic code, open space or floodplain development/restrictions.

Elements of Drinking Water Protection Plan for Source Water Protection

Based on the DEQ/DHS Source Water Assessments and the similarities between the Clackamas River Watershed and the McKenzie River Watershed, the strategies used by the CRWP will be similar in nature to the EWEB's Source Water Protection Program. The overall strategy includes the eight elements listed below and will be described in more detail in the next sections of the Plan. The first element outlines additional work that must be completed by the CRWP to better understand the watershed and to help prioritize mitigation strategies. The remaining elements outline a variety of mitigation strategies designed to protect drinking water. All eight elements are listed below:

1. Basin Analysis: Studies, GIS, Modeling and Water Quality Monitoring Sub-program, page 31.
2. Education and Research Assistance Sub-program, page 42.
3. Point Source Evaluation and Mitigation Sub-program, page 47.
4. Nonpoint Source Evaluation and Mitigation Sub-program, page 54.
5. Disaster Preparedness and Response Sub-program, page 66.
6. Public Outreach and Information Sharing Sub-program, page 72.
7. Watershed Land Use Tracking and Management Sub-program, page 75.
8. Land Acquisition Sub-program, page 77.

Drinking Water Protection Strategies

The overall drinking water protection strategy includes eight elements which outline management measures, programs, and strategies to accomplish the goal of addressing the various threats to water quality and to ensure the long-term viability of the Clackamas River as a drinking water source. For each of these source protection elements or subprograms, the following details will be discussed a) objectives and purpose; b) program description and scope; c) existing activities or programs; d) partnerships and CRWP's role and relationship with partners; e) estimated costs; f) potential funding sources and requirements/limitations of funding sources.

A separate Implementation Plan will be developed to implement the strategies and programs outlined in this Plan. There are more strategies and programs outlined in the Drinking Water Protection Plan than the CRWP will be able to accomplish under current staffing and funding levels. The purpose of the Implementation Plan is to discuss what criteria was used to prioritize the programs and strategies outlined in the eight elements of the Drinking Water Protection Plan. In addition, the Implementation Plan will propose 5 and 10 year implementation schedules and an estimated budget for Plan implementation. The implementation schedules and estimated budget will help guide the CRWP's annual workplan. The budget process will be flexible enough to allow for changes in drinking water rules and regulations. As more watershed data is collected program priorities could shift.

The reader may notice that the level of detail provided in the discussion of the eight subprograms varies throughout this document. This variation reflects the idea that some of the subprograms are currently being implemented, others are in planning stages, and still others are targeted for development at some future date.

1) Basin Analysis: Studies, GIS, Modeling & Water Quality Monitoring Sub-program

Objective: To better understand the Clackamas River watershed and the potential drinking water threats, there are four elements in this subprogram that the CRWP need to consider. They include additional studies, use of GIS to map land use and potential threats, pollutant load modeling, and developing a comprehensive water quality monitoring program. Each will be discussed in more detail below. Each of these elements will help inform decisions on how to better prioritize resources and mitigation strategies outlined later in the plan and allow the CRWP to monitor changes in water quality in the Clackamas River over time.

Scope:

I. Additional Studies

Over the years the water providers have conducted a number of studies in partnership with USGS, PSU and CRBC. These have included helping CRBC fund Watershed Assessments for Clear, Foster, Deep and Goose Creeks as well as developing their Clackamas Basin Action Plan. The water providers worked with USGS to complete two Pesticide Studies (2003 and 2008) in addition to an Algal Nutrient Study (2002) and a Flow Balance Study (2009). The CRWP has also worked with PSU for the last few years to model lower basin flows to better understand how municipal withdrawals impact flow and temperature. All of these studies have provided the water providers with valuable information regarding the watershed in general, the quality of the source water, and flow. Additional studies would help inform decision making. These studies, listed below, are not prioritized. They include the following:

a) Taste and Odor/ Algal Study – While not normally a direct drinking water threat, taste and odor events are a nuisance and do generate phone calls from concerned citizens. Algae can clog intake structures requiring a higher level of maintenance, and can occasionally prevent water systems from withdrawing water. In July 2008 the City of Lake Oswego had to issue a stage 1 curtailment notice to its citizens because algae was clogging their intake structure, reducing its capacity to withdraw water. The purpose of this study would be to investigate algal growth and bloom in the Clackamas River system and associated issues of taste and odor and intake clogging.

It would build on the study done by the water providers and USGS in 2003 and work in tangent with the Blue Green Algae (BGA) work being done by PGE's BGA team (CRWP is already a participating member). It would determine if algal blooms are associated with PGE operations or if they are associated with other human activities such as agriculture, forestry, urbanization, and

industrial development. By evaluating nutrient sources it would aid in development of prediction and mitigation strategies. Customer taste panels could also be included as part of this study.

b) Groundwater Study – The purpose of this study would be to develop a better understanding of groundwater/surface water interactions within the watershed. If areas of high groundwater/surface water interaction were identified this would help prioritize upland point and nonpoint pollution mitigation strategies. This would include looking at old abandoned wells (domestic, agriculture, and geo-tech) as potential sources of pollution.

c) Additional Flow Balance – See groundwater study section above. A network of ground-water wells could provide indication in the timing and spatial distribution of ground-water discharge to the lower Clackamas River. Between 2006 – 2009 the CRWP worked with USGS to conduct a flow balance study. The purpose of this study was to look at streamflow gain/losses in the lower Clackamas River, to track surface-water sources to (or sinks from) the lower Clackamas River, and to estimate the quantity of ground-water discharges in to the system. In addition, this work included USGS taking several cross sectional measurements to obtain additional bathymetry data which was incorporated into the CE-QUAL-W2 model. The results of the study did not show huge changes between flow from River Mill to the mouth (it was around + or – 10%). What the analysis did show, however, was that there are flow decreases and increases in between these two points around the Carver area. These changes could be the result of channel changes from the 1996 floods, or possible impact from the wells in the Carver area. Potential next steps include: 1) take additional stream flow measurements, 2) do further analysis of the uncertainty in stream flow measurements, 3) conduct ground water level monitoring to determine the relationship between surface water and ground water, 4) look at the seasonal differences in groundwater seepage to the stream.

d) Climate Impact study – The State of Oregon is in the process of developing an Integrated Water Resource Strategy for the entire state. The implications of climate change are identified as an area that needs more study to better understand how climate change will affect water supply over the decades to come. Climate change models for the Pacific Northwest predict that we will see warmer winter temperatures and winter precipitation in the form of rain instead of snow. This will lead to declining snow packs and reduced summer stream flows. The impact could be increased turbidity and flood events in the winter and degraded water quality due to less dilution during the summer months. Although regional modeling has been done, there has been little climate work done specifically on the Clackamas River. This kind of study would help the CRWP develop adaptation and mitigation strategies to deal with potential changes in Clackamas River flow quantity and water quality due to climate change.

e) CE-QUAL-W2 Modeling of the Lower Clackamas River – The CRWP has been working with PSU to model flows and temperature impacts in the lower Clackamas River for a number of years. This modeling could be expanded to include Ensemble Streamflow Prediction modeling. This would allow the CRWP to predict future summer conditions so that conservation and other mitigation programs could be adjusted accordingly.

f) Macro invertebrate Study - Stream-bottom macroinvertebrates provide valuable information about the quality of a stream over long periods of time. In a healthy stream, the stream-bottom community will include a variety of pollution-sensitive macroinvertebrates. In an unhealthy stream, fewer types of pollutant tolerant macroinvertebrates will be present. Macroinvertebrate sampling provides information about pollution that is not present at the time of sample collection but that has occurred recently. Identifying subwatersheds in the lower Clackamas and completing macroinvertebrate sampling studies will help establish a baseline for tracking pollution changes over time.

g) Carbon/Disinfection-By-Product Study – Clackamas River Water and Lake Oswego are currently conducting a Carbon study unrelated to CRWP efforts. The Results of their study will help establish a baseline for the seasonal quantity and character of organic carbon in the Clackamas River. Further sampling efforts could be integrated into the CRWPs water quality monitoring efforts.

h) Pharmaceuticals and Personal Care Products (PPCPs) - Pharmaceuticals have been found in treated sewage effluents, surface waters, soil, and tap water at extremely low levels (parts per trillion). Science currently shows that these levels are unable to induce acute effects in humans, as they are far below the recommended prescription dose, but they have been found to affect aquatic ecosystems. Although there currently are no drinking water standards/requirements for PPCPs there is growing public concern around this issue. It may be in the CRWP's best interest to learn more about these emerging contaminants and to develop a water quality sampling program in anticipation of future regulation.

i) Hydrocarbon Study - In 2005 the Clackamas River was part of USGS' National Water-Quality Assessment Program, Source Water-Quality Assessment. As a part of this work gasoline hydrocarbons were detected in the Clackamas River source water. Compared with the other eight community water systems sampled as part of the USGS SWQA study, concentrations of several gasoline hydrocarbons, including toluene, xylene, and benzene were highest in the Clackamas River. 14 gasoline hydrocarbons were detected, and the frequent occurrence of these compounds indicates a persistent source during much of the year. Sources of these compounds include vehicle emissions and fumes from fueling stations, runoff from roads and parking lots, ground-water discharge contaminated by leaky underground gasoline storage tanks, and exhaust from water craft,

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particularly two-stroke engines. Additional study of hydrocarbon may benefit the CRWP by understanding the timing of this kind of pollutant loading and may give the CRWP the leverage it needs to work with Oregon State Marine Board, WES and the community to address this issue.

j) Instream Flow Incremental Methodology (IFIM) study - This study provides information about the relationship between streamflows and fish habitat which could be used in developing minimum instream flow requirements for fish in the Clackamas River. This information would be entered into a hydraulic model to simulate the distribution of water depths and velocities with respect to substrate and cover under a variety of flows. This simulated information would then used to generate an index of change in available habitat relative to changes in flow; this index is referred to as "weighted usable area" (WUA). *k) Invasive Species* - Another issue that the CRWP will need to track and that may potentially need further study is the potential introduction of the invasive species of Zebra/Quagga mussels. This is an area where a risk analysis could be done, including ecosystem connectivity that indicate likelihood of zebra mussels expanding their reach from any existing areas to the Lower Clackamas. If Zebra/Quagga mussels get introduced and established in the Clackamas system it would be very detrimental, and potentially very costly, to CRWP members.

In addition there are other studies which could be done jointly through the CRWP rather than by individual CRWP members that could achieve cost savings and consistent data. These could include projects or studies on ASR, wellhead protection programs, and/or water treatment plant interconnections. *See Appendix A for a list of potential studies.*

Estimated Costs for Addition Studies: Costs are dependent upon the depth and level of study and will be determined at a later date.

II. GIS Assessment of Drinking Water Threats

Conducting a GIS analysis of water risks, as mentioned above, will provide spatial context of where the risks are located as well as their intensity (numbers of threats clustered together rather than spread out over a larger area). The GIS risk layers produced can then be overlaid with sensitive soil layers and/or proximity to tributaries which will identify potential hot spots. The purpose of this would be to help prioritize mitigation programs. The production of a detailed drinking water risk map will be a powerful tool for CRWP to prioritize source protection actions, seek grant funds, and bring in additional partners for projects on the ground. It will also be a visual tool to communicate with other agencies and organizations we are interested in partnering with and will allow the CRWP to begin a dialogue with industry and stakeholders to collaborate on future projects. It could potentially help gain more interest from universities, federal, state and local agencies, watershed councils and others to conduct studies and monitoring because we have taken the first step in

collecting, processing and analyzing the data within the watershed and have a better understanding of what needs to take place in order to protect the our drinking water source.

Scoping Study:

A scoping study would include an outline/concept of the data needs and data gaps, planning/assessment capabilities, and software/modeling options to develop a flexible and adaptable monitoring/modeling program. In order to map all of the drinking water threats in GIS the first step would be identification of what GIS data would be needed, what existing data is available, potential partners to acquire the GIS layers from, as well as identifying software/hardware needs. The second step would be to lay out how GIS development would integrate with water quality monitoring and pollution loading modeling work identified under the water protection plan. The last step will be determining where the GIS data will be housed and maintained, and if CRWP staff, CRWP member organizations, or consultants will perform the GIS work.

This scoping study will also help refine the budget estimate on what it will cost to perform the GIS work. In addition partnerships could be identified to help fund the project, whether with dollars or through in-kind services. This study will also include scoping and data needs for pollution load modeling to identify which kind of pollution load model is the most appropriate for the Clackamas watershed and to refine the costs of doing such modeling.

Estimated costs: \$5,000

Work Tasks Associated with the Assembly of a GIS database for Clackamas River watershed:

Relevant existing GIS data will be acquired from Clackamas County, USFS, ODOF, ODOT, the State of Oregon GIS Center, and other stakeholders identified in the scoping study for use in the Clackamas River watershed.

Deliverables: A geodatabase (format: personal, file, or SDE to be determined later) containing ArcHydro formal hydrography, terrain, and county sourced cadastral, roads, and risk layers covering the Clackamas River watershed.

GIS analysis support for assessing threats to water quality from septic systems: GIS staff will assemble a GIS layer of residential address point location data (or assessor tax lot centroids if address points are unavailable) in areas not served by municipal wastewater treatment facilities. Cluster analysis will be performed to identify areas of highest potential risk to water quality from septic systems. Additionally, septic system age and soils data will be combined with the results of cluster analysis to identify relatively high density septic system clusters, in proximity to surface water, in areas of rapidly draining soils. This analysis will assist the CRWP in assessing the threats to water quality from septic systems as well as help to target further monitoring efforts.

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Deliverables: GIS data and summary report including delineation of septic system cluster areas.

GIS analysis support for assessing threats to water quality from agriculture activities: Portions of the Clackamas River watershed contain significant areas of agricultural production. GIS staff will acquire data showing agricultural unit (field) locations and crop type. Assumptions on pesticide and fertilizer application rates will be appended to this GIS data set in order to assess potential effects of agricultural use on water quality and to facilitate further analysis and/or water quality modeling at a future date.

Deliverables: GIS layer containing agricultural fields with crop type and fertilizer/herbicide application rate assumptions for the Clackamas River watershed. The frequency of how often these layers will have to be updated will also be identified.

GIS analysis support for assessing threats to water quality from forestry activities: Forest cutting and herbicide/fertilizer spray application notices pertaining to properties within the Clackamas watershed will be acquired from ODOF. Cutting and spray areas will be digitized into GIS (if they cannot be obtained by the ODOF) with tabular information from the notices entered into a forest spray tracking database. Over time this will provide a means of assessing concentrations of pesticide applications on forestland and their potential threats to water quality.

Deliverables: Microsoft Access-based forestry pesticide application database and GIS data layer of spray areas and forestry activities on both public and private land

GIS analysis support for assessing threats to water quality from urban development/expansion of UGBs: County plan designation and tax assessor GIS parcel data will be combined with selected development constraints layers in order to develop a potential residential “build-out” capacity estimate, in terms of residential units, for the Clackamas River watershed.

Deliverables: A GIS build-out data layer and associated report.

GIS analysis support for assessing threats to water quality from vulnerable soils: An analysis of vulnerable soils would be completed and would include layers to evaluate erosion, runoff, landslides as well as sensitive areas such as wetlands, floodplains and water setbacks. This may also include the collection of LIDAR data from DOGAMI to identify areas where historic landslides could be reactivated by changes in land use practices, road building/alteration, and development.

Deliverables: GIS layer containing vulnerable soils in the Clackamas River watershed.

Estimated Costs: for GIS database creation and GIS analysis is approximately \$32,000 – \$60,000 for the initial construction of the GIS database. It is anticipated that periodic updates will need to

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be made every 3 – 5 years which could cost anywhere from \$5,000 - \$10,000 depending on how extensive the updates are.

III. Watershed/Pollution Load Modeling

Water quality and biological data collected through the water quality monitoring program will be used with GIS threat data layers to build a watershed model that will allow prediction of rainfall-runoff relationships, pollution load calculations, contaminant transport scenarios, and impacts due to changes in land use. This tool will allow the CRWP to analyze watershed data in a way that provides graphic results that demonstrate watershed health and allows CRWP to focus on areas of potential water quality degradation. “What if” scenarios associated with land use changes will be run to assist CRWP in prioritizing source protection efforts and to better understand long-term threats and trends in the Clackamas. Pollution load modeling will also determine what kind of water quality data is needed to support future water quality monitoring efforts.

To do this the CRWP will need to:

Look at the different kind of pollutant loading models that are available such as the MIKE Basin model. Clackamas County WES also has a pollutant load model for a small portion of the lower basin that could possibly be expanded to cover the whole watershed. In addition there are a number of modeling efforts ramping up for the 2012 update of the Willamette Total Maximum Daily Load (TMDL) (the Clackamas Basin is listed as part of the Willamette TMDL for both temperature and bacteria). This could lead to some partnering of resources. As part of this process it will be important to assess the data available to drive the hydrology modeling in the basin, as well as determine if additional rain gages are needed.

Once a pollution load model has been chosen, the CRWP will go out to bid to hire an organization to develop and run the model, as well as determine how the model will need to be calibrated. The information from this Request for Proposal process will provide budget estimates for the development and ongoing costs of calibrating and updating the pollution load modeling.

Estimated Costs for Pollution Load Modeling: Costs are dependent upon the depth and level of modeling and will be determined at a later date. Ideally some initial cost information will come out of the GIS scoping study but initial estimates are \$65,000 - \$80,000 to create the model, and \$3,000 - \$6,000 for model maintenance.

IV. Water Quality Monitoring

A key element of the Basin Analysis Subprogram is a water quality monitoring program. Water quality monitoring and the associated data will address four issues: 1) provide a baseline so the CRWP can observe water quality trends over time; 2) will be used in tandem with the GIS mapping

to verify identified hot spots; 3) be used to evaluate the relative success of restoration, other protection strategies, and BMP's over time; and, 4) will identify existing water quality monitoring gaps.

Addressing these four issues will allow water providers to evaluate water quality, biological health, and land use trends to pinpoint adverse trends that could become drinking water threats. This information will allow the CRWP to prioritize problems or threats to the drinking water source early on and target source water protection efforts based on this data. Water quality monitoring data will be used with GIS and in conjunction with hydrologic simulation and pollution loading models.

To do this the CRWP will need to:

1. Encourage and support existing monitoring programs for collection of baseline data (DEQ, USGS, WES, water providers, PGE, USFS) - fixed interval monitoring (i.e., monthly, quarterly).
2. Encourage more storm event monitoring.
3. Identify all of the existing monitoring programs in the watershed and identify gaps where the CRWP may need to do additional water quality sampling and monitoring.
4. Once monitoring gaps have been identified, the CRWP should develop additional monitoring approaches that address these data gaps. These could include the following:
 - a. Help develop a water quality monitoring plan for the whole basin.
 - b. Work with WES on developing a cooperative water quality monitoring plan and program which could include developing a storm event monitoring program for the area outside of WES service area. This would include identifying funding sources for water quality monitoring and/or writing MOUs or agreements with potential partners to do the work. Clear Creek, Deep Creek and Eagle Creek would be some of the first tributaries to target.
 - c. Develop a storm event monitoring program for a selected suite of analytes for laboratory analysis based on the land use and threat being evaluated.
 - d. Implement periodic water quality monitoring that targets specific pollution sources such as pesticides, pharmaceuticals and personal care products, disinfection by-product precursors, or hydrocarbons.
 - e. Implement water quality monitoring that verifies "hot spots" contamination potential.
 - f. Implement Performance Monitoring - this type of monitoring is associated with actual conservation, restoration, or source protection mitigation projects. The data collected as part of performance monitoring is critical to developing and evaluating source area mitigation strategies and ultimately designing treatment systems to reduce the amount of pollution entering the river.

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- g. Implement a Macroinvertebrate sampling program to establish a baseline for lower river sub-basins water quality and resample periodically.
5. Develop an information management tool to support the collection and management of water quality data.

Develop an information management tool

An integral part of the water quality monitoring element is data management, analysis, and reporting. Due to the long-term nature of a source protection analysis and water quality monitoring there is the potential for management of large data sets to clearly identify trends associated with water quality and watershed health. Therefore, development of the water quality monitoring element should include the development and implementation of an information management tool to support the collection and management of water quality data generated by the CRWP as well as from its partners.

A relational database should be developed to manage data collected as part of numerous field efforts associated with stormwater and urban runoff, shallow groundwater, river water quality parameters, bioassay and macro-invertebrate studies, stream flow, meteorological data, and industrial facility monitoring. This data would be incorporated into a centralized, SQL-compliant database (SQL Server). Additional data management modules could be added to this database as other subprograms are implemented over time. This database would provide the means to manage, analyze, and report data in support of the Drinking Water Protection Program.

In the future, this database would have the ability to interface with GIS and with hydrologic simulation and pollution loading models to further support the source water protection program. The combination of GIS and hydrologic simulation/load modeling would allow the CRWP to evaluate the effectiveness of its source water protection program and present meaningful data trends that describe the health of the Clackamas River watershed over time. One long-term benefit of using the data in a GIS/hydrologic model format is that as monitoring data is collected and the model is calibrated and refined there should be a corresponding reduction in the amount of data necessary to monitor watershed health and identify potential water quality degradation sources. This data management tool would be based off of the tool developed by EWEB.

Estimated Cost for Data Management Tool: To modify EWEB's current data model, implement the database, load Clackamas data, design a data loading and access scheme, and document the process is estimated to cost between \$35,000 and \$45,000. Estimated annual database supporting costs are approximately \$12,000 to \$20,000 a year depending on the amount of data.

Existing Monitoring Efforts

Numerous organizations, including the CRWP, currently conduct monitoring efforts on the Clackamas River. The CRWP should encourage and help support these efforts to ensure data consistency as well as a period of record long enough to draw statistically valid water quality conclusions. Continuing to work with partners will help spread basin wide monitoring costs out between numerous agencies.

The Clackamas Basin Technical Workgroup is comprised of stakeholders within the Clackamas River watershed, including DEQ, the CCSWCD, CRBC, USGS, and the water providers. The workgroup has been working to identify other organizations in the Clackamas Basin that are currently conducting, or have already conducted, water quality monitoring efforts in the Clackamas basin. A number of monitoring programs currently exist and include the Oregon DEQ ambient surface water sampling (every other month) to look at long term water quality trends, USGS' five continuous water quality gauges on the Clackamas (three of which are jointly funded by the CRWP), and the CRWP monthly samples taken throughout the watershed. These monitoring efforts are fixed interval, many involve simple grab sample collection methods (dipping a bottle into the river) and focus on limited parameters (dissolved oxygen, turbidity, temperature, conductivity, and pH). Clackamas River Water also has five sampling sites where they test monthly for orthophosphate, total phosphate, nitrite and nitrate, ammonium, and total kjeldahl nitrogen.

The limitations of these types of monitoring are that 70-90% of pollution runoff occurs during storm events and many of the contaminants that could pose drinking water risks are not covered in the suite of analytes (e.g., pesticides, organic compounds, metals) that are currently sampled for. Water Environment Services conducts storm sampling (associated with measuring effects of urban stormwater outfalls) within their service area which covers a small percentage of the Clackamas River watershed. USGS and the CRWP have funded two different Pesticide Studies in the last ten years which sampled lower Basin tributaries for pesticides and included storm sampling. The CRWP may want to consider working with its partners to implement an on-going storm sampling program to monitor pollutant loading. See Appendix B - Spreadsheet of current water quality data collection efforts in the Clackamas Basin.

The CRWP should continue to work with the Clackamas Basin Technical Workgroup to develop a Basin Wide sampling plan. This will help identify if additional water quality sampling is necessary, particularly associated with stormwater, urban runoff, and agricultural activities (especially in the Boring/Damascus area outside of WES service area), and/or to identify pollution loading or groundwater sampling in high-density septic tank areas.

Estimated Costs for Water Quality Monitoring: The CRWP currently has a Joint Funding Agreement with USGS for three water quality monitoring stations on the Clackamas. The CRWP current annual cost is around \$50,000 a year with annual increases at approximately 4-5%. Costs

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for additional water quality monitoring will depend on the nature of the efforts identified in a monitoring plan for the whole basin or for urbanizing areas outside of WES's service district and are unknown until these plans are completed. Estimated costs associated with implementation of water quality monitoring include staff time, equipment, analysis, consultant fees, and data management. The monitoring subprogram will be implemented in phases over time to reduce the financial impact. Full implementation of the subprogram may require one-time expenditures (for equipment, gauging station installation, and data management system design and set up) of approximately \$25,000 to \$90,000. Annual costs for full implementation (including consultants, analysis, equipment and gauging station O & M, and miscellaneous expenses) of the monitoring subprogram are estimated to be \$20,000 to \$90,000. These costs estimates are based upon what EWEB has done in the McKenzie River basin.

Partnerships: At this time, the CRWP enjoys active partnerships with a number of agencies and organizations and has identified others in which partnerships could be developed as the Basin Analysis subprogram is implemented. Current partners include:

1. *Clackamas River Basin Council.* The CRWP has worked with CRBC to implement a Pesticide Reduction Program as well as provide operational support so CRBC can be an active member in watershed protection efforts. CRBC is in the process of receiving a 319 grant to begin a water quality sampling program on lower river tributaries. This effort will help expand the basin wide water quality monitoring efforts. If the CRWP decided to implement additional monitoring in the future, CRBC may be able to assist in working with community members and property owners for access and to accept CRWP's monitoring subprogram.
2. *Water Environment Services.* The CRWP should continue to coordinate with WES regarding storm sewer and stormwater channel monitoring program. The CRWP could potentially assist in expanding their current monitoring program including GIS needs. This could be done through CRWP funding joint funding with WES, and/or finding other ways to leverage funding to pay for new water quality monitors.
3. *US Geological Survey.* The USGS and the CRWP jointly fund three water quality monitors on the main stem of the Clackamas, in addition to completing of a number of water quality studies. In these efforts USGS can often match funding (40/60% split).
4. *Oregon DEQ.* DEQ has provided technical support and is involved in doing the ambient monitoring on the Clackamas River. DEQ may be able to offer other assistance with regard to analytical services and source protection.
5. *Clackamas County Soil and Water Conservation District.* The CRWP has a good relationship with the CCSWCD and should pursue water quality monitoring projects that would benefit both organizations and share the funding burden.

6. *PGE*, the CRWP has been an active participant in the PGE FERC relicensing of the Clackamas project. The monitoring efforts by PGE being conducted under the new FERC license will be a valuable source of information and data.
7. *High Schools*, the CRWP has a relationship with a number of Clackamas High School teachers and should work with teachers and students at other CRWP High Schools to implement water quality sampling and macroinvertebrate and stream bioassessment surveys to further expand water quality monitoring efforts in the Basin.
8. *Volunteer Monitoring*, the CRWP should consider establishing a volunteer monitoring network that would meet quality assurance requirements. This would allow for additional monitoring for a lower cost.

Funding Opportunities: Currently there are not many grant or other funding mechanisms to pay for monitoring costs. It may be possible to use 319 Nonpoint Source Implementation grants through EPA/DEQ for monitoring. Some funding may be able to be leveraged through the partnerships discussed above, specifically, DEQ, USGS, NRCS, Willamette TMDL work, and possibly future EPA programs.

Long term goal: to have the data and tools to determine if water quality is improving over time and if mitigation strategies are successful. By utilizing GIS data, monitoring data, and hydrologic/hydraulic model simulations, conservation, restoration, mitigation scenarios can be investigated, data gaps identified, and proposed efforts can be tested prior to implementation to determine the most cost effective way to achieve CRWP's goals. The time spent doing this will ensure the long term viability of the conservation, restoration, mitigation efforts and will result in lower maintenance/operations costs and a higher level of project success. One or all of the above elements of the Basin Analysis subprogram will help inform the CRWP regarding the state of the watershed and will provide information to help prioritize or reprioritize the mitigation strategies that are outlined below. The prioritization process for the mitigation strategies and programs for the 5 and 10 year implementation/workplan are outlined later in this document.

2) Education and Research Assistance Subprogram

Objective: The objective of this subprogram is to encourage and promote the education of students, research issues related to watershed health, and protection of the Clackamas River as a valuable resource. The benefits of supporting the education of elementary, middle, and high school level students in understanding the various water quality, biological, and cultural issues that surround the health and future of the Clackamas River are numerous and far reaching. The CRWP benefits in the short-term by having students conduct water quality and biological monitoring to support the source protection program. The long-term benefits are that this curriculum helps

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educate the younger generation on the importance of these issues and promotes a sense of stewardship among the youth. It should also help to promote future professional interest in watershed topics. This subprogram also ties into Public Outreach and Sharing efforts discussed later in the plan.

Scope: Expand the current Water Conservation Programs' youth education program to include watershed health and protection issues. Working with University Research programs to better understand watershed functions, biological processes, and how to best apply restoration and mitigation strategies is an important part of this strategy. Research in the watershed will provide an excellent source of detailed data and information. The specific components of this subprogram include:

1. *CRWP Elementary and Middle schools.* The CRWP already has an active water conservation program that currently works with CRWP schools to provide free water conservation presentations and resources. This program can easily be expanded to include water quality and watershed related issues such as stream health, environmental quality of water, wetlands, river health, and could include for example, programs such as storm drain stenciling.
2. *CRWP High Schools.* The CRWP should build on the current youth education program with high school water science, biology, and chemistry programs to encourage teachers to conduct water quality, macroinvertebrate, and bioassessment survey work on the lower tributaries of the Clackamas as a part of their ongoing curriculum. This will provide students a comprehensive educational experience regarding water quality, aquatic habitat, stream morphology, riparian functions, and laboratory analysis associated with the health of watersheds. The CRWP should work with teachers on QA/QC procedures to make sure the data can be used to model pollution loadings, conduct trend analysis, and identify problem areas. This further benefits the students as they become involved in how their work and data are applied to solve real life problems. The CRWP should also pursue working with the PSU Student Watershed Research Project. The Student Watershed Research Project (SWRP) involves teachers, middle and high school students, scientists, businesses, governmental agencies, community groups, and metropolitan schools in Portland, Oregon, and Vancouver, Washington, in watershed education and collection of quality data. Working with SWRP most likely would mean contributing funding support to expanded SWRP water quality sampling efforts in the Clackamas River basin.

http://www.swrp.esr.pdx.edu/teacher_info/newteacher.htm .

3. *Research Assistance Program.* The CRWP and its partner organizations should work with local universities (Portland State University, University of Oregon, Oregon State University, Clackamas Community College and Portland Community College, Washington State University Vancouver Campus and University of Portland) to promote research and graduate work in the watershed. For this to be successful, the CRWP and partner

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organizations (USFS, USGS, BLM, DEQ, Clackamas County, EPA, and others) would identify issues or problems in the watershed that graduate research could provide direct benefit, communicate with universities to find graduate or undergraduate programs that match the issues or problems, and offer research grant funding for universities to conduct research. The Portland State University Senior Capstone project for all undergraduates is one example of how the CRWP could work with Universities to tie in basic monitoring and data analysis.

4. *Areas of Potential Study.* There are a number of areas that will require additional study that could utilize local universities or other CRWP partners. They include additional flow modeling on the lower basin, ensemble modeling, climate change studies, carbon studies, taste and odor/algal studies, ground water studies, additional flow balance studies, studies looking at the difference between treatment processes, how hydrocarbons get into the water, macroinvertebrate studies, and land use change modeling.

Existing Education Programs: As previously mentioned the CRWP has a strong educational program for elementary school students (and is in the process of developing a more robust program for middle and high school students). The goal of this program is to engage students regarding water conservation issues so they begin to develop positive water use behaviors.

The CRWP has been working with PSU for a number of years on modeling the impact of water provider withdrawals on flows. Additional investigation is necessary to explore the various graduate programs at the local universities to begin communication with these professors to promote research.

Partnerships: The CRWP currently has a solid partnership with CRWP schools to promote water conservation and these efforts can be expanded to include water quality and biological monitoring efforts. This could be expanded once problem areas are identified in the creek basins to look at mitigation or treatment techniques and involve students in implementation of natural filtration systems (i.e., wetlands, bioswales, etc.). The CRWP has developed partnerships with PSU and Clackamas Community College, in addition to Clackamas County, USFS, DEQ, and the USGS and could explore cooperative efforts to fund and promote research in the Clackamas River watershed. Other partnerships would need to be established with University of Oregon, Oregon State University, University of Portland, Washington State University Vancouver and other higher learning institutions, EPA, USDA, ODA, BLM, ODOF.

Estimated Costs: The annual cost associated with the CRWP source protection program support of CRWP schools is estimated to be \$2,000 to \$5,000. Costs associated with research grants would depend on the degree of partner involvement, university funding, and nature of the research.

Financial support for the SWRP is estimated to be \$6,000 - \$10,000 annually. An estimated \$15,000 to \$30,000 per year could be used for budget purposes.

Funding Opportunities: There are a number of grant opportunities for education programs and research. Through effective partnerships the CRWP, school districts, and universities could be successful in obtaining these grant funds which would alleviate the need for the CRWP to actually contribute funds toward research projects. Many potential grants require matching funds which would need to be budgeted in the CRWP Budget. The following is a summary of known potential funding sources:

1. *Environmental Education Grants Program (US EPA).*
<http://www.epa.gov/enviroed/grants.html>
 - a. Goal. To support environmental education projects that enhance the public's awareness, knowledge, and skills to make informed and responsible decisions that affect environmental quality.
 - b. Funding. Grants issued by EPA's Region 10 office range from \$3,000 to \$25,000. Grants issued from EPA HQ's office range from \$35,000 to \$125,000. A total of \$2 to \$3 million is available, which is typically awarded to 15-20% of the applicants.
 - c. Limitations. Grantees must provide non-Federal matching funds of at least 25% of the total project costs.
 - d. Due Date. Typically December of each year.
2. *Science to Achieve Results Program (US EPA)*
http://www.epa.gov/ncer/rfa/2009/2009_star_gradfellow.html
 - a. Goal. The Science to Achieve Results or STAR program funds research grants and graduate fellowships in numerous environmental science and engineering disciplines through a competitive solicitation process and independent peer review. STAR is focusing on the health effects of particulate matter, drinking water, water quality, global change, ecosystem assessment and restoration, human health risk assessment, endocrine disrupting chemicals, pollution prevention and new technologies, children's health, and socio-economic research.
 - b. Funding. Funding varies depending on the type of research grant or fellowship
Anticipated Type of Award: Fellowship
Estimated Number of Awards: Approximately 120 awards
Anticipated Funding Amount: Approximately \$4.5 million for all awards
Potential Funding per Fellowship: \$37,000 per year per fellowship. Master's level students may receive support for a maximum of two years. Doctoral students may be supported for a maximum of three years, usable over a period of four years. Cost sharing (matching funds) is not required.
 - c. Limitations. Must meet research requirements as outlined by EPA. Need to partner with a university or college.

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- d. Due Date. Typically August - October each year.
- 3. *National Integrated Water Quality Program (USDA)* <http://www.csrees.usda.gov/fo/waterqualityicgp.cfm>
 - a. Goal. The goal of the National Integrated Water Quality Program is to improve the quality of our Nation's surface water and groundwater resources through research, education, and extension activities. Projects funded through this program will facilitate achieving this goal by advancing and disseminating the knowledge base available to agricultural and rural communities. Funded projects should lead to science-based decision-making and management practices that improve the quality of the Nation's surface water and groundwater resources in agricultural and rural watersheds.
 - b. Funding. Grants issued by USDA for amounts up to \$660,000.00. A total of \$12 million was available for funding 2009 projects.
 - c. Limitations. If commodity-specific benefits, dollar-for-dollar funding match required. Need to partner with a university or college.
 - d. Due Date. Typically July of each year.
- 4. *Sustainable Agriculture Research and Education (USDA)* <http://www.sare.org/grants/>
 - a. Goal. To facilitate and increase scientific investigation and education to reduce the use of chemical pesticides, fertilizers, and toxic materials associated with agricultural practices. This may include design and implementation of best management practices, education, pollution prevention measures, and partnerships among farmers, nonprofit organizations, agribusiness, and public and private research institutions.
 - b. Funding. Ranging from \$30,000 to \$150,000 or more, these grants fund projects that usually involve scientists, producers, and others in an interdisciplinary approach.
 - c. Limitations. No match needed but would need to partner with a university or college.
 - d. Due Date. Typically November – December of each year.
- 5. Water Research Foundation (formerly part of AWWA) <http://www.waterrf.org/Pages/WaterRFHome.aspx>
 - a. Goal. The Water Research Foundation is a member-supported, international, nonprofit organization that sponsors research to enable water utilities, public health agencies, and other professionals to provide safe and affordable drinking water to consumers. The mission of the Water Research Foundation is to advance the science of water to improve the quality of life.
 - b. Funding. Depends on the program, up to \$150,000 for Tailored Collaboration programs.
 - c. Limitations. Most proposals need multiple partners.
 - d. Due Date. Proposal are excepted throughout the year

Other funding mechanisms may exist and will be more thoroughly researched and discussed during implementation of the source protection program.

Long Term Goal: Have high school students, higher learning institutions, or volunteer organizations help conduct water quality and biological monitoring to support the source water protection monitoring program.

3) Point Source (Water Quality and other Permits) Evaluation and Mitigation Subprogram

Objective: The objective of the point source subprogram is to inventory, track, evaluate, and monitor point sources (water quality and other permits) of potential pollution to understand these potential threats and work with regulatory agencies, facilities, and permittees to reduce the potential threat to drinking water. Modeling identified in the Basis Analysis Subprogram (hydrology with CE-QUAL-W2) will also be used to evaluate risks and responses to Point Sources. This includes looking at the following types of permits: 1) National Pollution Discharge Elimination System (NPDES) permits for wastewater treatment, fish hatcheries, water pollution control facilities, sand and gravel mining, and stormwater which include MS4 permits, 1200A, 1200C, 1200Z, and UIC permits 2) Confined Animal Feeding Operations (CAFO) permits, 3) above and below ground storage tanks permits, 4) PGE Dam permits and licenses, and 5) other permits such as air contaminant discharge permits. Much of point source pollution is regulated under the Clean Water Act through National Pollution Discharge Elimination System (NPDES) permits but there may be other types of permits that will be worth the CRWP tracking in the future. The risks associated with these kinds of point sources/permits include spills, and contaminant releases to groundwater and surface water.

See Appendix C for a list of the water quality permits identified within the Clackamas River watershed. Tracking and participating in the public comment process for these permits provides the CRWP an opportunity to emphasize local issues (such as drinking water quality) as the permits and new management plans are written. Permits and best management practices are the main tools used for controlling these sources of pollution.

Scope: The following is a summary of the various tasks and components associated with point source/permit evaluation and mitigation which could be done in partnership with one or more organizations such as Clackamas County's WES, or done separately by the CRWP:

1. *Inventory.* Obtain from DEQ an inventory of all the water quality and other permits for commercial and industrial facilities, permitted stormwater discharges, and other point source dischargers within the Clackamas River watershed. These permits will be located and the information housed in a GIS for spatial analysis and tracking.
2. *Evaluation and Tracking.* The CRWP will compile a database to evaluate all water quality permits and potential threats (NPDES permits, air quality permits, spills, hazardous material

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use and storage, etc.) posed by these point sources. Permit requirements and monitoring reports will be reviewed and tracked to identify potential problem areas. The CRWP will participate in the public review and comment period associated with the various permit renewals. This information will be tracked and evaluated using GIS to allow the CRWP to identify permits and facilities that have the potential to pose a higher risk to drinking water supply.

3. *Mitigation.* Based on facility type, waste management practices, permit requirements, permit compliance reports, results from additional water quality monitoring, and other information, permit holders or areas will be targeted for mitigation. Mitigation would consist of a number of different options that would lessen the potential impact to drinking water. For all categories of permits mitigation strategies could include:
 - a. Review and comment on permits to see if there could be an impact on drinking water quality.
 - b. Look at ways to enhance permit requirements.
 - c. Increased monitoring of the discharge itself.
 - d. The CRWP should become a member of the Pollution Prevention P2 team <http://www.ecobiz.org/aboutP2.htm> and support Eco-Biz Business Certifications. Pollution Prevention Outreach Team (P2O), consists of staff from the Cities of Portland, Gresham, and Troutdale, Clackamas County WES, Metro, DEQ, Clean Water Services, and Washington County. The P2O Team provides incentives for businesses that reduce, reuse, and recycle various waste streams.
 - e. Develop a recognition program for those business that take voluntary actions to improve water quality.
 - f. See more specific strategies by permit listed below.
4. *Education, Outreach, and Lobbying.* Provide, in tandem with DEQ, education and outreach to various facilities and permit holders regarding the potential degradation to community water supplies that could result from poor waste management and handling practices. Provide alternatives to hazardous material use and offer assistance (technical or financial) to change to eco-friendly practices. Educate facility owners on treatment options for stormwater runoff. Track potential regulations and encourage/influence laws and regulations that benefit protection of Clackamas River from facility pollution. This could also include following or participating on Advisory Committees such as the Greywater Advisory Committee or the Septic System Advisory Committee. In addition the CRWP should continue to support 3 Basin Rule protections for the Clackamas River.
5. *Notification.* Create a CRWP ‘notification policy’ to allow above organizations and facilities to call one number to notify all CRWP members of a spill, overflow, or contamination event. See the Section 5 Disaster Preparedness and Response Program on page 56 for more details.

A. NPDES Permits – wastewater treatment plants: There are three domestic wastewater treatment plants that discharge effluent into Clackamas River tributaries. They are the City of Estacada, City of Sandy and the Boring sewage treatment plant operated by Clackamas County Service District #1. In addition, the USFS Timberlake facility has a sewage treatment plant. Potential mitigation activities include the following:

- a. Review and comment on water quality permits for wastewater treatment plants as well as the supplemental management plans for biosolids and recycled water.
- b. Improve notification protocols for wastewater spills and sanitary sewer overflows (SSOs) by working with DEQ, Clackamas County WES, and the Cities of Sandy, and Estacada to review the protocols.
- c. Provide watershed residents outreach materials with information on proper pharmaceutical and household hazardous waste disposal methods as well as reduction of overall toxic chemical use (addressing other “emerging contaminants”).
- d. Support Drug Take Back Event(s) to properly dispose of pharmaceuticals.

B. NPDES Permits – fish hatcheries: There are two fish hatcheries located in the Clackamas watershed.

- a. Review fish hatchery NPDES permits including reviewing the facilities’ effluent discharges and chemical use to see if these could impact drinking water quality.
- b. Determine if there is the need for hatchery effluent monitoring for nutrients, BOD and pharmaceuticals (antibiotics). Based on monitoring results, management options to recycle water and otherwise minimize the release of hatchery water may be considered.
- c. Contact DEQ to inquire about the status of existing permits for identified facilities and if they are in compliance or not. Request compliance inspections and technical assistance for high risk facilities.
- d. Contact permittees and operators to talk to them regarding the location of their systems within the Clackamas drinking water protection area as determined by DEQ, and provide them with educational and technical resources to encourage them to use Best Management Practices.

C. NPDES Permits – other general permits (GEN01, 02, 14A and 14B): There are a number of general NPDES permits in the Clackamas watershed that cover industrial wastewater and food processing.

- a. Review permits to see if there could be an impact on drinking water quality.
- b. Contact DEQ to inquire about the status of existing permits for identified facilities and if they are in compliance or not. Request compliance inspections and technical assistance for high risk facilities.

- a. Contact permittees and operators to discuss the location of their systems as it relates to the Clackamas drinking water protection area. Educational and technical resources could be provided to encourage them to use Best Management Practices.

D. NPDES Permits – sand and gravel mines (GEN10 and 1200A):

- a. Identify mines and gravel pits within the Clackamas River Watershed to determine if they are active or not.
- c. Contact DEQ for permit and compliance status of identified facilities. Request compliance inspections and technical assistance for high risk facilities.
- b. Review mining NPDES permits including reviewing the facilities' discharges to see if these could impact drinking water quality.
- c. Contact DOGAMI to ensure that permitting staff is aware that the Clackamas River is a drinking water source before authorizing new mining permits. Request they do compliance inspections or provide technical assistance to mines in areas that are considered critical for drinking water protection.
- d. Contact mine owners and operators to discuss the location of their mines as it relates to the Clackamas drinking water protection area. Educational and technical resources could be provided to encourage them to use Best Management Practices.

E. NPDES Permits – stormwater (MS4, 1200Z, 1200C): There are two MS4 permits applicable in the area (only public pipes within Metro's UGB) held by Clackamas County and Incorporated Cities and a second for ODOT. The 1200 permits are general stormwater permits held by businesses and industry. Unpermitted stormwater will be addressed in the Non-point Source section of the Plan and many of the mitigation strategies for permitted or nonpermitted stormwater will be similar if not the same.

- a. Review and comment on MS4 permits.
- b. Work with WES and ODOT to understand how they are implementing their MS4 permits and where the CRWP can provide encouragement or pressure to do better. This would include engaging in WES' Stormwater Management Plan and their Watershed Action Plan for Rock Creek (see <http://www.riverhealth.org/ws-overview.cfm>). To do this the Water Resource Manager will meet periodically with the WES SWM Steering Committee and the WES WQ Analyst to coordinate updates and track progress on these efforts.
- c. WES and ODOT will be encouraged to reduce and/or cap stormwater pollution.
- d. Encourage WES, Clackamas County, and all Cities in the watershed, to periodically conduct dry weather field screening at all storm sewer outfalls in order to detect and control illicit discharges.
- e. Encourage WES to conduct more frequent inspections of commercial, multi-family residential and industrial facilities to control illicit discharges and to improve stormwater runoff quality.

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- f. Identify individual facilities, or areas with a concentration of facilities with 1200 permits, and encourage them to construct on-site and/or off-site treatment systems or buffers (e.g., wetlands, bioswales, retention ponds, etc.) and identify resources and/or partners that could help provide incentives to get these kinds of treatments implemented.
- g. For 1200Z permittees the CRWP should consider contacting permit holders to encourage them to reduce their stormwater pollutant concentration.
- h. For 1200C permittees the CRWP should encourage WES, which administers this permit as DEQ's agent in much of the county, to continue to reduce pollutant levels in discharges from 1200C permitted sites and enforce Erosion and Sediment Control Plans for construction projects.

F. Water Pollution Control facilities permits (WPCF) for domestic wastewater: These are larger permitted septic sewer systems. Smaller septic systems not all of which are permitted and are addressed in the Non-point Source Section of the plan.

- a. Review and comment on WPCF permits for any impact to drinking water quality.
- b. Contact permittees and operators discuss the location of their systems as it relates to the Clackamas drinking water protection area. Educational and technical resources could be provided to encourage them to use Best Management Practices.
- c. Mitigation strategies listed for smaller non-permitted septic systems would also be appropriate for these larger systems. See the Non-point source section for more details.

G. Confined Animal Feed Operation (CAFO) Permits – GEN01: There are three permitted CAFOs within the Clackamas watershed.

- a. Review and comment on CAFO permit renewals, as part of the public comment process, to make sure that Animal Waste Management Plans are protective enough of the drinking water supply.
- b. Contact individual CAFO owners to ensure that their emergency response programs establish adequate spill notification methods with the CRWP and that Animal Waste Management Plans are protective of the drinking water supply.

H. Above and Below Ground Storage Tank Permits: Commercial underground storage tanks (USTs) holding more than 110 gallons and farm or residential USTs holding more than 1,100 gallons of motor fuel for noncommercial purpose must register the UST and have an operating permit. For above ground storage tanks (ASTs) a permit is required for the storage of flammable or combustible liquids above ground in excess of 1,000 gallons in either individual or aggregate quantities as specified in the Oregon Uniform Fire Code Section 7901.3.2. These permits are overseen by the State Fire Marshall. Non-regulated tanks (farm and heating oil tanks) and AST's will be addressed in the non-point source section. The Source Water Assessment identified a number of these within the drinking water protection area.

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- a. Review and comment on these types of permits, as part of the public comment process, to ensure they are protective enough of the drinking water supply. Due to the number of these permits, GIS analysis should be used to identify only those permits in high risk areas (potential impacts to groundwater could impact surface water supplies, proximity to river or tributaries, etc).
- b. Begin a dialog with individual, commercial, and industrial facilities, or areas with concentration of facilities, regarding reducing hazardous chemical use and storage to protect water quality. This could be done via dissemination of brochures, through mailings, or via the CRWP website.
- c. Establish a list of commercial/industrial users along the Hwy 212/224 corridor for outreach and education, in partnership with DEQ and WES, regarding pollution prevention using data obtained from DEQ. Send letters to individual owners/operators encouraging them to use best management practices for drinking water protection and provide them with information on pollution prevention.
- d. Facilitate employee training workshops on proper spill cleanup, catch basin maintenance, and waste reduction to raise awareness of drinking water and potential impacts from mismanagement of hazardous waste.
- e. Work with permittees to ensure they have proper spill response and notification plans. See the Disaster Preparedness and Response Subprogram.

I. PGE Hydroelectric Permits and FERC license: The CRWP has been an active participant representing the water providers in PGE's FERC relicensing process which includes a 401 certification.

- a. The CRWP should continue to be involved in this process as well as continue to be an active participant in post license activities.
- b. Continue to be a part of the PGE's Blue Green Algae team which oversees a blue green algae sampling program and is trying to correlate PGE operations with taste and odor events.

J. 401 Water Quality Certifications and Section 404 Permits: A 401 Water Quality Certification (WQC) is required as a component of any federal action that has the potential to result in a discharge to waters of the state. In Oregon, these federal actions are typically Federal Energy Regulatory Commission (FERC) hydropower projects, U.S. Coast Guard (USCG) projects, or U.S. Army Corps of Engineers (Corps) Section 404 permits. These permits authorize activities altering waters of the U.S. and may also require state removal-fill permits issued by the Department of State Lands (DSL). Evaluate existing permits, and participate in the public process for changes to these permits or on new permits. See PGE FERC license above.

K. Underground Injection Control (UIC) Program: Injection systems are any man-made design, structure, or activity which discharges below the ground or subsurface. Common uses include: stormwater discharge, industrial/commercial and process waste water disposal, large domestic onsite systems and cesspools, sewage drill holes, aquifer remediation systems, motor vehicle waste disposal, agricultural drainage, geothermal systems, aquifer recharge (AR), and aquifer storage and recovery (ASR). Common designs include drywells, trench drains, sumps, perforated piping, floor drains, drain fields and drill holes. Any actions would be focused on areas where groundwater recharge could impair surface water. DEQ is currently developing templates for writing UIC WPCF Municipal and Industrial/Commercial permits <http://www.deq.state.or.us/wq/uic/uic.asp> .

L. Solid Waste/Composting Permits: These types of permitted facilities include: compost, municipal solid waste (disposal) landfills, material recovery, transfer stations, waste tire and household hazardous waste. Evaluate existing facilities and comment on changes or new facilities. DEQ is currently permitting composting facilities under fairly recently adopted rules. <http://www.deq.state.or.us/lq/sw/disposal/permittedfacilities.htm>

M. Air Contaminant Discharge Permits: In the future the CRWP may want to look at air quality permits for the Portland metro area to determine if air quality has an impact on water quality issues. If decided there is a relevant correlation then, the CRWP should track and comments on these types of permits as they do for other types of permits.

Partnerships: The CRWP should establish and enhance its partnerships with critical agencies that regulate sources of pollution (EPA, DEQ, Fire Marshall, WES and the Cities in the watershed). DEQ offers a hazardous waste technical assistance program, which has been very successful in targeting geographic areas to provide assistance to facilities to reduce hazardous material use and wastes. In addition, The CRWP should consider becoming an active member of the Pollution Prevention Outreach Team (P2O). A number of other partnerships would be pursued as the subprogram develops (Clackamas County, individual facilities, etc.).

Estimated Costs: The CRWP's costs for implementation of the point source evaluation and mitigation subprogram would mainly be associated with staff time and database/GIS design and use. Since staff time is already accounted for in the source protection budget and GIS is used with many of the other source protection programs, the costs are minimal for this subprogram. Additional costs may be associated with education and outreach, increased monitoring downstream of high priority facilities, design and implementation of BMPs, restoration, or other mitigation projects. Costs would depend on the level of cooperation and financial commitment with individual facilities and other partners. The following are estimates based on the assumption that facilities and partner organizations do not contribute a significant amount of funding to these efforts:

1. Approximately \$5,000 to \$11,000 per year for additional staff time, and GIS/database related costs.
2. Increased monitoring at high priority facilities may require \$11,000 to \$30,000 for analysis, equipment, and additional staff time.
3. Design and implementation of mitigation projects could range from \$30,000 to \$150,000 depending on the scope and scale of the project. Ongoing O & M costs associated with these projects are assumed to be covered by individual facilities and/or partner organizations. If not, it is estimated that approximately 15% of total project costs would be needed for annual O & M activities and performance monitoring.
4. Outreach to permittees and participation in the P2O group are expected to cost around \$4,000 annually.

Funding Opportunities: A number of grants, technical assistance, and other revolving loans exist to assist facilities and/or the CRWP with evaluation and mitigation of point sources of pollution. The following is a summary of known funding sources associated with point source investigation and mitigation.

1. *National Integrated Water Quality Program (USDA)*. See description under Education and Research Assistance Program.
2. *Water Quality Cooperative Agreements (US EPA)*.
<http://www.epa.gov/OWM/cwfinance/waterquality.htm>
 - a. Goal. To support the creation of unique and new approaches to meet stormwater requirements. Among the efforts that are eligible for funding are research, investigations, experiments, training, surveys, environmental technology demonstrations, and studies related to the causes, effects, extent, and prevention of pollution.
 - b. Funding. Unknown at this time.
 - c. Limitations. While cost sharing is not required, EPA will consider an applicant's offer to voluntarily share cost or leverage other resources. Cost shares must be comprised of eligible and allowable cost. Applicants may also discuss how EPA funding will leverage other resources, even though the leveraged resources would not be eligible and allowed cost, e.g. construction of a building
 - d. Due Date. Applications are accepted on an ongoing basis.

4) Nonpoint Source Evaluation and Mitigation Subprogram

Objective: The objective of the nonpoint source subprogram is to inventory, track, evaluate, and monitor nonpoint sources of potential pollution. Modeling identified in the Basin Analysis Subprogram will help define and provide a better understand nonpoint source risks and potential

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mitigation strategies. Stormwater runoff from urban and rural areas, and from agricultural and forestry activities is the biggest contributor to nonpoint source pollution in the Clackamas watershed. It is also important to understand the impact of septic systems and recreational uses (boats and floaters) and other nonpoint source pollution sources in the Clackamas watershed as potential drinking water threats; and to work with regulatory agencies, land owners, and business groups to implement best management practices and mitigation strategies to reduce the potential threat to drinking water. Much of the urban stormwater runoff within the UGB is regulated and is addressed in Chapter 3 Point Source/Permit section of the plan for permitted stormwater.

Scope: The following is a summary of the various tasks and components associated with nonpoint source evaluation and mitigation. In addition there are specific mitigation strategies outlined for each nonpoint source pollution category.

1. *Inventory.* Review, and update if necessary, DEQ's Source Water Assessments inventory of potential nonpoint source areas of pollution within the Clackamas River watershed. Areas of nonpoint source pollution would be mapped and the information stored in the GIS site, as part of the GIS Assessment Identified in the Basin Analysis, for spatial analysis and tracking.
2. *Evaluation and Tracking.* Evaluate and track activities associated with nonpoint source pollution such as pesticide use and application schedules, crop types and cycles, forest management activities, building permits with septic systems, evaluation of high risk areas due to septic system density, age and past failure rates. The comprehensive monitoring subprogram will provide good information on the actual impacts from these activities. This information will be tracked and evaluated using GIS to allowing the CRWP to identify high-risk areas (areas that are already impacted as well as those at risk for impact).
3. *Mitigation.* Based on the scope of the potential problem, type of nonpoint source, results from the comprehensive monitoring subprogram, and other information, hot spot areas will be targeted for mitigation. Hot spots are defined as sensitive areas such as flood plains, highly permeable soils, thin soils, high slopes, areas in close proximity to Clackamas River and its tributaries, or in areas where risk is clustered (numerous risks in a small geographical area rather than spread out). Mitigation would consist of a number of different options that would lessen the potential impact to drinking water, such as:
 - a. Increased water quality monitoring in impacted and/or high priority areas to verify and monitor impacts.
 - b. Encourage landowners and DEQ, ODF, ODA, CCSWCD, CRBC, WES and the County to implement Best Management Practices (BMPs). BMPs are typically established by an agency depending on their management goals. The CRWP could also work with these organizations to enhance existing BMPs or to develop new ones.
 - c. Identify and implement (potentially fund) projects to enhance riparian functions in the vicinity of nonpoint source problem areas to increase filtering capabilities and stream health.

- d. Identify landowners and/or business associations and encourage them to construct on-site and/or off-site treatment systems or buffers (e.g., wetlands, bioswale, retention pond, etc.). Identify resources (technical assistance) and/or partners that could help provide incentives (funding or grants) to get these kinds of treatments implemented.
 - e. Additional targeted nonpoint source mitigation programs are noted below.
4. *Education, Outreach, and Lobbying.* Provide education and outreach to the various groups that represent the activities associated with nonpoint sources (agricultural industry, forestry industry, builder and developer associations, etc.) regarding the potential degradation to community water supplies that could result from poor practices and provide information and assistance for implementing BMPs. Educate landowners and business organizations on reduction of, and treatment options for, stormwater runoff. Track potential regulations and encourage/influence laws and regulations that benefit protection of Clackamas River from nonpoint sources of pollution. Support and publicize model agricultural practices, forest practices, and stormwater management plans that protect water quality and habitat. Share this information with involved partners, land managers, and government agencies.

A. Unpermitted Urban Stormwater Runoff: Urban runoff to the Clackamas River is one of the most significant threats to the CRWP's water source. Urban runoff can contain elevated concentrations of fecal coliform bacteria, petroleum hydrocarbons, sediment, metals, nutrients, pesticides, chlorides, poly aromatic hydrocarbons, and other organic compounds. Storm water runoff can be reduced and controlled through low impact development (LIDs) practices, proper drainage design, best management practices and state-of-the-art stormwater management techniques. The CRWP should work with organization such as WES and DEQ to analyze and map current conditions of stormwater channels and receiving creeks and help develop mitigation strategies. Many of the urban stormwater mitigation activities will be similar or the same as those found in the Point Source/Permit section of the plan for permitted stormwater. These could include:

- a. Work with WES on stormwater and urban runoff monitoring and provide support on implementing their Storm Water Management Plan and their Watershed Action Plan for Rock Creek as required by their MS4 permit. See the Point Source/Permit Section on page 35 for more information.
- b. Work with WES and the planning departments of the Cities in the watershed to encourage wider and more fully functioning riparian buffers and the implementation of riparian best management practices to enhance the function of degraded buffers.
- c. Promote or provide technical assistance regarding sustainable and low impact development practices (such as green streets) within the Clackamas Urban Growth Boundary to reduce stormwater discharge volumes and pollutant loads. This could be done through support of the "Nature in the Neighborhood" workshops and/or helping develop new ordinances.

- d. Strive to obtain reduced stormwater volumes and pollutant levels in the watershed's urban areas through the use of best management practices over time (detention ponds, retention ponds, vegetated swales and filter strips, urban forestry, street cleaning, eco-roofs). This could include developing incentive programs to encourage voluntary implementation of these types of best management practices.
- e. Visit and/or make contact with the Cities of Estacada, Damascus, Happy Valley and Sandy to understand their stormwater practices and suggest how they could be enhanced.
- f. Encourage partners to enhance implementation of erosion and sediment control programs. This could be through technical assistance, providing funding or identifying other resources.
- g. Identify commercial and industrial customers with large manicured landscapes including golf courses and State, County, and city parks and facilities within the watershed and work with them to decrease fertilizer and pesticide use and to implement Integrated Pest Management methods. This could include facilitating and/or providing training for these users.
- h. Refer businesses and citizens to the P2O Team's Ecobiz Certified Landscape program. See Section 3 page 35 for more details.
- i. Facilitate workshops geared for parks, maintenance facilities, nurseries, etc. on chemical applications, pollution prevention and waste reduction, and proper chemical use, storage, and disposal.
- j. Continue to conduct workshops such as Naturscaping, Rainwater Harvesting, and Golf Course Quality Lawns for the community. The CRWP is currently implementing these kinds of workshop in partnership with the Clackamas County Soil and Water Conservation District.
- k. Look for ways to support (financially or otherwise) Clackamas River Basin Council efforts to enhance riparian areas in the vicinity of these facilities or permittees to increase filtering capabilities and stream health.
- l. Support financially or through grants a Doggie Doo? Doggie Don't program to supply county and city parks with boxes that hold plastic bags for pet waste scooping.
- m. Educate the watershed community about the impacts that stormwater runoff has on the water quality of the Clackamas River. See Public Outreach and Information Subprogram.

B. Rural runoff in unincorporated areas: Run off in unincorporated residential rural areas can lead to turbidity, erosion, and bacteria that can impact water quality. To better understand these potential impacts the CRWP should:

- a. Develop education and outreach materials for rural residents including: promoting proper household hazardous waste and pharmaceutical disposal, encourage best management practices for pesticide use, storage and application, aboveground and underground storage tank operation, maintenance and leak prevention, private well maintenance, septic system operation/maintenance, and animal waste management.

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- b. See if private wells are a conduit to groundwater pollution in areas where groundwater recharges surface water. Encourage well registration and proper well maintenance. This could also include incentives to ensure proper well abandonment.

C. Agricultural Mitigation Programs: Agricultural activities within the Clackamas Basin are characterized by a high diversity of crops on small acreages. It is important to develop long-term relationships with growers, local and regional markets, local agricultural agencies, watershed stakeholders, universities, and others to reduce chemical use while increasing the economic vitality of the Clackamas River watershed agricultural community as valuable stewards of the watershed. Voluntary programs and best management practices are the most effective tools for controlling agricultural nonpoint source pollution. This program would include:

- a. Identify and map crop types in the Clackamas Basin using aerial photography, GIS analysis and ground truthing to develop a baseline inventory of agricultural activities in the Clackamas watershed.
- b. Conduct an initial analysis of crop types, potential fertilizer and pesticide use based on crop type, soil type, and proximity to surface water bodies to highlight agricultural areas that have a higher potential for storm runoff to be contaminated by fertilizers and pesticides.
- c. Conduct a windshield survey of agricultural lands and inform SWCDs and ODA about potential WQ concerns (or consider contract with SWCD to do the survey?) within drinking water supply areas
- d. Determine if additional water quality monitoring would be appropriate in high priority areas. Also determine the ideal frequency for additional pesticide monitoring.
- e. Identify areas where buffer strips (or riparian restoration) could be installed or enlarged to capture runoff from agricultural lands.
- f. Provide agriculture landowners with information on recycling and reusing water from irrigation as well as look at agricultural ponds for potential impacts on water quality. Bring watershed stakeholders, agricultural agencies, universities, and grower/landowners together to share information and engage in meaningful discussion on current agricultural activities in the watershed and ways to assist growers while maintaining the exceptional water quality of the Clackamas River.
- g. Work with agricultural partners to prioritize technical assistance efforts in areas that are higher risk to the drinking water supply. Help growers become eligible for the USDA Conservation Stewardship Program (http://www.nrcs.usda.gov/programs/new_csp/csp.html) in the Clackamas Watershed. The CSP is a voluntary program that provides financial and technical assistance to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on Tribal and private working lands. For example the CRWP could offer to collect and analyze soil samples from active croplands to meet one of the requirements of this program. The CRWP would coordinate

with the NRCS and CCSWCD, the organizations that implement this program in Clackamas County.

- h. Consider providing technical and/or financial assistance to help the CCSWCD to carry out implementation of Conservation Reserve Enhancement Program (CREP) goals in Clackamas County
<http://www.fsa.usda.gov/FSA/webapp?area=home&subject=prod&topic=cep>. CREP is a local, state, and federal cooperative program that encourages agricultural producers to voluntarily retire streamside agricultural lands by paying to establish riparian buffers that will protect water quality and restore fish and wildlife habitat. Note: Clean Water Services in Washington County found that they needed to pay landowners to participate in the CREP program.
- i. Agricultural Chemical Removal Program – the CRWP should work with DEQ, CCSWCD, Clackamas County, Metro, CRBC and others to implement Pesticide Round Up Events to remove banned legacy pesticides, organophosphates, herbicides, and fertilizers from the Basin. The purpose of this would be to help growers remove and properly dispose of old agricultural chemicals that still may exist in barns and sheds.
- j. Organic Farm Certifications – The CRWP will evaluate whether or not to offer farmers in the Clackamas watershed partial to full reimbursement of organic certification costs (\$299 - \$10,000 per farm depending on size and gross income from sales) as an incentive for farms to obtain certification through Oregon Tilth. <http://www.tilth.org/certification>
- k. Pesticide Reduction Program – Continue to work with CRBC by providing funding and direction on public education and outreach efforts (brochures, educational flyers, and surveys) regarding pesticide issues. This includes targeting pesticide education for urban and rural lower basin landowners, encouraging nursery and agricultural industry to reduce pesticide application, and encouraging alternatives to pesticides. Conduct workshops and/or training with ODA, Extension Service, and/or DEQ for chemical applicators licenses for pesticides on proper handling, storage and disposal of pesticides, herbicides and fertilizers. Continue to work with the Pesticide Stewardship Partnership (PSP) to focus resources in the Clackamas basin. The PSP is a voluntary collaborative approach to identify problems and improve water quality associated with pesticide use at the local level. The PSP approach uses local expertise in combination with water quality sampling and toxicology expertise of ODEQ to encourage and support voluntary changes that result in measurable environmental improvements.

D. Forestry Mitigation Programs: Forest management activities such as the use of chemical applications for stand treatment, road building, and various timber harvest techniques have the potential to adversely impact downstream water quality.

- a. The CRWP should continue to be an active participant of the Clackamas Stewardship Partners, a group working with the USFS on road decommissioning and restoration projects in the Clackamas watershed.
- b. The CRWP should map all timber harvests, in the National Forest, as well as on private timber land, that have occurred in the watershed in the past five years and those that are anticipated to happen in the next five years. In addition to mapping timber harvests, identify if chemical spray treatments were/will be applied. ODF may not have digitized maps for cut units. Land owners, however, are required to submit a paper copy with the application so the information is available but would have to be collected and digitized for a GIS layer. Mapping of timber sales is already done by the USFS, so the CRWP could get the GIS layers from the Forest Service.
- c. Start meeting with private timberland owners, timber companies, industry groups, and others to share information and engage in meaningful discussion on current forest activities in the watershed and ways to assist foresters while maintaining the exceptional water quality of the Clackamas River.
- d. Conduct an analysis of the creek basins that received aerial applications of pesticides or herbicides to highlight the basins that had higher amounts of chemicals applied.
- e. Determine if there is a need to begin a storm event monitoring in creek basins that have a higher risk of chemical runoff due to recent stand treatment and harvest activities.
- f. Coordinate with the County and Cities on urban forest planning.

E. Road Vegetation Management: Herbicides applied to gravel shoulders along major roads within the watershed can have a negative impact on water quality, if any herbicide or breakdown product washes into a creek or the river. BMPs for roadside applications are addressed in Clackamas County's (for areas inside the UGB) and ODOT's MS4 permits. ODOT also has guidance outlined in their document "Routine Road Maintenance WQ and Habitat Guide, BMPs, revised 2004". There is, however, always room for the CRWP to evaluate what they are currently doing and see if there are opportunities for improvement. The CRWP should:

- a. Maintain good communications with Clackamas County Road Department, and the Cities within the watershed public work departments, the USFS, and ODOT to encourage them to continue to manage vegetation without herbicides.
- b. Learn more about the County, Cities, ODOT, and the USFS' Integrated Pest Management programs and encourage improved application methods and the use of Integrated Vegetation Management programs to decrease the amount of chemicals and to possibly switch to less toxic herbicides used to achieve effective management of roadside vegetation.
- c. Review existing BMPs within Clackamas County and ODOT's stormwater MS4 permit and recommend additional measures for protection if necessary.
- d. Determine if additional storm event monitoring for herbicides, metals, inorganics, nutrients, Biochemical Oxygen Demand (BOD), turbidity, Total Organic Carbon (TOCs),

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conductivity, Volatile organic compounds (VOCs), and suspended organic carbons (SOCs) should be implemented and how it would be funded.

F. Non-permitted landfills/dumps/illegal dumping/junk yards: Illegal dumpsites have taken a toll on federal forested lands in Clackamas County over the years and threaten the water quality of the Clackamas River. This continuing problem has prompted the closure of some recreation areas in the county and other sites are being considered for closure. The CRWP should:

- a. Identify the status of existing permits for landfills, dumps and similar facilities.
- b. Contact facility owners and operators to inform them of their location and the proximity to drinking water intakes, and provide resources to encourage the use of BMP's.
- c. Education and outreach – work with DEQ, WES, CRBC to put articles in the local and county newspapers and local newsletters.
- d. Work with Clackamas County Dump Stopper program.
- e. Help ensure continued funding for Clackamas Dump Stopper program. This could be done by advocating for continued funding for the program to Clackamas County, or by evaluating whether the CRWP should provide funding to help support the program.
- f. Encourage use of hazardous material disposal programs, such as the Metro household hazardous waste facility so waste will not end up in an illegal dumpsite.

G. Construction and Development: It is well known that construction activities rank as one of the main sources of sediment pollution to stormwater conveyance systems and receiving water bodies. The effects of excessive sediment loading on receiving streams and the river include deterioration and/or destruction of aquatic habitat, destruction of spawning areas, deterioration of aesthetic value, increased water treatment costs, and transport of pollutant such as metals, nutrients, organo-chlorine pesticides, PCB's and other organic compounds. The CRWP should:

- a. Encourage the County, and the Cities within the watershed, to implement BMP's that optimize erosion and sediment control.
- b. Encourage inspection and enforcement of erosion control measures at construction sites.
- c. Develop additional education resources to educate contractors and developers about the importance of BMP's and how these can protect water quality.
- d. Encourage plan review for new developments for erosion prevention, water quality/quantity and mitigation of the impacts of new impervious areas.

H. Septic System Assistance Program: Improperly maintained septic systems can be a significant source of groundwater contamination. On-site septic systems can release high concentrations of organic matter, ammonia nitrogen, phosphates, bacteria, viruses, nitrates, synthetic organics, toxic metals, PCP's, and pharmaceuticals to groundwater. It is important to develop long-term relationships with watershed residents, developers, septic system installation contractors, and regulatory agencies to maintain an inventory of septic systems, ensure proper placement and

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construction of new systems, and work to replace old systems that are at the end of their useful life. The CRWP should:

- a. Identify and map in GIS properties with septic systems in the Clackamas watershed and overlay with information on septic system age and sensitive areas such as FEMA flood plain maps, soil/geology maps for highly permeable, thin soils, high slope, proximity to ditches, streams or rivers which could be used to determine high risk areas.
- b. Target high risk septic system areas for further outreach efforts, technical assistance, or incentive programs.
- c. Determine if additional water quality (surface/groundwater) sampling is necessary. If so develop a plan and implementation approach in partnership with DEQ and WES to conduct water quality monitoring of septic systems impacts.
- d. Consider providing homeowners with technical or financial support through CRWP funding and/or grants to inspect and pump-out (if needed), repair and/or upgrade septic systems that have been identified in high risk areas.
- e. Offer workshops with easy to understand information about maintenance of systems and options/recommendations about the need upgrades and/or replacement of old on-site system that are failing or near failure.
- f. Encourage and advocate for state-wide or county enhanced regulation of septic systems – i.e. maintenance schedules, required inspections on property sale. In addition, encourage WES to conduct septic inspections in high risk areas and encourage property owners to inspect septic systems at time of sale.
- g. Encourage DEQ and WES, as the administering agency to adopt a more stringent proactive septic inspection program rather than the current, complaint driven reactive approach.

I. Recreation impacts: The Clackamas watershed has a variety of recreation facilities including Forest Service and PGE campgrounds, county and state parks and boat ramps, as well as a number of golf courses. Recreational activities also include hiking, rafting, kayaking, fishing, hunting, and floating. Potential contamination from these activities include: petroleum products, solvents, paints, oils and grease, and untreated or partially treated human waste (nutrients and pathogenic microorganisms). Sedimentation can also be an issue resulting from stream bank erosion from boaters, anglers, off-trail hiking, or Off Highway Vehicle (OHV) activities. Golf courses and parks may use herbicides, pesticides, fungicides, and fertilizers. To address these potential impacts the CRWP should:

- a. Advocate for the creation of boat no-idling zones around drinking water intakes.
- b. Consider monitoring for fecal coliform at two or three strategic locations relative to high use/impact areas. The recreation seasons should be considered and reflected in the sampling sites chosen.
- c. Work with the Forest Service on the issue of dispersed camping and how to reduce the impact of these kinds of sites. This could include mapping these sites, supporting federal

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funding for the Forest Service to close these sites, or working with the Clackamas Stewardship Partners to earmark stewardship restoration dollars to reduce the impact of this kind of camping.

- d. Support programs that provide and maintain restrooms and portable outhouses for river users.
- e. Become involved with the Oregon State Marine Board (OSMB) Oregon Clean Boater Program to encourage boaters to implement environmental practices while boating, to help protect water quality.
- f. Aid the OSMB with education efforts regarding Quagga and Zebra mussels. This could include developing signage for Clackamas River boat ramps, posting information on the CRWP website, or passing out information at summer events.
- g. Provide incentives/rebates/and/or coupons (maybe \$50) for boaters to upgrade 2-cycle engines to 4-cycle. This information could be provided at Clackamas Boat ramps targeting Clackamas River users.
- h. Provide free spill kits (such as absorbent pads) for boats.
- i. Encourage PGE to join OSMB's Clean Marina program and encourage "Clean Boater" BMPs for reservoir and campground areas.
- j. Education efforts aimed at recreational users and golf course landscape managers would be the most effective means for reducing impacts from most recreational activities. This would include installation of education signage providing information about Drinking Water Source Protection at trailheads, county parks and boat ramps.
- k. Support the Clackamas River Annual River Clean Up and CRBC's Stash the Trash Bag program.

Partnerships: The CRWP currently enjoys active partnerships with some critical agencies that regulate or are involved in oversight of nonpoint sources of pollution or large landowners in the watershed (USFS, Clackamas County WES, CCSWCD, and DEQ). The CRWP should continue to work with the Pesticide Stewardship Partnership group to focus resources and funding efforts on the Clackamas watershed. Additional partnerships need to be developed with the ODA, EPA, BLM, USDA, NRCS, ODOF, and business associations.

Estimated Costs: Costs for implementation of the nonpoint source evaluation and mitigation subprogram would mainly be associated with staff time and database/GIS design and use. Since staff time is already accounted for in the source protection budget and GIS is used with many of the other source protection subprograms, the costs are minimal for this subprogram. Additional costs associated with increased monitoring downstream of hot spot areas, design and implementation of BMPs, restoration, or other mitigation projects would depend on the level of cooperation with business associations, landowners, and other partners. The following are estimates based on the

assumption that landowners and partner organizations do not contribute a significant amount of funding to these efforts:

1. Approximately \$5,000 to \$11,000 per year for additional staff time, and GIS/database related costs.
2. Increased monitoring at hot spot areas may require \$11,000 to \$28,000 a year for analysis, equipment, and additional staff time.
3. Design and implementation of mitigation projects could range from \$30,000 to \$150,000 per project depending on the scope and scale of the project. Ongoing O & M costs associated with these projects is assumed to be covered by landowners and/or partner organizations. If not, it is estimated that approximately 15% of total project costs would be needed for annual O & M activities and performance monitoring.
4. Additional funding would need to be allocated if the CRWP was interested in providing grants for either two stroke boat motor rebates, or for a septic system inspection program.

Funding Opportunities: A number of grants, technical assistance, and other revolving loans exist to assist landowners, businesses, local governments, and/or the CRWP with evaluation and mitigation of nonpoint sources of pollution. Responsibility for mitigation of nonpoint sources of pollution is not always clear making it difficult to “force” mitigation in order to effectively protect a drinking water source. Approaches for mitigation of nonpoint sources will likely be cooperative and voluntary actions among a number of partners. The following is a summary of known sources of funding.

1. *Flood Hazard Mitigation and Riverine Ecosystem Restoration Program (Army COE)*. See description under the Point Source Evaluation and Mitigation Subprogram.
2. *National Integrated Water Quality Program (USDA)*. See description under Education and Research Assistance Subprogram.
3. *Safe Accountable Flexible Efficient Transportation Equity Act (SAFETEA-LU) Funding Programs (Federal Dept. of Transportation and ODOT)*. See description under Education and Research Assistance Subprogram.
4. *Water Quality Cooperative Agreements (US EPA)*. See description under the Point Source Evaluation and Mitigation Subprogram.
5. *Sustainable Agriculture Research and Education (USDA)*. See description under Education and Research Assistance Subprogram.
6. *Science to Achieve Results (US EPA)*. See description under Education and Research Assistance Subprogram.
7. *Watershed Protection and Flood Prevention Program (USDA)*.
<http://www.nrcs.usda.gov/programs/watershed/>
 - a. Goal. Authorized NRCS to cooperate with States and local agencies to carry out works of improvement for soil conservation and for other purposes including flood prevention;

- conservation, development, utilization and disposal of water; and conservation and proper utilization of land.
- b. Funding. Funding amounts vary, but typical projects entail \$3.5 to \$5 million in federal assistance.
 - c. Limitations. Need to make a formal request to the Natural Resource Conservation Service (NRCS) for project funding under this program. Projects need to be approved by the NRCS and may require cost sharing. Projects are limited to watersheds containing less than 250,000 acres.
 - d. Due Date. Applications are accepted on an ongoing basis.
8. *State Revolving Fund for Drinking Water (DEQ/EPA)*.
<http://www.epa.gov/safewater/dwsrf/index.html>
- a. Goal. To make funds available to drinking water systems for infrastructure improvements. The program also emphasizes funding small and/or disadvantaged communities, as well as programs that encourage pollution prevention as a tool for ensuring safe drinking water. Oregon also offers SRF Grant funds to PWSs for protection for up to \$20K per PWS. There are similar conditions to the loans.
 - b. Funding. Oregon's share of the SRF funding was \$14.6 million for 2010. Loans are provided on a points basis.
 - c. Limitations. Loans are for planning, designing, and/or construction activities associated with a project. Submit a Letter of Intent to the Oregon Department Health Services.
 - d. Due Date. Applications are accepted on an ongoing basis, and money is distributed until funding runs out for the year.
9. *Nonpoint Source Implementation Grants (319 Program) (DEQ/US EPA)*.
<http://www.deq.state.or.us/wq/nonpoint/grants.htm>
- a. Goal. To promote nonpoint source pollution reduction projects to protect drinking water sources and the general quality of water resources in a watershed. Types of projects that will be funded include: Riparian & In-channel restoration (erosion control, large wood placement). Pesticide partnership projects and/or specific toxic reduction projects. Innovative storm water planning/tools, education and demonstration projects (includes hydromodification modeling, tools, and low impact development approaches practices (LIDA)). Agriculture BMPs (includes fencing & digester projects).
 - b. Funding. In Oregon, about \$1.5 million of federal grant dollars will be available under Section 319(h) of the Clean Water Act. The maximum amount available for any one grant is \$150,000 per year.
 - c. Limitations. Application made to DEQ should demonstrate that the project supports State priorities. 319 funds typically support Total Maximum Daily Load (TMDL) process and target areas where TMDLs are being done. Applicants are required to provide 40% matching funds of total project costs.
 - d. Due Date. November of each year.

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10. *Clean Water Act State Revolving Loans (DEQ/US EPA).*

<http://www.epa.gov/owm/cwfinance/cwsrf/index.htm>

- a. Goal. The CWSRF provides low interest rates and flexible loan terms for funding wastewater treatment plants, nonpoint source pollution control and estuary protection. The CWSRF assists a variety of borrowers including municipalities, farmers, homeowners, small businesses and nonprofit organizations.
- b. Funding. The total amount available for the nation is approximately \$5 billion annually. Oregon's piece of this funding is \$35 million. Maximum per year loan amounts are approximately \$1.7 million. Loans are provided for planning activities (monitoring, investigation, evaluation of options, etc.) and construction of treatment systems. Interest rates for planning loans average 2.2%. CWSRFs can fund 100 percent of the project cost and provide flexible repayment terms up to 20 years.
- c. Limitations. Loans are made to government organizations only. Project work should address high priority concerns associated with CWA sections 319 and 320 and per Oregon DEQ water body priority list.
- d. Due Date. Applications are accepted from mid-December through February. Planning loans are almost always available. Construction loans are prioritized and typically have a long waiting list.

11. *Five-Star Restoration Program (US EPA).* <http://www.epa.gov/wetlands/restore/5star/>

- a. Goal. To support community-based wetland and riparian restoration projects. Support will be provided to projects that have a strong on-the-ground habitat restoration component that provides long-term ecological, education, and/or socioeconomic benefits to the people and their community.
- b. Funding. The average amount of grant finds awarded to any single project is \$10,000.
- c. Limitations. Projects must involve contributions from multiple and diverse partners, including citizen volunteer organizations, youth groups, charitable foundations, corporations, private landowners, local conservation organizations, and federal, state, or local governments. Each project should involve at least five partners who contribute funding, land, technical assistance, work force support, or other in-kind services that are equivalent to the federal grant amount.
- d. Due Date. Mid February of each year.

12. The Meyer Memorial Trust and Bonneville Environmental Foundation also periodically have grants available if the project involves restoration that improves Salmon habitat.

5) Disaster Preparedness and Response Subprogram

Objective: The purpose of the disaster preparedness and response subprogram is to recognize and be prepared for events that may have a low probability of occurring, but if they happen may cause

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extensive problems for the CRWP member's drinking water source. This includes coordinating CRWP emergency response efforts and planning, delivering emergency training exercises to CRWP members, as well as enhancing preparedness for spill prevention and spill response. Another objective is to ensure that water providers always receive prompt notification when medium and large spills do occur.

This strategy includes promoting relationships with federal, state, and local agencies to develop an emergency response system that would identify 1) sections of roads and bridges, and 2) facilities (industrial sites with large above ground tanks) that could be high risk areas for spills. The use of GIS to display information on watershed characteristics, potential threats, critical emergency response resources, spill response strategies, equipment, and emergency contacts and response personnel, is an important part of this strategy.

Other potential disasters (forest fires, terrorism, landslides and volcanic activity associated with Mt. Hood) threaten the CRWP's drinking water source and should be addressed as part of a prevention and preparedness strategy.

Scope: The first part of this scope addresses the need for CRWP emergency planning coordination. Following this are four categories of *potential disasters* that could have significant impact upon the Clackamas River and the CRWP's drinking water:

- 1) *CRWP Emergency Preparedness.* All CRWP members have Emergency Response Plans and have done some planning on how to respond to emergencies. These efforts for the most part have taken place individually rather than collectively. The CRWP should identify ways that its members can work together more effectively during an emergency. This would include:
 - a. Review the current process of water provider notification system and identify ways it could be improved. The system could then be used for notification of spills, taste and odor events, boil water notices, and other high priority events.
 - b. Conduct emergency training exercises and drills for CRWP member's staff.
 - c. Encourage CRWP members to become active ORWARN members.
 - d. Be a conduit to pass on emergency planning information from the State and County to CRWP members.
 - e. Continue to participate on the Clackamas County Homeland Security Task Force and the Urban Area Security Initiative Public Works Group as a means to develop relationships with the emergency management community, as well as to position the CRWP for potential federal grants.
 - f. Continue to pass on information and encourage CRWP member's participation in FEMA/ICS training so CRWP members staff are more familiar with ICS structure and federal emergency procedures in case of an event. In addition encourage CRWP member's

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to become NIMS compliant so that the CRWP would have more access to UASI, and Homeland Security grants.

- g. Pursue grants and other funding to purchase mobile water treatment plants, generators, and other backup equipment. . This equipment could be strategically placed throughout the CRWP service area to be used in emergency.

2. *Hazardous Substance Spill.* Potential spills involve a release of a hazardous material or petroleum products during transit along the river or elsewhere within the watershed. A recurring theme associated with major spills or releases is confusion and uncertainty for first responders in the initial hours following an event. It is during those early hours when the opportunity to contain the spill may still exist. Once a large spill enters a flowing body of water, it can quickly become out of control, impacting downstream critical resources (drinking water intakes, endangered species habitat, spawning beds, nesting areas, hydroelectric facilities, well fields, etc.). The goal of the watershed emergency response system is to provide first responders with the information, support, equipment, and training to efficiently and effectively respond to and stabilize a major chemical spill or release and avoid the initial confusion associated with spill response. Modeling identified in the Basin Analysis Subprogram will also help guide scenario responses and impacts. To address this threat the CRWP should:

- a. Ensure that notification calls to water providers are made as soon as a spill occurs.
- b. Develop effective partnerships with federal, state, and local agencies that would play a role in a large scale incident in the Clackamas River.
- c. Work with Clackamas County Fire & Rescue organizations to look at the feasibility of establishing a Regional Spill Response Team that would be active within the Clackamas River watershed. This would include organizations such as the Gresham Hazmat Team, CCOM, LCOM, ODOT, OERS, WES, and the Union Pacific Railroad.
- d. Conduct an assessment of the Regional Spill Response Team member's service areas, geographic areas, and gaps in coverage (i.e. minimum response thresholds, with respect to quantity and type of material released, work hours – no staff on Sundays, etc.) in order to identify areas where spill prevention and response activities could be enhanced.
- e. Assess equipment needs by comparing agency equipment inventories with equipment needs associated with various spill response strategies to identify equipment gaps.
- f. Identify critical resources in the watershed that would need to be protected in the event of a spill or chemical release. Examples include drinking water intakes, endangered or threatened species habitat and spawning areas, nesting areas, and wetlands.
- g. Develop response strategies to address the most probable chemical threats (i.e, petroleum spill).
- h. Encourage the Regional Spill Response Team members to conduct regular joint interagency drills and training in response to spills in order to build trust and camaraderie between agencies and to better understand each other's roles and responsibilities.

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- i. Evaluate the transportation of chemicals and hazardous substances through the watershed. This may include conducting a corridor study to assess the amount of truck traffic associated with chemical transportation. The data collected could be used to find where historic spills occurred and to look at opportunities to request the restriction of, or limiting the amount of, certain chemicals or hazardous substances transported through the watershed.
 - j. Establish a dialogue with PGE to better understand their operation and spill response program and look for ways to better coordinate with the CRWP. This would include understanding their hazardous material handling, storage, and spill response capabilities associated with electric generation projects in the watershed, and developing a notification protocol (see above). CRWP members would be notified about operational changes that could lead to changes in turbidity levels, taste and odor events, and/or notification of gasoline, diesel or chemical spills.
 - k. Work with DEQ, the County, Cities and individual facilities that use, store, or generate hazardous substances to reduce usage of chemicals and waste generation, find alternatives to hazardous substances, and upgrade storage and security of chemicals. Encourage periodic updates of emergency and spill response plans, notification procedures, and provide general information about our drinking water source and the water treatment processes.
 - l. Encourage WES to provide fire districts/departments and spill responders with current maps of storm and sanitary sewer systems and drinking water intakes in the Clackamas County Service District (CCSD) #1's portion of the watershed. This information would also be needed for areas outside of CCSD #1.
 - m. Use GIS to develop an Emergency Response System similar to Eugene Water and Electric Board's. This is a computerized, web-based program, allowing first responders to retrieve information quickly and make assessments about the tools and equipment needed to deal with an emergency. This would allow first responders to:
 - Type in the location of a spill and then zoom in on a map and photo of the area. The responder then can visually assess the situation.
 - Get a detailed, specific response plan for the segment of the river where a spill occurred. Each response strategy provides detailed information and instructions the responder will use to mitigate a spill.
 - Get an inventory of equipment that is available.
 - Get a list of contacts and where equipment is located.
 - Identify storm drains and culverts.
 - Create a report that shows the travel time of the pollutant that has spilled.
 - Get an estimate of the population that might be affected.
 - Get a list of upstream facilities that use or store hazardous materials.
3. *Anti-Terrorism Measures.* After 9/11 water utilities were required to conduct and implement the findings of Vulnerability Assessments to address potential threats to drinking water systems.

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Much of this work looked at treatment plants and distribution systems and only took a cursory look at raw water sources. The following measures can be taken to reduce the threat of a terrorist attack on the CRWP water supply:

- a. Develop a relationship with Homeland Security for their input and technical assistance, and identify potential Homeland Security grant funds that might be available to assist with implementation of these measures. (See number 1 above).
 - b. Evaluate potential chemical/biological compounds/mixtures that could be used to contaminate raw water;
 - c. Purchase buffer areas or install physical obstacles upstream from the water intakes to prevent easy land access to the intakes;
 - d. Install surveillance cameras, sensors, or other detection equipment at intake structures;
 - e. Install an early warning water quality monitoring system on the Clackamas River: Have a "canary" (sensitive aquatic organisms) in a tank through which raw water flows, to provide early warning of toxics moving into treatment facilities;
 - f. Educate the community, police, and city employees to raise awareness of these critical areas and to report suspicious activities.
4. *Forest Fire Preparedness.* Watershed vegetation is a valuable asset. Severe forest fires in a watershed can cause long-term problems to a drinking water source from ash runoff, retardant/extinguishing agents, high erosion rates, and charred debris buildup in rivers and streams. Prior post-wildland fire assessments have found substantial impact from areas used to stage heavy equipment, due both to petroleum-product leakage and extreme soil compression, affecting permeability and local vegetation. The CRWP has a responsibility to actively work with the USFS, BLM, ODOF, private timber owners, and other agencies to understand the fire threat in the Clackamas watershed, and to offer support for prevention and preparedness to reduce the threat, and respond, if a fire breaks out. Forest fires can change the hydrology of a watershed considerably. Hydrology and W2 modeling identified in the Basin Analysis Subprogram can evaluate scenario impacts and responses from forest fires. To accomplish this the CRWP should:
- a. Encourage forest diversity which promotes healthy forests, decreases the risk of fire, and insect infestation and the spread of tree disease.
 - b. Encourage thinning on forest lands as a means to achieve forest diversity, reduce fuel loads and create jobs.
 - c. Actively participate in the evaluation of fire threats with the USFS and BLM and support their efforts to prevent forest fires in the watershed.
 - d. Collaborate with the USFS, BLM, and ODOF to identify fire mitigation and response strategies in case of fire (i.e. sediment and debris traps).
 - e. Become a member of the Wildfire Planning Executive Committee to help with implementation of fire prevention objectives outlined in the Clackamas County Community

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5. *Natural Disasters Preparedness.* Potential disasters include earthquakes, floods, landslides, volcanic eruptions, and associated extensive mud flows in the watershed. The only protection from a significant natural disaster is to have a backup water supply until the river can recover from the event. The CRWP should pursue emergency interties with the Bull Run, Tualatin or Willamette systems as an emergency backup to the Clackamas River source. The Regional Water Providers Consortium is currently conducting a Regional Intertie study that inform water providers in the Portland Metro region where interties between agencies would be beneficial so water could be rerouted in the event of an emergency. DOGAMI LIDAR data will help identify landslide prone areas.
6. *Dam Breach.* PGE operates a number of dams on the Clackamas River. PGE will have prepared emergency management plans for their facilities and potential dam breaches, but CRWP may be interested in predicting the effects (such as short duration but high intensity erosion and sedimentation) of dam failure on drinking water infrastructure.

Partnerships: The CRWP has established relationships with USFS, Clackamas County Emergency Management, DEQ, and Clackamas County WES. Additional partnerships with commercial timber companies, ODOF, ODOT, FEMA, BLM, EPA, Oregon Emergency Management, Clackamas County Public Works, Clackamas Fish Hatcheries, State Fire Marshal's Office, and others will be pursued as the source protection program is implemented.

Estimated Costs: Potential costs to implement CRWP disaster preparedness programs are difficult to measure and may not accurately reflect costs incurred under the Source Protection Program (e.g., finding additional sources of water). The costs that can be attributed to these subprograms and are a part of source protection include: staff time, spill equipment, training costs, and use of GIS to manage information and conduct spill analysis (i.e., river booming strategies, spill equipment storage locations, resource allocation, etc.). Estimated annual costs associated with spill response, community preparedness, and forest fire prevention may range from \$10,000 to \$50,000 depending upon the CRWP level of commitment. Costs associated with anti-terrorism and natural disaster events would not be part of the source protection budget.

Funding Opportunities: A number of funding sources are available for spill response preparedness and training (EPA and FEMA), chemical transport corridor studies, anti-terrorism measures (FEMA, OEM, and others), and fire prevention and training (FEMA, USFS, BLM, and others). There may also be funding available through EPA for regional response training.

6) Public Outreach and Information Sharing Subprogram

Objective: The objective of the public outreach and information sharing subprogram is to widely disseminate data and information collected as part of the source protection program to CRWP water customers, Clackamas River watershed residents, and other stakeholders. To promote community awareness of the watershed as a drinking water source by developing educational materials and outreach programs that bridge the gap between public perception of the watershed and the technical information about the limiting factors affecting it. The overarching goal is for the watershed community to help protect the water quality of the Clackamas River and be engaged in implementing this Plan.

Scope: The following is a summary of the various tasks and components associated with public outreach and information sharing:

1. *Clackamas Watershed Residents.* It is important to educate residents in the watershed about better stewardship (i.e., pesticide use, septic system maintenance, importance of riparian area, etc.) as well as provide information about CRWP actions to protect the watershed as a drinking water source. In addition it is important to communicate the challenges and trends in the watershed. The CRWP currently has an education and outreach program that focuses on drinking water and water conservation. This program should be expanded to include watershed and source water protection education messages. Expanded education and outreach efforts should also include expanding current storm drain stenciling programs, providing technical support for building rain gardens and Backyard Habitat Certification programs, implementing program such as a Fish-Friendly Car Wash program or an ADOPT a Stream program, and supporting or encouraging involvement in the OSU Extension Master Watershed Steward program <http://extension.oregonstate.edu/watershed/who-are-they>. Master Watershed Stewards with special training, serve their communities by completing a project with assistance from OSU Extension, resource agencies or watershed councils, and becoming points of contact for their communities. Adopt a stream programs are programs that are support groups of citizens taking care of a stream through various activities including visual inspections, water quality monitoring to detect problems, trash pickups, and conducting restoration projects. These programs should also be offered to CRWP water customers that are not within the watershed. The Clackamas River Basin Council (CRBC) also has public outreach and education efforts to engage landowners in restoration, and protection activities. The CRWP should support CRBC's effort in addition to expanding our own education and outreach efforts.
2. *CRWP Water Customers.* Periodic information about the CRWP's source protection efforts should be provided to our customers through newsletters, insert in monthly bills, local events, youth education programs, media releases, watershed tours, workshops, annual consumer confidence reports and through the CRWP website. The current public education

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and outreach program should be expanded to include source water protection and watershed issues noted above. CRWP customers (and their elected officials) should be educated with regard to the objectives and scope of the source protection program so if future funding is needed for the program, customers will be aware of its purpose. Periodic updates on the progress of implementation would allow customers to see how their funds are being used for protection of the Clackamas watershed.

3. *Lower Watershed Businesses and Residents.* Areas that are upstream of the CRWP raw water intakes should be targeted to provide information and data from WES's storm event monitoring program and potential future CRWP water quality monitoring to educate businesses and residents about practices that could reduce pollution runoff into the stormwater system. These areas should also be targeted for education regarding the problems caused by increased impervious surfaces and alternatives to paving. This effort should be conducted with support and input from WES, Clackamas County the Cities of Estacada, Sandy, Happy Valley, Damascus, the Soil and Water Conservation District, and other stakeholders.
4. *Stakeholders.* The CRWP will provide draft documents to stakeholders for their review and feedback on the direction of the source protection program. Stakeholders will continue to be given the opportunity to provide comments and feedback on source protection program implementation and review of draft documents. The CRWP will provide data and information generated from implementation of the source protection program and in return the CRWP will be seeking data and information from various stakeholders.
5. *Database and GIS Management.* One goal of the Comprehensive Monitoring subprogram is to develop a database to manage the various data collected from its monitoring subprogram as well as other subprograms (Source and Nonpoint Source, Land Use Tracking, etc.). GIS will be used to manage spatial information and conduct various analyses to evaluate the relationships between geographic data over time. In addition, hydrologic models will be used to further analyze the data to calculate pollution loadings, conduct hydrologic simulation scenarios and trend analysis. Ideally the database and data analysis results will be designed to eventually allow this information to be posted on the CRWP's web site for dissemination to a wider audience and provide linkages for data and support collection of new data on watershed conditions. Online GIS and potentially integrated model system would provide an excellent way to communicate information to the audiences targeted for educational outreach. Classes could utilize the system to engage in what-if scenario style learning exercises, query data, and conduct mini-experiments using the spatial, monitoring, and modeled data.
6. Become a member of the Regional Coalition for Clean Rivers and Streams. This is a partnership of eight public agencies in the Portland/Vancouver metropolitan area that is dedicated to educating the public about the impact of stormwater runoff pollution on the

health of our rivers and streams. <http://www.cleanriversandstreams.org/> Cost to participate are unknown at this time but would help pay for their media campaign.

Partnerships: The CRWP currently partners with Clackamas County Water Education Team (CCWET) which is made up of other Clackamas County water resource organizations working on education and outreach efforts. In addition the CRWP will continue to work with the CRBC on Pesticide Reduction education and outreach efforts. The CRWP will share its data and information with and, in turn, will need to obtain data, GIS coverage, and other information from Clackamas County, WES, USGS, DEQ, USFS, BLM, ODA, ODOF, USDA, CCSWCD, NRCS, PSU, PSP, and various business associations. The CRWP already has active partnerships with many of these organizations.

Estimated Costs: Costs for implementation of the public outreach and information sharing would mainly be associated with staff time, production and mailing of fact sheets or other outreach materials, and database/GIS design and use. Since staff time is already accounted for in the source protection budget and GIS is used with many of the other source protection subprograms, the costs are minimal for this subprogram. It is estimated that approximately \$5,000 to \$15,000 per year for outreach materials production and mailing, and GIS and database related activities (web site design and production) could be attributed to the Public Outreach and Information Sharing Subprogram.

Funding Opportunities: A number of grants are available for public education programs. In addition, working with the various partners will help reduce the individual agency costs by sharing of overall costs for implementation of this subprogram. The following is a summary of potential funding sources:

1. *Environmental Education Grants Program (US EPA)*. See description under Education and Research Assistance Subprogram pg 31.
2. *Sustainable Agriculture Research and Education (USDA)*. See description under Education and Research Assistance Subprogram pg 31.
3. *Watershed Protection and Flood Prevention Program (USDA)*. See description under Nonpoint Source Evaluation and Mitigation Subprogram pg 46.
4. *Water Quality Cooperative Agreements (US EPA)*. See description under Education and Research Assistance Subprogram pg 31.
5. *Five Star Restoration Program (US EPA)*. See description under Nonpoint Source Evaluation and Mitigation Subprogram pg 46.
6. *Nonpoint Source Implementation Grants (319 Program) (DEQ/US EPA)*. See description under Nonpoint Source Evaluation and Mitigation Subprogram pg 46.
7. *Targeted Watersheds Grant Program (US EPA)*.
 - a. Goal. Competitive grant program based on the fundamental principles of environmental improvement: collaboration, new technologies, market incentives, and results-oriented

strategies. The Targeted Watersheds Grant Program focuses on multi-faceted plans for protecting and restoring water resources that are developed using partnership efforts of diverse stakeholders.

- b. Funding. The total funding available is \$600,000 with the maximum amount awarded to individual watershed partnerships being \$30,000.
- c. Limitations. Matching funds are encouraged but not required.
- d. Due Date. Unknown

7) Watershed Land Use Tracking and Management Subprogram

Objective: The objectives of the land use tracking and management subprogram are to gain a thorough understanding of current land use activities and zoning regulations in the watershed; develop a mechanism for tracking land use activities; and, become an active participant in shaping land use and zoning policy in the watershed to protect the Clackamas River as a drinking water source. The effects of land use changes on the basin and subbasin water balances can be simulated using integrated hydrologic/hydraulic modeling identified in the Basin Analysis Subprogram. GIS analysis will also quantify areas of different land use types and densities on the ground (vs. what an area is zoned for) to get a better idea of the potential non-point source pollutants to prioritize strategies to change behavior. This will provide a means to better communicate the current state of the basin, as well as a method to assess proposed changes in land use.

Scope: The following is a summary of the various tasks and components associated with land use tracking and management:

1. *Assessment*. The first task is to conduct a comprehensive assessment of existing land use and zoning laws, adopted comprehensive plans, and regulations in the watershed. This information may exist as a data layer in the County's GIS. This assessment would also:
 - a. Use GIS analysis to quantify areas of different land use types and densities on the ground (vs. what an area is zoned for) to get a better idea of the potential non-point source pollutants to help prioritize strategies to change behavior.
 - b. Identify ways the CRWP could automatically be notified of new building permits and zoning/land use change requests to the Cities and County within the watershed.
 - c. Identify future changes in zoning laws and/or land use that may positively or negatively impact source protection efforts. The CRWP would request inclusion for receiving information regarding development of these changes.
 - d. Evaluate existing laws and regulations, and recommend areas where the CRWP should focus efforts to change or influence the interpretation of these laws to be more protective of the watershed.

- e. Allow the CRWP to develop, and keep current, a list of key positions in City, County, and State government and industry representatives (developers, realtors, builders, etc.) to document the players associated with land use and zoning issues. The CRWP would contact these key positions as necessary regarding land use and zoning changes or to discuss the future direction of land use and zoning in the watershed to protect the Clackamas as a drinking water source. This could be developed in a manner similar to the Key Contact Program developed by ASCE.
2. *Tracking.* Based on the information compiled as part of the assessment phase, the CRWP would implement the tasks necessary to be automatically notified for new or expansion building permits, land use or zoning change requests, and law/regulation changes related to land use or zoning. Tracking mechanisms would be developed to manage this information and allow easy assessment of the priority for CRWP to become involved in a particular land use or zoning issue. This information would be managed in a database and tracked/evaluated using GIS to allow CRWP to identify high-risk areas to focus our efforts.
3. *Management.* As the tracking and evaluation efforts identify high priority items or issues, CRWP will become proactive in working with partners and key players to influence the direction of land use and zoning activities to be protective the Clackamas River as a drinking water source. Another option for high priority areas that have incompatible zoning or land use is to target these areas for land acquisition before they become an issue. The tools for influencing land use or zoning activities may include:
 - a. Education and outreach efforts to articulate the potential long-term impacts from these activities or in support of activities that set precedence for good stewardship.
 - b. Provide detailed comments in support of or against these high priority issues, including applications for various land use approvals.
 - c. Build coalitions with other partners in the watershed that share similar concerns and/or support land use or zoning issues.
 - d. Lobby local or State government regarding potential changes to land use or zoning laws and regulations and the interpretation of these rules.
 - e. Introduce or actively support the introduction of favorable land use or zoning ordinances to protect the Clackamas River Watershed.
 - f. Track large developments and determine if there are water quality impacts.
 - g. Become involved with other planning efforts such as the Damascus/ Boring Concept Plan, PGE – FERC relicensing (already in progress), WES Watershed Action Plan for Rock Creek.

Partnerships: CRWP needs to cultivate and build partnerships with Clackamas County, cities in the watershed, ODA, ODOF, Oregon Division of State Lands, industry groups (realtors, developers, builders, and suppliers), and landowners (large and small).

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Estimated Costs: Costs for implementation of the land use tracking and management subprogram would mainly be associated with staff time and database/GIS design and use. Some staff time is already accounted for in the source protection budget, however, additional staff time would be needed to implement this subprogram and effectively interact with government agencies and industry groups. GIS is used with many of the other source protection subprograms so the costs are minimal for this subprogram. Costs associated with land acquisition would be included under the Land Acquisition Subprogram. It is estimated that approximately \$10,000 to \$15,000 per year for additional staff time and GIS/database related costs could be attributed to the Watershed Land Use Tracking and Management Subprogram.

Funding Opportunities: At this time, there does not appear to be outside funding available for this subprogram except through sharing costs with successful partnerships.

8) Land Acquisition Subprogram

Objective: The objective of the land acquisition subprogram is to target critical properties in the Clackamas River watershed for purchase or conservation easement in order to protect the watershed over the long term as a high quality source of drinking water. A secondary goal would be to split the cost of land acquisition with other organizations.

Scope: The land acquisition subprogram will use the data and information compiled from the monitoring, point source, nonpoint source, and land use tracking and management subprograms to target areas that are threatened or degraded for protection or restoration, respectively. As these subprograms are implemented, hot spots of pollution, areas of high risk, and areas with zoning that is incompatible with protection strategies will be targeted for land acquisition. Hot spots are defined as areas where drinking water risks are in sensitive areas, in close proximity to Clackamas River and its tributaries, or in areas where risk is clustered (numerous risks in a small geographical area rather than spread out). The CRWP should work with organizations such as Metro, Clackamas County, the Three Rivers Land Conservancy, and the Nature Conservancy to acquire critical pieces of land. Once the scope of the potential properties that should be acquired is better understood, it may be necessary to consider additional mechanisms for providing a continual flow of funds for acquiring property in the watershed.

Source Water, Climate & Carbon Connection⁶ - Evolving carbon markets may create opportunities for additional land-based source water protection. Proposed federal climate change legislation may require regulated entities that generate carbon emissions to reduce them or purchase offset credits to meet emission reduction obligations. Offset credits are contracts purchased by a regulated emitter for project-based greenhouse gas emissions reductions or sequestration by an unregulated party. In the future the CRWP could purchase land in the Clackamas watershed and plant native species of trees and restore native grasses to improve source water quality. Because these kinds of effort also sequesters carbon from the atmosphere, the CRWP could use accepted protocols to quantify the amount of carbon to be sequestered and then sell credits in a carbon market to help finance land acquisition and restoration projects. The CRWP should continue to monitor Federal Climate legislation regarding carbon emission and consider entering the offset carbon market in the future.

Partnerships: Develop a relationship/partnership with the Three Rivers Land Conservancy with the goal of meeting with them on a regular basis to work towards aligning goals for land acquisition with those of the source protection program. The Three Rivers Land Conservancy conserved 29 acres in the Clackamas River Bluffs area, located on the north side of the Clackamas River between Carver and Barton Park, in September 2005. This property was conserved in partnership with the landowners, as well as financial assistance from Clackamas County's Title III grant program. Three Rivers will continue working with landowners to protect this unique conservation corridor and plans to acquire another 80 acres. Additional partnerships will need to be developed with other conservation organizations, Clackamas County, the Oregon Watershed Enhancement Board, and Metro.

Estimated Costs: The potential costs of this subprogram will need to be further evaluated once there is a better understanding of the scope of lands needed for protection and restoration. It is assumed that the costs for implementation of the land acquisition subprogram would be allocated primarily to the Three River Land Conservancy. If Metro or another organization buys and manages land, the CRWP's costs would be zero.

Funding Opportunities: The Three Rivers Land Conservancy works with landowners who voluntarily agree to preserve their land or create conservation easements. In rare cases they purchase property. OWEB is also a source of funding for land acquisition that is important for protection or restoration of fish habitat. Other potential funding mechanisms include:

⁶ Source: *Water & Wastes Digest* November 2009 Volume: 49 Number: 11
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1. *State Revolving Fund for Drinking Water (DEQ/EPA)*. See description under the Nonpoint Source Evaluation and Mitigation Subprogram.
2. *Clean Water Act State Revolving Loans (DEQ/US EPA)*. See description under the Nonpoint Source Evaluation and Mitigation Subprogram.

Conclusion

This plan offers the CRWP a road map for engagement and leadership as we move forward in protection of our drinking water source. There are more strategies, and programs outlined in this plan than the CRWP will be able to accomplish under current staffing and funding levels.

Therefore a separate Implementation Plan will be completed that will discuss how criteria was established to prioritize the implementation of the eight elements, In addition the Implementation Plan will provide a proposed 5 and 10 year implementation schedule as well as the estimated budget for implementation of the Drinking Water Protection Plan. The implementation schedule and estimated budget will help guide the CRWP's annual workplan and budget process but will be flexible enough to allow for changes as drinking water rules and regulation change and as more watershed data is collected that could shift program priorities.

Appendix A

Additional studies that could done jointly by water providers

- 1) Aquifer Storage and Recovery
- 2) Wellhead Protection
- 3) Water Treatment Plant Optimization
- 4) Treatment options for different compounds such as pesticides
- 5) Water treatment plant interconnections
- 6) Finished water DBP Study

Appendix B
Water Quality Sampling in the Clackamas Watershed

Appendix C
Water Quality Permits in the Clackamas Watershed