CHAPTER 3

UNDERSTAND THE COMING PRESSURES THAT AFFECT OUR NEEDS AND SUPPLIES

Photo: USDA Forest Service

Water and Energy

Climate Change

Water and Land Use

Infrastructure

Education & Outreach

Oregon must anticipate and prepare for some of the most powerful changes that may affect both water resources and water needs into the future. The Oregon Legislature has expressed particular interest in preparing communities for the water-related implications of climate change, population growth, and changes in land use. The Strategy addresses these three issues, as well as the connection between energy and water, and the need to improve our water and wastewater infrastructure in response to anticipated pressures.

Education and outreach is another critical issue to consider as we plan for future instream and out-of stream water needs. The health and sustainability of Oregon's water resources, and the businesses and communities that depend on them, could benefit greatly from a variety of education and outreach efforts.

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City of Medford Wastewater Treatment Plant

Clean Water Services' LEED Certified Pump Station

Lacomb Irrigation District Turbine, Linn County

Photos: J. Gillaspie, Oregon ACWA; E. Teragli, Clean Water Services; G. Scholl-Erdmann, Farmers Conservation Alliance

In the United States, a tremendous amount of energy is used to deliver water to where it is needed. The amount of energy used to pump, treat, and heat water accounts for at least 13 percent of the nation's total electricity use, according to The River Network. Much of that electricity is used to heat water. According to the Oregon Department of Energy, heating water accounts for 15 to 25 percent of a typical home's energy bill.

The nexus between water and energy, in terms of producing and using each resource, has largely been unaddressed in water policy, studies, or planning activities in Oregon. With the Integrated Water Resources Strategy and new efforts to develop a 10-year Energy Action Plan, Oregon should take this opportunity to better connect the management of these two resources, and design a set of strategies where both resources are managed in an integrated and sustainable manner.

Energy Needs in the Water Industry

For a municipality, the energy costs for managing water and wastewater can represent one-third of the total energy bill. The U.S. Environmental Protection Agency estimates that U.S. drinking water and wastewater facilities spend about $4 billion annually on energy costs alone.

Some wastewater treatment facilities here in Oregon have been able to trim energy use with new pumps, drives, motors, and other energy efficient equipment with assistance from the Energy Trust of Oregon. Energy Trust has helped pay for a variety of renewable energy technologies that are highly cost-effective in wastewater facilities, including: converting methane (digester gas) to electricity using internal combustion engines, micro-turbines or fuel cells; or using fats, oils and grease to supplement digester gas; installing micro-hydroelectric power using a plant's outfall or flow of water; and using solar electric systems or small wind turbines.

Energy Trust's programs also offer technical assistance and help with feasibility analysis. Already, treatment plants in Washington County and the Cities of Pendleton, Mosier, Cottage Grove, and Portland have made money-saving energy gains by taking advantage of Energy Trust's programs. Oregon should continue these assistance programs, helping treatment plants move toward energy independence.

Water Needs in the Energy Industry

Just as we need energy in order to use water, we also need water to produce electricity. Natural gas and coal facilities require water for cooling purposes and bioenergy systems rely on water to grow fuel crops. Geothermal systems use groundwater as a medium for heat, while hydroelectric and wave energy facilities are powered by the movement of water.

In the Pacific Northwest, hydropower plays a prominent role in meeting our energy needs. According to the Northwest Power and Conservation Council, 40 percent of the electricity used in the Northwest is generated at federal hydropower dams in the Columbia River Basin. The federal Bonneville Power Administration, based in Portland, markets wholesale electrical power from federal dams in the Columbia River Basin.

According to the Oregon Department of Energy, 42 percent of the state's electric power mix in 2009 was sourced from hydropower facilities, federal or otherwise. By comparison, the second largest electricity resource consumed in Oregon is coal, at 34 percent.

The State of Oregon has adopted goals for the development of new electricity production from renewable resources. The 2007 Legislature created a Renewable Portfolio Standard (RPS) that requires the largest utilities in Oregon to provide 25 percent of their retail sales of electricity from newer, clean, renewable sources of energy by 2025.

Recommended Action 4.A
Analyze the Effects on Water from Energy Development Projects and Policies

How to implement this action:

- Analyze the water demands and water quality impacts of current and proposed water-intensive energy development projects (bio-energy, geothermal, solar, natural gas, and hydroelectric) 🕮

While some of these energy resources will not use water in a consumptive manner, the presence and availability of water is essential to their success. The development of renewable power systems in order to achieve a cleaner energy mix and new economic opportunities brings with it as-yet-unquantified demands for water. An analysis of demands for water intensive energy-development projects and policies in each energy sector is needed. It would provide a better scientific understanding of the state's future water commitments.

Expanding Oregon's Hydroelectric Portfolio

New hydroelectric projects will likely be part of the new resources developed as part of the State's Renewable Portfolio Standard. According to the State of Oregon's 2011-2013 Energy Plan, new growth in the hydropower sector is most likely to occur in three areas: pumped storage; the addition of power facilities on existing dams; and the addition of power within existing irrigation systems.

Pumped Storage Systems

A pumped storage system consists of two reservoirs, one at a higher elevation than the other, in which water moves down to the lower reservoir to generate power when demands are high; and then water is pumped back up to the higher reservoir when prices and demands are low, usually at night. Pumped storage systems are not considered to be a renewable power source. In fact, they operate at a net power loss.

Because of the balancing services pumped storage systems provide to the grid, they can be considered both a power management tool and an energy storage device. These plants can operate at any size, but most proposals are very large—around 1,000 megawatts (MW). By comparison, Bonneville Dam on the Columbia River has a capacity of 1,189 MW. There are several proposals for pumped storage, but no developed projects yet in Oregon. The proposals are located near high-voltage transmission or existing water infrastructure.

Hydroelectric Development

The economics of energy has stimulated large water users and private developers to consider opportunities for adding hydroelectric projects to existing infrastructure.

Incentive programs and policy initiatives have enhanced the ability for projects that do not have new impacts to other natural resources to be developed more quickly, as compared to larger hydropower projects that may have an impact on natural streams or waterways.

The Northwest Power and Conservation Council's Fish and Wildlife Plan discourages new hydropower development on many streams in the Northwest, unless the project can be developed at an existing diversion or within the infrastructure beyond the diversion.

Recommended Action 4.B
Take Advantage of Existing Infrastructure to Develop Hydroelectric Power

How to implement this action:

- Utilize the state's expedited application process to develop hydroelectric projects at existing infrastructure

The Federal Energy Regulatory Commission (FERC) is the major federal agency responsible for balancing energy needs and the protection of natural resources for major hydroelectric projects. FERC authorizes two types of exemptions that can be approved in a much shorter time frame than a standard license: "exemption" projects added to an existing dam structure with a capacity of five megawatts or less; and "conduit exemptions." Conduit exemptions are power generation projects that occur within or at the end of a pipeline or conduit beyond the original diversion. A conduit may be an open canal or a pipeline in an irrigation district, a pipeline in a municipal water or wastewater system, or a pipeline within an industrial operation.

Oregon has an expedited review process for new hydroelectric projects at existing infrastructure. The amount and timing of water diverted for an existing water use must remain unchanged (ORS 543.765). Holders of water right certificates under these provisions can secure approval to install hydroelectric generation inside or at the end of existing transmission pipelines or conduits. The resulting hydroelectric water right certificate will include the Oregon Department of Fish and Wildlife's requirements for fish screens, by-pass devices, and fish passage.

Oregon's review process for standard hydroelectric projects is thorough and complex. The multi-stage process provides for a preliminary permit to reserve a project site while environmental and cultural studies are conducted to assess the impacts of a project and to identify measures to mitigate those impacts. The review includes an assessment of the potential for cumulative impacts with other existing or proposed hydroelectric projects within the same river basin. It also includes an assessment of the public interest issues of the project. A contested case hearing is required for these major projects and the general public is offered an opportunity to provide oral comments at the hearing.

Oregon's existing water infrastructure—its dams and delivery systems—are already being utilized for energy development. Water users should continue exploring options for adding power generation facilities to existing infrastructure, while adhering to existing environmental protections.

Kevin Crew,
Black Rock Consulting

Conduit Hydroelectric Projects in Central Oregon

Most of the hydropower projects in the irrigation districts of Central Oregon have placed conserved water instream as the result of converting leaky, open canals into closed pipes. The districts have permanently placed 40 cubic feet per second (cfs) of senior water instream—through the State's Allocation of Conserved Water Program—in exchange for public funding to help purchase pipe. Examples include:

- Central Oregon Irrigation District recently completed a 3.8 MW Juniper Ridge Hydroelectric Power Generation Facility, which began full power production in 2011.

- Swalley Irrigation District installed a 0.75 Megawatt hydroelectric power plant located in Central Oregon near Bend.

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- The Blue Lake (Camp Caldera) Hydropower Site features a 20 horsepower project with Fish Screening and Passage Design. This unique project involves a fish screen that meets the State's passive cleaning criteria. Fish passage at the project utilizes a unique stainless steel design developed using the insight of renowned sculptor, Lee Kelly. The project has won several engineering excellence awards both in Oregon and nationally and has presented a viable alternative to traditional concrete ladders.

Blue Lake Hydropower Site with Fish Passage and Screening

Gaining Water and Energy Savings

The Alliance for Water Efficiency and the American Council for an Energy Efficient Economy recently published a "blueprint for action," identifying ways to gain efficiencies in both water use and energy use. For the past 30 years, strategies to conserve energy and increase the efficiency of water use have been widely pursued. However, until now, efforts to save water and energy have historically not worked together in a coherent, collaborative manner. Instead, separate but parallel efforts exist. Significant savings could be realized from coordinating water conservation and energy conservation efforts.

Saving Water and Energy through Building Codes

New building construction or remodeling existing facilities is a great opportunity to integrate water and energy conservation into the design process. Oregon has statewide mandatory building codes in 11 different specialty areas, including plumbing and energy. The codes are based on national model codes and are updated on three-year cycles. They establish minimum requirements for all commercial and residential construction in the state.

To provide guidance to local jurisdictions on water conservation, the State of Oregon Building Codes Division (BCD) approved Statewide Alternative Methods (SAMs) for rainwater harvesting (applicable to both commercial and residential construction as well as potable and non-potable uses) and for the use of graywater for toilet flushing. The Division also published a series of *Oregon Smart Guides* for consumers, two of which focus on rainwater harvesting and water conservation systems.

The Building Codes Division recently finalized two new building codes, known as the Oregon Residential Reach Code and the Oregon Commercial Reach Code, that offer an optional set of construction standards for achieving greater energy efficiency in buildings that are newly constructed, reconstructed, altered or repaired for residential and commercial buildings. Because pumping and treating water and wastewater can require a significant amount of energy, BCD opted to include water conservation measures in the Reach Code.

Oregon should continue to implement and evaluate building codes to further improve water and energy efficiencies.

Saving Water and Energy in Agriculture

Agricultural producers in Oregon are usually looking for ways to save on water and energy-related costs. The 2011 Industry Report from the Oregon Board of Agriculture describes an upward trend in the number of Oregon producers adopting changes resulting in energy and cost savings. Nearly 5,000 Oregon farms reported making changes in the past five years to their equipment or management practices that reduced energy use or conserved water. Although there is no published state-level inventory of agricultural electrical consumption by kilowatt-hour, Oregon growers reported about $49 million for electricity costs in 2008 related to pumping irrigation water. The water came from about 21,000 pumps serving approximately 1.8 million acres.

Many of Oregon's farmers and ranchers have implemented energy efficiency projects, and a few have implemented renewable energy projects. Some of the most attractive projects are those that provide significant co-benefits, such as labor savings, water savings, and improved soil productivity. Irrigation efficiency and reduced or no till cropping systems were the most popular types of energy efficiency projects among farmers/ranchers who responded to a 2010 ODA survey. Efficiency projects included use of efficient water application equipment, energy-savings pumps and motors, soil moisture monitoring programs, reduced tillage or no-till cropping systems, precision fertilizer application, and installation of more efficient lighting systems.

Recommended Action 4.C
Promote Strategies That Increase/ Integrate Energy and Water Savings

How to implement this action:

- Move toward energy independence for publicly operated treatment works (wastewater treatment)
- Encourage communities to look for and integrate ways to conserve both energy and water 🕮
- Continue to implement and evaluate building codes that encourage water and energy efficiencies
- Ensure that efficiency programs capture and publicly report both water and energy savings data 🕮
- Partner with Oregon's 10-year Energy Action Plan to promote conservation strategies for water and energy

Achieving greater efficiencies in water application—for example, moving from flood irrigation to drip irrigation—may simultaneously increase the demand for energy and may drive up energy costs. This tradeoff of increased energy use may outweigh the water-use efficiency benefits, and should be considered during the design of a project, especially for non-pressurized water systems.

Many agricultural-related energy programs are driven primarily by energy efficiency goals, such Energy Trust's irrigation efficiency incentives, and the *Save Water, Save Energy* program offered by some BPA-affiliated energy providers. Likewise, water programs typically highlight the benefits of water conservation for fish and instream flows. Oregon should look for ways to integrate energy-efficiency and water savings programs within agriculture and across other water sectors, and capture the results of project efforts. Integrating these programs can lead to more wide-ranging benefits, help eliminate unintended consequences, and provide better information for the design of such programs in the future.

Saving Water and Energy in the Home

Energy Star, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy rates energy efficient products and practices to help consumers and businesses save money and energy on new purchases. Many qualifying appliances also reduce water use. A full-sized Energy Star clothes washer, for example, uses 14 gallons of water per load, compared to the 27 gallons used by a standard machine. This can result in a savings of 43,000 gallons of water over the machine's lifetime.

The Energy Trust of Oregon offers a number of cash incentives for participating customers of Portland General Electric, Pacific Power, NW Natural, and Cascade Natural Gas. The cash incentives are wide-ranging, with benefits for residences, businesses, industries, and agriculture. The Energy Trust promotes Energy Star products as well, offering cash back on premium-efficiency qualifying clothes washers.

The Oregon Department of Energy also offers residential energy tax credits statewide, allowing Oregonians to claim a credit for energy efficient upgrades in their homes. The state tax credit is available for premium energy-efficient water heating technologies, such as tankless, heat pump, and solar water heaters.

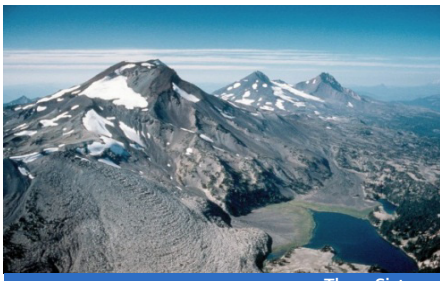
Several of Oregon's water providers also offer water saving incentive programs to their customers. In recent years, water providers in the Portland metropolitan area have partnered with the Energy Trust and Portland General Electric to offer co-audits that identify both water and energy savings.

Strengthening Coordination and Partnerships

Undoubtedly, there are very good reasons to consider the relationship between water and energy. Water has played a key part in meeting our energy demands in the Pacific Northwest, and may play an even greater role as we look to renewable energy and other technologies to meets our needs in the future. The importance of the state's water resources for meeting often competing needs makes it even more imperative to consider how energy development affects our demands for water.

Addressing the water and energy nexus cannot be focused on only one sector. We all depend on water and energy, and we can all contribute to making more efficient use of both. Oregon's state agencies and partners should focus efforts on strengthening the coordination between water and energy conservation programs. Developing new partnerships with water users to identify and promote optimal combinations of on-site water and energy efficiencies will be necessary to advance statewide conservation efforts.

CRITICAL ISSUE: CLIMATE CHANGE


Three Sisters

Warner Wetlands, Lake County

Trapper Creek, Odell Lake Watershed

Photos: USGS, BLM, USFS

The consensus among climate scientists is that climate shift is occurring and that significant impacts to the environment will be felt in this century. An analysis of the global climate models used in the 2007 Intergovernmental Panel on Climate Change assessment show an increase in annual average air temperatures in the Pacific Northwest through the end of the 21st century.

An increase in average air temperatures has potential consequences for Oregon's water resources. Oregon's wetlands, estuaries, rivers, and streams—even groundwater—are all affected by changes in climate. Oregon's forest ecosystems, essential for storing and filtering water, will also be affected by climate change. These changes will have implications for our ability to meet instream and out-of-stream water needs. Oregon will need to continuously monitor climate change effects on Oregon's water resources and help water users adapt to climate change.

Climate Change Research and Partnerships in Oregon

Many institutions at the local, state, and federal level are conducting climate change research, identifying and assessing risks and actions specific to the Pacific Northwest. Many of Oregon's drainage basins have been the focus of these latest research efforts. In 2010, for example, teams of university researchers began evaluating how climate change, population growth, and economic growth will alter the availability and the use of water in the Willamette River Basin on a decadal to centennial timescale. This research will help water managers and natural resource agencies develop placed-based strategies for addressing climate-related impacts on water quality, water quantity, and ecosystems. Today, there are many opportunities for further collaboration between government agencies and research institutions.

Oregon Climate Change Research Institute

The Oregon Climate Change Research Institute (OCCRI) has been tasked by the Oregon Legislature to foster climate change research among faculty of the Oregon University System. In 2010, OCCRI released the *Oregon Climate Assessment Report*, a compendium of research on climate change and its impacts on the state of Oregon. The report draws upon a large body of work on climate change impacts in the western United States, including work conducted by the Climate Impacts Group at the University of Washington, and the California Climate Action Team. The report also identifies several knowledge gaps and the need for more research in certain areas.

Researchers are also examining climate change impacts on a regional scale, looking specifically at risks to the Pacific Northwest. The National Oceanic and Atmospheric Association awarded a five-year grant to establish and coordinate a regional consortium of climate variability assessment, research, and outreach in the Pacific Northwest. Funds were used to establish the Climate Impacts Research Consortium (CIRC), which includes OCCRI and other researchers from universities and extension services within Oregon, Washington, and Idaho. The Consortium provides information and tools for making decisions about landscape and watershed management in a changing climate. CIRC expects funding of $3.8 million to continue climate change research over the next five years. CIRC has been home of the Regional Integrated Sciences and Assessments (RISA) for the Pacific Northwest since September 2010, one of eleven currently funded RISAs in the country.

Recommended Action 5.A
Support Continued Basin-Scale Climate Change Research Efforts

How to implement this action:

- Improve climate change projections at a basin scale 🕮
- Develop reliable projections of basin-scale hydrology, and their impacts on other systems 🕮

Oregon's Climate Change Adaptation Framework

The Oregon Department of Land Conservation and Development recently led an interagency effort to develop the *Climate Change Adaptation Framework* for the State of Oregon. The Framework provides a broad-scale qualitative assessment of risks to people, infrastructure, communities, and natural resources that are expected to result from the effects of variable and changing climate conditions. The Framework was developed in parallel with OCCRI's *Oregon Climate Assessment Report* and provides initial recommendations for preparing for the likely impacts of climate change, including planned and needed actions by state agencies. The Framework describes eleven likely changes in climate conditions in Oregon over the next three to five decades.

Oregon Global Warming Commission

The Oregon Global Warming Commission's general charge is to recommend ways to coordinate state and local efforts to reduce Oregon's greenhouse gas emissions consistent with Oregon's reduction goals, and to recommend efforts to help the state, local governments, businesses and residents prepare for the effects of global warming. In 2010, the Oregon Global Warming Commission began its Roadmap to 2020

Project. It will offer recommendations for how Oregon can meet its goal of cutting greenhouse gases by 10 percent below 1990 levels by 2020, and achieve a minimum of 75 percent reduction from 1990 levels by 2050. A key action for the Roadmap is to increase water efficiency, because water use is an important component of many industrial processes and should play a part of Oregon's greenhouse gas emissions reduction strategy.

Climate Change Projections for Oregon

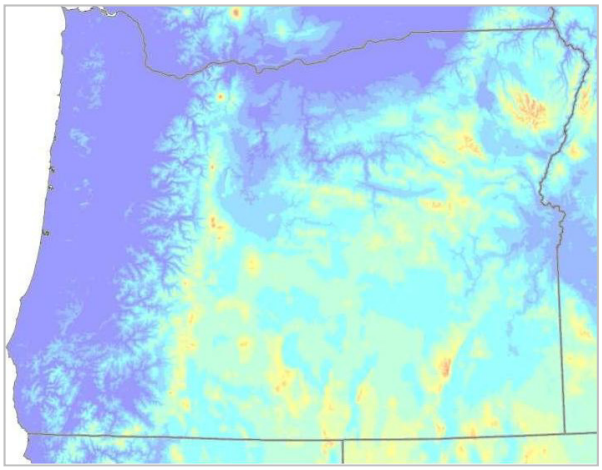
Many of the likely changes (or risks) that are predicted will affect water resources. Climate change will likely alter the hydrology of many streams throughout Oregon, affecting the availability and quality of water. Increasing temperatures will affect snowpack in the Cascades, which will alter the timing of runoff and water availability in large areas of the state. Following is a summary of some of the risks identified in the *Climate Change Adaptation Framework*, OCCRI's *Assessment*, and other recent studies.

Declining Springtime Snowpack

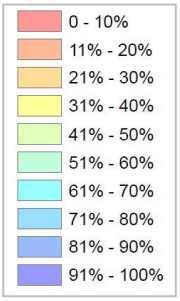
Climate models project an average rate of warming of approximately 0.1 – 0.6° Celsius per decade through the 2050s. The rate of change after the 2050s depends increasingly on the choice of greenhouse gas emissions scenarios.

If Oregon's mean annual temperature increases, the percentage of precipitation that falls as snow will be significantly less. The accompanying figures show the percentage of precipitation that falls as rain in two scenarios: current precipitation conditions and conditions with a rise in temperature of 3.0° Celsius.

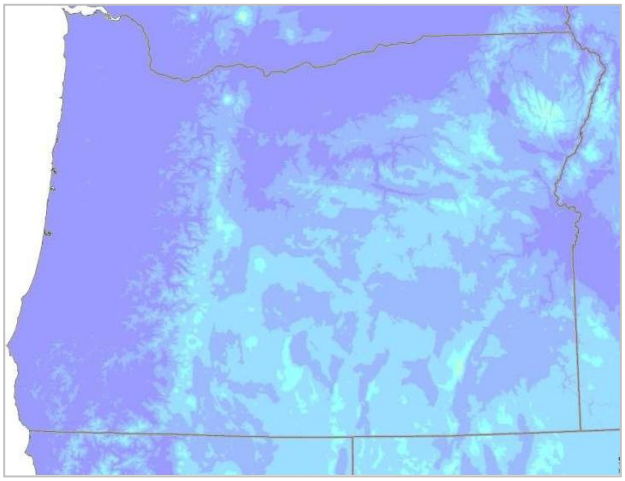
Current Precipitation Conditions



Red, yellow, and orange hues represent areas where a large percentage of precipitation falls as snow.



Future Scenario (3.0°C Temp Increase)



Snow-dominant areas largely disappear with a rise in air temperature.

Significant declines in snow water equivalent in the Pacific Northwest and a shift in precipitation from snow to rain coinciding with increases in air temperature since the 1950s are well documented. Precipitation arriving as rain instead of snow could pose several challenges to water systems, such as flashier flood-prone systems, decreased summertime run-off to surface water, and reduced recharge to groundwater aquifers. Water users who are dependent on snowpack for summertime water could see significant decreases in water when they need it most.

Oregon, like much of the Northwest, is highly dependent on temperature-sensitive springtime snowpack to meet growing and often competing water demands. A study completed by the Climate Impacts Group at the University of Washington indicates that approximately 50 percent of Oregon water users are located in areas of the state that are dependent on snowpack to meet their water needs.

This means that water availability significantly depends on the presence of natural storage, with water becoming available during heavy use periods as a result of snow melt. Loss of natural storage means less water will be available to meet instream and out-of-stream needs during summer and fall months. This issue will be compounded by the potential for warmer summer months and a longer growing season.

Storing water, via built and natural systems, is important for meeting Oregon's water needs. More work is needed to understand how the loss of natural storage can be mitigated through structural and non-structural approaches.

Increased Incidence of Drought

Drought has historically been an issue in Oregon largely because precipitation in the Pacific Northwest is highly seasonal. The Pacific Northwest is prone to three types of drought: low winter precipitation, low summer precipitation and lack of snowpack due to warm winter temperatures. A 2002 statewide hazard analysis found six counties—Harney, Jefferson, Klamath, Sherman, Wallowa, and Wheeler —ranking drought as their "number one" natural hazard concern. Gilliam County also ranked it highly.

When drought conditions exist, the Governor can issue a formal drought declaration, which triggers a number of water management tools to which users would not otherwise have access. The declaration allows water users to apply for emergency permits under an expedited process, temporary transfers, and temporary substitutions of a supplemental groundwater right for a primary surface water right. A drought declaration also allows the Water Resources Commission to grant a temporary preference of use for human consumption and/or stock watering. The Commission may also order state agencies and local governments to develop and file Conservation and Curtailment Plans with the Water Resources Department.

Due to the annual variability of precipitation in the Northwest, not all droughts can be attributed to climate change. However, with more winter rainfall, declining snowpack, and earlier spring snowmelt as a result of increasing air temperatures, drought conditions are likely to increase throughout the next century.

The possibility of drought, and longer and drier growing seasons, could result in an increased demand on groundwater resources and increased consumption of water for irrigation. With a 1° Celsius rise in temperature, irrigation demands are projected to increase by 10 percent. An increase in irrigation-related water consumption can translate into higher irrigation costs. The economic impact of more frequent drought conditions may negatively affect the agriculture industry, as farmers see reduced yields and quality in some crops.

Determining how water rights for irrigation will fare with changing crop needs and growing seasons under various climate change scenarios is needed. Updating Oregon's crop water use tables, published in 1992, and used by water managers and consultants throughout the state for designing irrigation systems/scheduling, water right transfers, and other studies may be needed to help better prepare agricultural water users for the impacts of climate change.

More Frequent Precipitation Events and Flooding

Floods are a common and widespread natural hazard in Oregon. Floods west of the Cascades tend to be associated with larger scale, more widespread events, while eastern Oregon typically experiences more localized, intensive events.

The National Flood Insurance Program reports that 256 communities in Oregon are prone to flooding, in all 36 counties. Oregon has seen the damaging effects of severe winter storms and resulting floods as recently as January 2012, with a major disaster declaration issued for twelve counties in Oregon.

There is confidence that flooding will increase in the 21st century, particularly in areas that have a history of chronic flooding. Flooding in Oregon generally occurs due to extreme precipitation events, rapid snowmelt, or rain-on-snow precipitation events. In the next few decades, extreme daily precipitation events may increase, but exact locations cannot be predicted with certainty.

Increasing Wave Heights, Storm Surges, and Sea-Level Rise

The coast is vulnerable to a number of climate-related impacts, which will exacerbate many of the stresses and hazards facing the Oregon coastal zone. Oregon's winter storms have historically been the primary factor for coastal erosion and flooding. Maximum wave heights have increased significantly from the period of the late 1970s to 2005, from 9 meters to about 12 meters. The combination of the likely possibility of increasing storm-generated wave heights and rising sea-levels may present a substantial threat to the Oregon Coast.

Such threats include increased erosion and the loss of beaches and significant coastal land areas. Other threats include increasingly stressed infrastructure facilities built under older engineering standards. Infrastructure at risk can include water treatment plants, diversion facilities, and wastewater plants. The intrusion of salt water to such facilities will be a risk in some coastal communities.

Sea-level rise will also have impacts beyond coastal Oregon, affecting tidally-influenced rivers, such as the Willamette, and surrounding inland communities, where rising river levels can pose flooding problems.

Oregon will need to ensure that it is capable of providing water and wastewater services in the face of a changing climate. This can be done by making water systems more resilient by improving storage and transmission capacity, building in system redundancy (back-up supplies, intergovernmental agreements), and further pursuing water conservation, reuse, and efficiency projects in partnership with neighboring communities.

Stacy Vynne and Roger Hamilton,
The Resource Innovation Group

Willamette Valley Resilience Compact:
Enhancing Climate Change Coordination among Local Governments

Local jurisdictions across the Willamette Valley are coming together to develop a Willamette Valley Resilience Compact among city and county governments. The purpose of the Compact is to coordinate and enhance efforts to build the resilience of the Valley's economy, public health, food, water, and energy supplies, in the face of natural hazards and anticipated impacts from a changing climate. The Compact is a cooperative approach led by local governments, but which engages state and federal agencies, stakeholders from the private sector, and non-governmental organizations in order to strengthen community and regional resilience to build a sustainable future for the entire Willamette Valley. The Resource Innovation Group, a nonprofit organization based in Eugene, is facilitating this process. City and county governments plan to move the Compact forward for adoption in late 2012.

Climate Change and Ecosystems

Climate change projections show negative consequences for Oregon's ecosystems. As such, Oregon will need to support efforts to improve the resiliency of its diverse ecosystems in response to climate change.

Fortunately, much work has already been done to increase the resiliency of Oregon's natural environment, through local restoration efforts under the Oregon Plan for Salmon and Watersheds and other habitat restoration and conservation programs. Protecting and restoring streamflows, wetlands and floodplains, and improving riparian zones, uplands, and forests are efforts that should be continued and strengthened.

Loss of Wetland Ecosystems

Sufficient scientific evidence suggests that climate change is now having and will have significant impacts on millions of coastal, estuarine, and freshwater wetlands throughout the United States due to increased temperatures, changes in precipitation, and sea-level rise. Sea-level rise predictions for Oregon wetland refuges indicate different types of impacts across different estuaries or estuarine segments.

Wetlands are more sensitive to small changes in precipitation and temperature than other ecosystems and thus may be degraded or lost as a result of future climate conditions. Depending on the sea-level rise scenario, analyses indicate that Bandon Marsh National Wildlife Refuge is predicted to lose between 19 and 92 percent of its swamp by 2100.

Effects on Forest Ecosystems

A recent U.S. Forest Service report describes how warmer temperatures and changing water quantities can heighten changes in forest vegetation and forest mortality. Higher summer temperatures and earlier spring snowmelt are expected to increase the risk of forest fires. An increase of insect outbreaks, wildfires, and changing species composition in forests will pose challenges for ecosystems and significant challenges for water management.

Effects on Aquatic Species & Habitat

The distribution of cold-water species will potentially shrink and become disconnected as thermal regimes in river networks warm. Climate change projections show that 37 percent of the current locations of 57 North American freshwater fish species would not support these species over the next century.

Other studies show trout habitat in the Pacific Northwest declining between 8 and 33 percent by 2090. Salmon is even more vulnerable to the effects of climate change because more of its habitat is located at lower, warmer elevations. Projections show that suitable salmon habitat in Oregon and Idaho may shrink as much as 40 percent by 2090.

Climate Change and Water Quality

Climate change impacts to our built and natural systems will be compounded by the water quality issues we are already facing in Oregon. High water temperatures are already a major water quality concern in more than 17,000 miles of Oregon's streams and rivers today. Water temperature is projected to rise as air temperature increases in the 21st century, particularly in urban streams where natural riparian vegetation is typically lacking. A decline in summer streamflow will exacerbate the increase in water temperature, because low volumes of water can heat up more quickly than during periods with larger streamflows.

In snowmelt-dominated watersheds, increases in runoff will result in warmer summer water temperatures, increased pollution, and sedimentation, all of which have negative consequences for natural systems, salmonids, and other estuarine and marine populations.

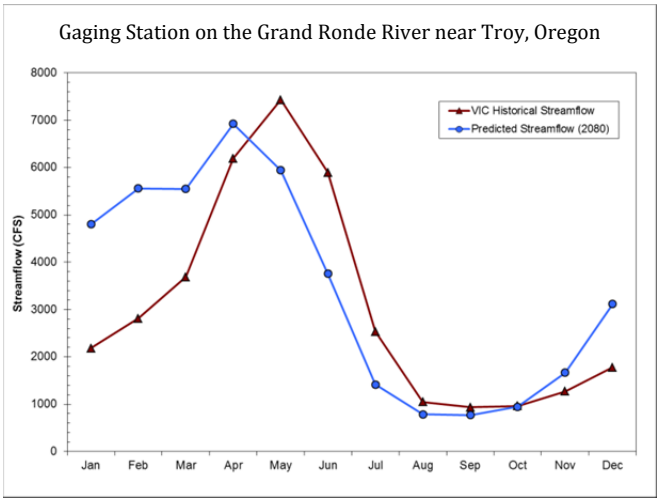
The water quality effects of climate change not only affect our natural systems, but can also affect our built systems as well. Increased runoff, storm events, and sedimentation can further impair water quality, and may overwhelm drinking water and wastewater treatment facilities, possibility leading to increases in pollution and higher treatment costs. The Climate Ready Water Utilities Program at the U.S. Environmental Protection Agency is a resource that can help water providers develop and implement long-range plans that account for climate change impacts. Water providers in Oregon should consider use of this program to prepare for climate change.

Climate Change and Water Quantity

The change in timing and availability of water as a result of climate change may affect whether or not water users are able to utilize their water rights as authorized. It could also mean that instream water rights are not met as often in the future.

The scenario at the right demonstrates how dramatically the hydrograph (a depiction of streamflow) could shift in one stream, due to a loss in snowpack. Where snowmelt historically resulted in high flows from April to June, future precipitation in the form of rain may instead result in high flows from March through May.

The implications of this shift could be significant for water right holders, particularly for those who have historically relied on surface water during June, July, August, or September.



For an explanation of the climate scenarios used, visit the Climate Impacts Group site at: www.hydro.washington.edu

Water rights that protect water instream for a certain amount, time of year, and location may no longer be adequate due to precipitation changes, decreased snowpack, and changes in species distribution. An increase in regulation to meet senior out-of-stream water rights, to protect instream needs, and to meet water quality needs could result.

Water managers and water users will need to look for more efficient ways to conserve, store, and reuse water, while also considering innovative alternatives or new ways to meet needs in a changing climate, especially during times of critical low-flow periods. Future efforts should include an analysis of how instream and out-of-stream water rights would fare with significant hydrologic changes. Analyzing the potential local effects of climate change will help planners build alternatives into place-based, integrated, water planning efforts.

Supporting Climate Change Research and Adaptation Strategies

Oregon should continue collaborating with existing climate change research organizations and institutions to improve climate change projections at a basin scale. Basin-scale data is needed to help Oregonians begin preparing responses and strategies to address climate change.

Collaboration includes working with the Oregon Climate Change Research Institute and Pacific Northwest Climate Impacts Research Consortium on basin-specific studies. Oregon's natural resource agencies at the local, state, and federal level should invest and make improvements in the long-term monitoring of surface water and groundwater resources, including the NRCS's SNOTEL network. Investments are also needed to improve the real-time forecasting of water deliveries, basin yields, monthly streamflow, flood frequency projections, and drought frequency projections.

Oregon needs to develop reliable climate change projections for hydrology at a basin scale, and determine the associated impacts to built and natural systems, such as:

- the flooding potential with precipitation arriving as rain instead of snow;
- the effects on groundwater recharge from loss of snowpack;
- changes in timing and streamflow as well as potential impacts to water quality;
- the impacts on various life stages of aquatic species, including species abundance and distribution;
- changes in municipal and agricultural demand, shifts in water-related infrastructure needs (e.g., treatment, storage, transmission); and
- the impacts on wetland and floodplain restoration efforts.

Recommended Action 5.B
Assist with Climate Change Adaptation and Resiliency Strategies

How to implement this action:

- Provide support to communities to incorporate climate change into their planning decisions 🕮
- Look for more efficient ways to conserve, store, and reuse water in anticipation of climate change
- Invest and make improvements in surface water and groundwater monitoring
- Invest in real-time forecasting of water deliveries, basin yield, streamflow, flood and drought frequency projections
- Analyze how instream and out-of-stream water rights will fare with hydrologic changes
- Analyze how water rights will fare with changing crop needs 🕮
- Use the U.S. Environmental Protection Agency's Climate Ready Water Utilities Program
- Increase ecosystem resiliency to climate change
- Ensure continued water and wastewater services in a changing climate

Catherine Creek State Park, Union County

Harney County

Santiam State Forest

Photos: Gary Halvorson, Oregon State Archives, Oregon Dept. of Forestry

Land and water are connected in many ways. The way in which we manage the landscape—our forests, farmlands, rangelands, and urban spaces—can have positive or negative implications for water resources. Protections have been put into place to ensure that streams, rivers, and groundwater resources are managed for the long-term sustainability of Oregon's ecosystems, economy, and quality of life. Proper land management can play a critical role in the health and availability of water resources for future generations.

Local government land use planners do not always have the information they need to make long-term decisions that affect water resources. Oregon can help remedy this issue by improving communication and coordination between state and local governments on land use matters and water resources. Considering the pressures of projected increases in population, Oregon's communities need to adequately plan and prepare for meeting a larger demand on a shared resource. Water quality, water quantity, and ecosystems will all need to be considered within the context of land management and development. Efforts that are aimed at minimizing the impact of development can help meet statewide goals related to protection and use of water resources.

Planning for Land Use in Oregon

Oregon's statewide land use planning program was designed to foster livable and sustainable development; to protect farms, forestlands and other natural resources; to conserve coastal and ocean resources; and to improve the well-being and prosperity of Oregon's citizens, businesses, and communities. Originating in 1973 under Senate Bill 100, the program has positioned Oregon as a nationally recognized leader in the arena of land conservation and development.

Land use management is a function that resides with local planners, local planning commissions, boards, and councils, all of which include a public process and oversight from the state Department of Land Conservation and Development.

Local governments in Oregon are responsible for implementing their own Comprehensive Land Use Plan that complies with the 19 statewide planning goals. The Land Conservation and Development Commission will acknowledge a local government's comprehensive plan when it complies with the goals. Many of these planning goals relate to protecting and maintaining water resources, both quality and quantity.

- **Goal 5** requires protection of state-designated areas with known water supply or water quality issues, along with protection of wetlands and significant riparian corridors. Specifically, Goal 5 and its administrative rules require local governments to protect "significant natural resources." These include 1) critical groundwater areas and restrictively classified areas designated by the Oregon Water Resources Commission,

and 2) certain wellhead protection areas. Few local governments have completed this planning, particularly since completing the process for wellhead protection areas is not mandatory.

- **Goal 6** is aimed at maintaining and improving the quality of the air, water, and land resources of the state. This goal has no implementing rules. Although the goal directs local governments to consider the effects of land use on water quality, it does not contain specific requirements on how to achieve this aim.

- **Goal 11** and its administrative rules require cities with a population greater than 2,500 to prepare public facilities plans addressing drinking water, wastewater disposal and treatment, and stormwater management needs. These plans focus on the costs and timing of infrastructure needs and coordination among providers within the jurisdiction.

The 19 Statewide Planning Goals

Goal 1	Citizen Involvement
Goal 2	Land Use Planning
Goal 3	Agricultural Lands
Goal 4	Forest Lands
Goal 5	Natural Resources, Scenic and Historic Areas, & Open Spaces
Goal 6	Air, Water and Land Resources Quality
Goal 7	Areas Subject to Natural Hazards
Goal 8	Recreational Needs
Goal 9	Economic Development
Goal 10	Housing
Goal 11	Public Facilities and Services
Goal 12	Transportation
Goal 13	Energy Conservation
Goal 14	Urbanization
Goal 15	Willamette River Greenway
Goal 16	Estuarine Resources
Goal 17	Coastal Shorelands
Goal 18	Beaches and Dunes
Goal 19	Ocean Resources

There are also other goals that indirectly affect water resources, such as development restrictions on forestlands and agricultural lands. Development on forestlands is limited by Goal 4 and by county regulations. Forests encompass a large part of many watersheds, particularly in the upper reaches. Limiting land uses that could have a detrimental effect on water quality is one of the purposes of restrictive forest zoning.

Water and Changes in Land Use and Plans

Changes in land use, whether to forestlands, wetlands, or other landscapes have an impact on water resources. For example, Oregon's forests are a source of high quality drinking water and directly support public drinking water systems and ecosystem health. Changes within the forested landscape may decrease the quality of this water, which is among the best source water in the nation today. Like forestlands, Oregon's 17.1 million acres of agricultural lands, have been preserved by Oregon's land use planning system, helping to keep Oregon one of the most agriculturally diverse states in the nation.

Urbanization and significant new rural development on what was formerly farm or forestland may result in increased consumptive use of water, while at the same time altering the stormwater regime and contributing to nonpoint source pollution. Local development regulations created in response to the Clean Water Act and Goal 6 help address runoff and other quality concerns. Finding and maintaining high quality drinking water sources are increasing challenges for municipalities and for rural land owners in some areas of the state.

Planning for Growth

Continuing to protect natural resources will become even more important and challenging with expected population growth in Oregon. Some areas that are seeing a growth in population are also areas with known water resources issues. Many of the state's groundwater restricted areas fall within portions of Marion, Polk, Yamhill, Washington, and Clackamas counties, all of which saw a population increase of at least 10 percent since 2000.

Deschutes County is another area where population has grown steadily. Growing from a population of about 62,000 in 1980, Deschutes County is now home to nearly 158,000 people. Many residents live within the upper Deschutes Basin where future groundwater use has been limited to protect existing water uses, including scenic waterway flows and instream water rights. Planning for future development must take into account current pressures on Oregon's water resources, in terms of both water quantity and water quality.

Each city and metropolitan area in Oregon has an urban growth boundary that separates urban land from rural land. The boundary controls urban expansion onto farm and forestlands. By law, every city has to maintain a long-term supply of buildable land in its UGB to accommodate growth. In the Portland area, Metro is the responsible governing body and in 2011, for example, Metro added 1,985 acres to the UGB to help address the anticipated 20-year need for new housing and jobs. Medford and Bend are among the cities currently updating and expanding their urban growth boundaries. Over the next 50 years, urban and rural transition zones may become areas where the availability and quality of water resources play a more important role during the planning process.

Information Used in Land Use Planning

Considering the need to comply with several, very different land use goals, the information needed and used to develop land use plans covers a wide spectrum. Oregon Department of Forestry's stream classification maps, Oregon Department of Fish and Wildlife's fish presence surveys, Local Wetland Inventories, the National Wetland Inventory, and the Federal Emergency Management Agency's floodplain maps are often used by land use planners to develop local riparian corridor and wetland protections.

Some local governments use Drinking Water Source Area maps and Source Water Assessment Reports (when available) to voluntarily initiate a process to protect drinking water sources. Population and employment forecasts are of interest to municipalities when estimating demand for residential, industrial and other sectors.

Studies conducted to support individual land use requests, particularly to show that there is an adequate supply of water for a proposed rural use, are frequently completed. These customized studies are usually based on existing data such as well logs, basin studies, and previous reports.

Finally, Oregon's land use laws provide opportunities for counties to consider the appropriate level of rural development in areas that are not zoned for "resource" (i.e., farm or forest) use and to study whether new areas for development should be designated. The planning goals require counties to address the carrying capacity of the land when considering how much development, particularly of residential use, is appropriate. Developments in most rural areas of the state depend on groundwater to supply residential needs. Counties need data on the availability of groundwater in order to make informed decisions on what density of development to permit in rural development zones.

There are areas, however, where data is lacking and improvements could be made to connect land use planning and water resources planning. Of chief concern, local land use decision makers need more information about groundwater availability at specific locations, as well as the long-term ability of local aquifers to yield water, when making decisions about appropriate locations for development, particularly in rural areas. Available groundwater information today tends to be either too broad (based on regional studies) or too narrow (based on specific project sites) to help with land use planning decisions.

Land use decision makers also need better information about the cumulative impacts of development on water quantity and quality, including better information about the carrying capacity of land to absorb stormwater and wastewater through on-site disposal systems over the long-term.

Oregon's cities and counties employ a variety of techniques to meet statewide planning goals, including data collection and monitoring, for the protection of natural resources within their boundaries. The accompanying essay provides examples of protection efforts in Benton County and Marion County.

Greg Verret, Benton County
and Lisa Milliman, Marion County

Using County Codes and Outreach to Collect Data, Make Decisions, and Educate Residents
Benton County's Development Code requires demonstration of an adequate water supply (both quantity and quality) to serve any proposed development. The quantity requirements are scaled to the development and range from pump tests for building a home to a full hydrogeologic study in a large-land subdivision. In 2011, the County adopted erosion control and long-term stormwater management requirements for new developments, as well as an ordinance prohibiting discharge of pollutants to streams and stormwater conveyances. The County is also developing a stream, wetland, and riparian protection program for rural portions of the county.

Marion County's Rural Zone Code requires water level measurements for wells on newly approved land divisions or lots, along with a requirement to implement a well monitoring program for new subdivisions. Marion County has initiated an ongoing public outreach effort to educate landowners about proper use and maintenance of onsite sewage treatment systems and identifying old, poorly designed systems that should be upgraded, especially in areas where water quality problems have been identified, clusters of small properties along salmon bearing streams and rivers, and areas with shallow wells and small lots.

Perspectives from Oregon's Counties

In 2011, the Water Resources Department conducted a survey of Oregon's county commissioners to better understand where information is lacking and what improvements could be made to connect land use planning and water resources planning. Twenty-three of Oregon's 36 counties participated, responding to questions regarding their water-related data needs, the status of integrated water resources planning, their relationships with stakeholders, and the types of assistance needed from state agencies.

Water-Related Issues

Commissioners noted which water issues had come before their county commissions during the past 12 months. Counties have had very different exposure to water-related issues, with more than half of the respondents (12 counties) discussing at least seven water-related issues during the past year. One county commission reported having discussed all 16 of the listed issues, compared with two commissions that had dealt with only one issue each.

The issues themselves were wide-ranging, with the most frequent discussions focusing on the need for better water data (indicated by 15 counties), water resources planning (14), water-related funding (14), water quality (13), and wastewater infrastructure (12). See accompanying table.

The Number of County Commissions Discussing…

15	Water Data
14	Water Resources Planning
14	Water-Related Funding
13	Water Quality
12	Water Related Infrastructure
11	Water Conservation
11	Water & Energy Development
11	Water Storage
10	Water Reuse
10	Streamflow Restoration
9	Public Health & Water
9	Water Education & Training
9	Water Supplies
8	Ecosystems & Water
6	Climate Change & Adaptation

November 2011 Survey of Oregon Counties – OWRD

Commissioners then responded as to whether they feel their county commission is well versed in water resources issues. Responses diverged widely, but tended toward the negative, with nine respondents "disagreeing" or "strongly disagreeing" with the statement.

Results tended even more toward the negative when asked to comment on whether their county is well underway with county-wide, integrated water resources planning (meeting water quantity, water quality, and ecosystem needs). More than half of the counties represented (12), did not believe their counties were participating in such planning activities.

County & Stakeholder Relationships

In an effort to discern how well county commissions are positioned to undertake or participate in place-based, integrated water resources planning, the survey asked about the nature of their relationships with local stakeholders and partners. In general, the surveyed commissions indicated regular contact existed between counties and soil and water conservation districts, watershed councils, and irrigation districts. Regular contact with wastewater and stormwater managers, businesses, and municipal water providers occurs less often. County commissions have the least contact with environmental groups and tribes. Of all stakeholder groups, survey respondents ranked their working relationships with neighboring county commissions as the highest.

State Assistance

Finally, the survey asked commissioners what is needed to assist with local water resources planning. "Funding with grants" was the most frequent response (indicated by 16 counties), followed by providing water quality data (12), providing water availability data (11), assistance identifying other funding sources (9), and identifying best practices in water management (8).

Recommended Action 6.A
Improve Integration of Water Information into Land Use Planning (& vice-versa)

How to implement this action:

- Develop and share information regarding the location, quantity, and quality of water resources
- Protect water sources in the course of land use decisions

Importance Confirms Previous Survey

Feedback from the 2011 survey also confirms the results of a previous water supply planning survey of county planners conducted a few years ago. In that survey, counties also ranked water data as their number one need. The majority of counties surveyed in 2007 (85 percent), requested more information on the availability of water supplies in their communities, more specifically, groundwater.

Oregon should improve the integration of water information into land use planning, and vice-versa. This involves developing and sharing information regarding the location, quantity, and quality of groundwater resources. Such information would help inform comprehensive plans, shovel-ready certified sites, capital improvement plans, water management and conservation plans, and other activities that contribute to land use decisions. Studies of exempt-use wells, assessments of drinking water sources, and improved information regarding underground injection control systems would aid community-based protection and management strategies. This information is critical to protecting water sources during the course of land use decisions.

Coordination among State and Local Governments

Each local government in Oregon with responsibility for land use management coordinates with various state agencies to ensure that state agency actions (e.g., permitting) are consistent with local comprehensive plans, and vice versa. The Water Resources Department, for example, coordinates with

local governments on actions involving applications for water use permits, transfers, water exchanges, instream water rights, and reservations for economic development.

To ensure compliance and compatibility with local comprehensive plans, twenty-five agencies have developed State Agency Coordination Programs, most of which were certified by the Land Conservation and Development Commission around 1990. Since that time, only one state agency has updated its State Agency Coordination Program.

Recommended Action 6.B
Update State Agency Coordination Plans

How to implement this action:

- Update State Agency Coordination Programs in coordination with DLCD

Changes to state rules and programs, and to comprehensive plans, may lead to incompatibilities that are detrimental to public and private interests. The Strategy should ensure that state agency coordination programs are keeping pace with local permitting decisions and changes in comprehensive plans, while meeting multiple state agency requirements.

Low Impact Development & Green Infrastructure

Runoff from urbanized land areas and impervious areas such as paved streets, parking lots, and building rooftops during rainfall and snow events often contains pollutants that adversely affect water quality. This polluted runoff commonly includes heavy metals, pesticides and fertilizers, oil and grease, bacteria, and sediment. The U.S. EPA describes urban runoff as one of the leading sources of water quality impairment in surface waters. Urban sources can also contaminate groundwater. Humans and their actions are the most significant sources and causes of polluted runoff.

The negative effects of polluted runoff to human health and watershed health can be minimized through effective stormwater management. In 2007, the Oregon Environmental Council convened a stormwater solutions team to look for ways to reduce stormwater impacts in Oregon's urban landscapes. The team identified two major approaches to accomplish this: 1) improve the way stormwater is managed by promoting green infrastructure and other best management practices; and 2) reduce the source of pollutants commonly found in stormwater.

Recommended Action 6.C
Encourage Low Impact Development Practices

How to implement this action:

- Compile and provide online information on low impact development policies 🕮
- Update local development codes, improving local capacity to review and permit green infrastructure designs

The use of low impact development and green infrastructure may help cities and counties meet statewide goals for water quality, particularly in management of stormwater and urban runoff. A 2008 report by OSU's Sea Grant Extension Program and the Oregon Department of Land Conservation and Development (LCDC) defines low impact development (LID) as a "stormwater management strategy that emphasizes conservation and use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial, and industrial settings."

The U.S. EPA describes green infrastructure as generally referring to systems and practices that use or mimic natural processes to infiltrate, evapotranspirate, or reuse stormwater or runoff on the site where it is generated. Green infrastructure is actually very similar to low impact development in its approach to managing water resources. The goal of both approaches is to treat stormwater runoff at its source before

it reaches the sewer system. This can be done through the use of bioswales, rain gardens, or vegetated roofs, for example. Rainwater harvesting is another useful approach, one that utilizes water as an on-site resource for activities like lawn watering or gardening.

LID Barriers and Opportunities

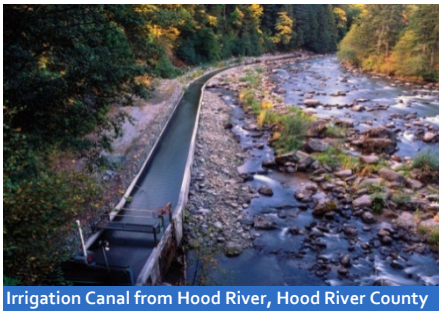
The OSU/DLCD report referenced earlier also examined the barriers and opportunities for employing low impact development designs among three Oregon communities. One significant theme that emerged was a lack of basic understanding—a disconnect between today's land use and development decisions and tomorrow's consequences, in terms of both costs and resource quality.

The report also found a need for strong administrative support and direction to incorporate LID practices into codes or to encourage developers to try such projects. Local planning departments need technical resources and assistance to help familiarize themselves with low impact techniques, and to allow such projects to move through the local government approval process. Oregon's public and private partners should compile and provide information on LID policies in cities and counties across the state, as it would help encourage more effective use of these practices. Oregon communities should consider updating local development codes, where appropriate, and improving local capacity, both technically and legally, to review and permit green infrastructure designs.

CRITICAL ISSUE: WATER-RELATED INFRASTRUCTURE

Owyhee Dam, Malheur County

Bonneville Fish Ladder, Columbia River


Irrigation Canal from Hood River, Hood River County

Photos: U.S. BOR; U.S. ACE; G. Scholl-Erdmann, Farmers Conservation Alliance

Infrastructure is another important, but often overlooked, piece of the water equation. It takes an extensive system of pumps, pipes, treatment, and storage facilities to deliver water to our homes, businesses, and farm fields every day. In the United States, drinking water alone is delivered through a network of more than one million miles of pipes, and wastewater sewer lines cover more than 600,000 miles.

Maintaining the infrastructure to move water and wastewater is an expensive, but necessary task. Much of the nation's infrastructure is aging and will soon reach the end of its useful life. Ensuring that Oregon's water-related infrastructure is well maintained and functioning is important for a variety of public health and safety reasons, but also for meeting our state's economic needs.

Infrastructure for Irrigation

Irrigation districts throughout Oregon are responsible for maintaining the infrastructure needed to divert and transport water to their patrons. The Oregon Water Resources Congress, a nonprofit trade association, describes irrigation-related infrastructure as an integrated system that encompasses all of the components necessary to get the water from its source to the farm or other water users. Examples of irrigation infrastructure include:

- storage facilities, such as dams;

- the reservoir behind the dam (and any recreation facilities associated with it);
- regulating reservoirs;
- wells;
- diversion and delivery systems such as canals (lined and unlined) and pipelines;
- pumps and pumping stations;
- headgates, headworks, and valves;
- spillways; siphons; drains; penstocks (for power) and transmission lines;
- telemetry systems;
- measurement devices such as weirs, flumes, meters, gaging stations, and data loggers; and
- infrastructure for species and habitat, such fish screens and fish passage facilities.

The cost of delivering water, which includes maintaining all of the infrastructure components listed above, is typically covered by irrigation district patrons or individual irrigators. Some irrigation and water districts have been successful in obtaining federal cost-share funding—through the Bureau of Reclamation's WaterSMART program, for example—to improve the efficiency of their water delivery systems. The presence of properly maintained irrigation infrastructure is incredibly important to Oregon's farmers and ranchers. Without it, many agricultural operations would not have any physical access to water because the source of irrigation water can be located several, or even hundreds, of miles away.

Other funding sources for irrigation-related infrastructure exist at the state level as well. The Oregon Department of Fish and Wildlife offers a cost-share program or tax credit to assist with installation of fish screening devices and passage facilities. Tax credits are also available through the Oregon Department of Energy for irrigation system improvements in pumping volume and head requirements that save annual energy usage from irrigation pumps. The Energy Trust of Oregon offers cash incentives for improvements in on-farm irrigation systems (linear, pivot, wheel, hand line), as well as irrigation pumps for customers within Pacific Power and Portland General Electric utility service territories.

Oregon needs to ensure that these and other funding mechanisms continue to be made available for water-related infrastructure for irrigation, but also for our drinking water and wastewater treatment facilities. This includes ensuring that basic maintenance needs continue to be eligible for grant and loan funding, such as fixing leaks, replacing wooden pipes, and installing measurement devices and other technologies. Grant and loan programs should continue to make funding available for the maintenance of existing systems, especially when it is more cost-effective than constructing new facilities.

Dams and Wells

In Oregon, the construction and maintenance of infrastructure, such as dams and wells, are regulated by the Water Resources Department. Such constructed facilities are inspected routinely by the Department to prevent system failures and contamination of water resources.

Dams

Drinking water, power generation, flood control, irrigation and recreation are a few of the benefits that dams can provide. Dams can also be used to release water to benefit instream needs, by augmenting streamflows at critical times for fish spawning and migration. The construction and repair of dam infrastructure can be extremely expensive. Dams require regular inspection to determine if actions are required to keep them safe. This is especially true of high hazard dams—those where, in the event of a dam failure, fatalities are likely.

There are more than 85,000 dams in the United States today that meet height and storage standards of the National Inventory of Dams, maintained by the U.S. Army Corps of Engineers. Of these "statutory"

dams, 1,567 are located in Oregon. Most of these dams are classified as low hazard, meaning there is little chance of fatalities or serious property damage if the dam should fail. At the present time, there are 129 high hazard dams in Oregon. Of these high hazard dams, 61 have been rated as being in satisfactory condition, 43 were rated in fair condition, 16 were rated in poor condition, and four of these dams were rated in unsatisfactory condition (five dams had insufficient data for rating).

Nationwide, the average age of a dam is about 51 years old. The National Infrastructure Report Card gave dams in the United States a "D" grade, citing that deficient dams are often a result of aging, deterioration, or lack of maintenance. The Oregon Section of the American Society of Civil Engineers rated Oregon's dam and levees a "C" grade, citing the lack of safety assessments for many of the irrigation structures in the state. The National Report Card further explains that more dams nationwide are being identified as unsafe or deficient because of an increased scientific understanding about large flood events and earthquakes, and the ability to predict a dam's structural response to such extreme events.

Oregon's Dam Safety Program

The Water Resources Department operates Oregon's dam safety program, reviewing and approving the design/specifications of new dams and existing dams that are undergoing major repair, along with conducting inspections on existing hydraulic structures that could pose a threat to life and property. The Department coordinates with other state and federal agencies on dam inspections and training for its personnel and dam owners.

In cooperation with the National Performance of Dams Program (NPDP), Oregon's Dam Safety Program keeps a current inventory of dams that meet both NPDP and Oregon criteria. Dams that are ten feet or greater in height and also impound 9.2 acre-feet (3,000,000 gallons) or more are subject to the requirements of the Dam Safety Program. As of September 2011, approximately 1,300 dams are within Oregon's dam safety jurisdiction for design review, and of these, OWRD has lead inspection responsibility for 940 dams. High hazard dams have annual periodic inspections, significant hazard dams are inspected every two to three years, and low hazard dams are inspected every five to six years. Oregon's dam safety engineer is assisted in the field by the Department's watermaster corps.

As structures age and additional seismic information becomes available, Oregon's state agencies are encouraging dam owners to evaluate and retrofit dams in anticipation of seismic events, aging, and other extreme events. The Water Resources Department encourages dam owners to evaluate and modify dams, as needed, because of structural deterioration, potential earthquakes, and extreme floods. Doing this work requires significant financial resources. As more is known about the effects of climate change on local flooding, resources will be needed to conduct an evaluation of older dams and dams where the hazard rating has changed due to downstream development.

Oregon's Well Construction Program

Oregon's well construction standards are designed to protect groundwater resources and the public by preventing contamination, waste, and loss of artesian pressure. With several thousand drilled each year, state oversight is critical to ensure wells are constructed using proper methods, materials, and equipment. Licensed and bonded water well constructors have the equipment, knowledge, and experience required for proper well construction.

Along with construction, any alteration, deepening, or abandonment of a well must be done in accordance with groundwater laws and general standards. Unused wells that are not properly abandoned provide avenues for contamination and are a public safety concern. In particular, abandoned, large-diameter, open wells could potentially lead to the trapping or drowning of small children or animals.

Decommissioning Dams and Wells

As with groundwater wells, some dams or other water impoundment structures no longer serve the purpose for which they were constructed. When a dam has significantly deteriorated, the costs of repair may exceed the expected benefits, and dam removal may be a less expensive alternative. For example, if fish cannot adequately pass upstream of the dam and reservoir, the cost of adequate fish passage facilities might exceed the project benefits. In such a case, dam removal may be a less expensive alternative. Other reasons for dam removal can include renewed access to submerged cultural or historic resources or improved access to white-water recreation.

Infrastructure, dams and other facilities and structures that have been abandoned or are otherwise non-operational and in derelict condition should be identified and removed/decommissioned, and the sites occupied or affected by them should be restored to pre-project conditions.

Planning for Infrastructure Emergencies

In Oregon, money from FEMA grants is used to help dam owners create Emergency Action Plans (EAP). An EAP helps identify situations where a dam failure might occur, actions to take that could save the dam, if possible, and evacuations in situations that could result in dam failure. There is an Oregon-specific EAP template available, designed for owners of remote dams that have limited personnel. Approximately 75 percent of state-regulated high hazard dams have, or are currently developing EAP's. The State is encouraging the development of emergency action plans (EAP) for all remaining high hazard dams in Oregon.

Using an Asset Management Approach

The approach in the utility industry is to encourage an "asset management" approach, upgrading and replacing water and wastewater infrastructure when it no longer serves its purpose. Asset management means taking a systematic approach to managing capital assets in order to minimize costs over the useful life of the assets, while maintaining adequate service to customers.

In 2009, the League of Oregon Cities surveyed its members to obtain information about utility rates and other system characteristics. The survey asked, among other things, whether communities have asset management plans and whether those plans are sufficiently funded.

For communities with less than 10,000 residents, a significant percentage of systems do not have asset management plans in place for water and wastewater systems. Communities between 10,000 and 25,000 have the highest percentage of systems with asset management plans, yet most of those systems are deemed inadequately funded.

Of the largest systems—those serving greater than 25,000 people—more than 40 percent do not have a water utility asset management plan.

For stormwater utilities, asset management planning is lacking, compared to water and wastewater planning. The survey found that

Recommended Action 7.A
Develop and Upgrade Water & Wastewater Infrastructure

How to implement this action:

- Improve dam safety; retrofit for seismic issues
- Develop emergency action plans for high hazard dams
- Properly abandon infrastructure at the end of its useful life
- Use an "asset management" approach to identify and plan for rehabilitation, upgrade or replacement of infrastructure
- Ensure that basic maintenance needs continue to be eligible for grant and loan funding
- Advocate for continued infrastructure funding
- Encourage communities to consider natural infrastructure in lieu of, or as a complement to, built infrastructure

60 percent of the largest systems who responded reported not having a stormwater asset management plan, and for those that do, only 20 percent are adequately funded.

The U.S. Environmental Protection Agency's (EPA) Sustainable Water Infrastructure Initiative includes asset management among its examples of best management practices. The EPA already encourages asset management because it can help utilities reduce overall costs for both operations and capital expenditures, improve responses to emergencies, and improve the security and safety of assets.

Regional Infrastructure

Many Oregon communities, particularly smaller ones, are struggling to adequately fund water and wastewater-related infrastructure. The high capital costs related to infrastructure, the construction, operation, and maintenance cost of facilities, and the salary and training costs of retaining qualified personnel all seem prohibitively expensive to communities with a small ratepayer base. In Oregon, these tend to be rural, coastal, and/or small urban communities.

The financial need for water infrastructure continues to grow nationally. In EPA's 2009 Drinking Water Infrastructure Needs Report (based on 2007 data), the state of Oregon reported a total need related to water infrastructure financing of $3 billion. This compares to an overall national need of $325 billion, for water transmission, source water protection, treatment, and storage needs. This dollar figure places Oregon at the lower end of the "need" scale, particularly compared to states on the east coast. This may be in part because Oregon's infrastructure is newer by comparison, and because Oregon has fewer, less dense population centers.

Recommended Action 7.B
Encourage Regional (Sub-Basin) Approaches to Water and Wastewater Systems

How to implement this action:

- Provides incentives, such as funding and technical assistance

In 2002, the U.S. Government Accountability Office surveyed several thousand drinking water and wastewater utilities and found that a significant percentage of the utilities—29 percent of the drinking water utilities and 41 percent of the wastewater utilities—were not generating enough revenue from user rates and other local sources to cover their full cost of service. Roughly one-third of the utilities 1) deferred maintenance because of insufficient funding, 2) had 20 percent or more of their pipelines nearing the end of their useful life, and 3) lacked basic plans for managing their capital assets.

Developing a regional water and wastewater system makes sense, if it is cost-effective. A regional system could include physical consolidation, system redundancy, or shared contracts, services, and purchases. State and federal agencies often provide incentives such as funding and technical assistance to encourage a regional approach to meeting water needs. Oregon should continue providing these types of incentives to encourage more regional approaches to providing water and wastewater services to Oregonians, especially if it provides significant financial and environmental benefits within these smaller communities.

Infrastructure Funding for Drinking Water and Wastewater Systems

There are several agencies and organizations in Oregon aimed at helping communities with the financial costs of water-related infrastructure. The Infrastructure Finance Authority (IFA), for example, is a state agency that helps communities build infrastructure capacity to address public health and safety issues, as well as support their ability to attract, retain and expand businesses.

The IFA has resources available to finance water and wastewater infrastructure needs through Community Development Block Grants, the Water Fund (a special public works fund and water/wastewater financing program), and the Safe Drinking Water Revolving Loan Fund. Several million dollars have been awarded through these programs from 2001-2010 (see table below). Funding has also been provided for technical assistance projects, such as developing or updating facility plans, system master plans, engineering studies, and preliminary or final designs for projects.

IFA Water and Wastewater Project Awards by Financing Program (2001-2010 totals)

Water Infrastructure	Wastewater Infrastructure	Water Tech. Assistance	Wastewater Tech. Assistance
Community Development Block Grants			
$ 12.8 million	$34 million	$1.37 million	$5.6 million
Water Fund *(Includes Special Public Works Fund and Water/Wastewater Financing Program)*			
$44.3 million	$58.25 million	$0.46 million	$1.5 million
Safe Drinking Water Revolving Loan Fund			
$227 million	n/a	n/a	n/a

Federal funds for the Community Development Block Grant program and the Safe Drinking Water program have been declining the last few years, and are expected to continue to decline further. Oregon will need to continue advocating for continued funding of revolving loan funds from the federal Clean Water Act and Safe Drinking Water Act. Recapitalizing the state's Special Public Works Fund will be needed to continue providing low interest loans and grants to partially offset capital costs of building new infrastructure or updating existing infrastructure.

Some communities choose to finance part of their water and wastewater infrastructure portfolio through the bond market, as described in the following essay.

Jim Wrigley and Katie Schwab,
WedBush Securities, Inc.

Financing Water Projects with Bonds

Water-related projects are often financed with bonds that can be secured by the full faith and credit of the issuer (taxes and other lawfully available funds), by revenues generated by the water system, or by assessment to properties that benefit from the project. The Local Oregon Capital Assets Program (LOCAP) is a pooled financing program co-sponsored by the League of Oregon Cities and Association of Oregon Counties. LOCAP provides financing for water, wastewater and stormwater projects. Documents are standardized and the costs of issuance are prorated amongst participants. Participants are only responsible for their own obligations.

Streamflow Measurement Demonstration

Public Works in Action

Stream Ecology

Photos: T. Louden, OWRD; F. Reed, Tualatin Valley W.D.; T. Price, Oregon's Environmental Literacy Plan

Although Oregon is generally regarded as a "wet" state, many watersheds and their surrounding communities are facing water scarcities today. Looming pressures on our water resources, including population growth and climate change, are not yet "real" in the personal lives of many Oregonians, making it difficult to convey the seriousness of the issues we face today and may face in the future. Education and outreach efforts by state agencies and their partners should be targeted to all age levels and should address water quality, water quantity, and ecological needs and issues.

The health and sustainability of Oregon's water resources could benefit greatly from a variety of education and outreach efforts. The value of water and the role that it plays in Oregon's economy and the environment is not always well understood, or even recognized. Oftentimes, access to safe and abundant water is taken for granted. Everyone, both young and old, can benefit from a reminder that our human activities and decisions can have a significant impact on both the quantity and quality of our water, as well as the many economic and ecological uses it supports.

Oregon's Environmental Literacy Plan

In 2009, the Governor and the Oregon Legislature launched the development of an Environmental Literacy Plan as part of the *No Child Left Inside Act*. Oregon is the first state to pass legislation directly related to the development of an environmental literacy plan. The Plan, finalized in October 2010, is aimed at helping students become lifelong stewards of their environment and community, exercising the rights and responsibilities of environmentally literate citizenship, and making choices to interact frequently with the outdoor environment.

One of the goals of the Plan is to prepare students to understand and address the major environmental challenges facing Oregon and the rest of the country, including the relationship of the environment to national security, energy sources, climate change, health risks and natural disasters.

Recommended Action 8.A
Support Implementation of Oregon's K-12 Environmental Literacy Plan

How to implement this action:

- Support funding for implementation
- Natural resource agencies, community organizations, and others should engage in education for environmental literacy activities.

The Plan provides an opportunity for Oregon's youth to gain a greater understanding about the state's vital natural resources, and to develop a sense of stewardship toward Oregon's environment, thus helping them make informed decisions about Oregon's natural resources in the future. Under this Plan, students graduating from high school should be environmentally literate.

Fortunately, high quality, water-related curricula exists for all ages. Project WET, established in 1984, has a coordinating center at Western Oregon University, and other coordinating centers located nationally and internationally. Project WET's materials, available for a fee, provide a good overview of water quality and quantity issues, focusing on topics such as watersheds, wetlands, oceans, sanitation and hygiene, water history, and more.

The U.S. Environmental Protection Agency and the U.S. Geological Survey also have water related resources available for K-12 education. Many local water providers, watershed councils, and non-profit organizations in Oregon have also developed their own educational and outreach materials. Oregon's natural resource agencies, community organizations, and others should continue engaging in education for environmental literacy activities in support of Oregon's Environmental Literacy Plan. Oregon should also support funding for implementation of the Plan.

Oregon's Next Generation of Water Experts

The need to provide education and training on water, specifically water management, took center stage several decades ago. During the 1970s and 80s, the water and wastewater treatment industry grew rapidly to fulfill the requirements of the federal Clean Water Act and the Safe Drinking Water Act.

During that time, grants from the U.S. Environmental Protection Agency also became available for states to train water and wastewater plant operators. Now, with impending retirements expected from the baby boomer generation, the water and wastewater industry faces some devastating losses in its workforce.

The Water Environment Federation appointed a task force on water sustainability to look at this issue. In its 2008 final report, the task force noted that 37 percent of water utility workers and 31 percent of wastewater utility workers in the United States would retire by 2018. Add to this a 2003 Congressional Budget Office study noting that a shortage of qualified workers in *all* industries is expected to continue for an entire generation, comprising almost two decades. Although retirements have slowed a bit due to the economic recession, the loss of knowledgeable staff is still a concern.

One troublesome worry that comes with this wave of retirements is well described in a 2005 paper, *Succession Planning for a Vital Workforce in the Information Age*, which notes that much of our systems information in the U.S. is not well documented, making 80 percent of useful operating knowledge susceptible to loss through retirements.

Changes in the Water Industry

The gap left by these departures is further compounded by the rate at which scientific advancements have changed the water industry. In the Journal *Science* (May 2010), author Carol Milano examines the growing list of needs in a very diverse field of water. Milano notes the increasing recognition for the value of restoring ecosystems to their natural condition will demand more scientists trained in ecological areas such as soils, biology, zoology, chemistry, and geology, as well as environmental, civil, and mechanical engineering.

Manufacturers who are trying to decrease water use and toxic discharge need chemical engineers, synthetic and system biologists, and nanotechnologists. Regulatory agencies and environmental health professions need toxicologists, epidemiologists, chemists, engineers, hydrologists, and legal and policy professionals.

According to the Bureau of Labor Statistics, employment growth of 18 percent is expected for hydrologists between 2008 and 2018, which is faster than the average for all occupations. Employment

of the broader category of environmental scientists and specialists is expected to increase even more, by 28 percent between 2008 and 2018. The need for energy, environmental protection, and responsible land and water management will spur this demand.

Recommended Action 8.B
Provide Education and Training for Oregon's Next Generation of Water Experts

How to implement this action:

- Conduct a survey of water organizations in Oregon 🕮
- Determine whether educational programs in Oregon are equipped to meet the coming demand for water professionals
- Offer internships, fellowships, and job shadow programs to expose students to careers in water
- Continue funding support for water-related trade programs at Oregon community colleges

The Bureau of Labor Statistics explains that the demand for hydrologists will be strong as the population increases and moves to more environmentally sensitive locations. As more people migrate toward coastal regions, for example, hydrologists will be needed to assess building sites for potential geologic hazards and to mitigate the effects of natural hazards such as floods, landslides, and hurricanes.

Hydrologists also will be needed to study hazardous waste sites and determine the effect of pollutants on soil and groundwater so that engineers can design remediation systems. Increased government regulations, such as those regarding the management of stormwater, and issues related to deteriorating coastal environments and rising sea-levels will stimulate employment growth for these workers.

Professional Water-Related Training in Oregon

The Oregon Community College Association reports that out of the seventeen publicly chartered community colleges in Oregon, only two community colleges offer water/wastewater operator training programs: Linn-Benton Community College (Albany) and Clackamas Community College (Oregon City).

These programs are critical resources for plant operators, as they prepare for the certification and licensing exams underpinning the water and wastewater utility industry. These courses are designed to give water technicians and operators the tools to protect public health and environmental health.

There is only one community college, Lane Community College in Eugene, with a water conservation technician program—specializing in the nexus between energy and water efficiency. There are no community college programs in Oregon with a robust curriculum in hydrographics—measuring water level and streamflows, and then processing the records for use after data collection.

The American Water Works Association, the Water Environment Federation, and the U.S. Environmental Protection Agency have partnered to create a website to promote career choices in the water sector. Geared toward jobseekers at all levels—high school, vo-tech, college, military second career, and advanced science—the workforwater.org website hosts a clearinghouse of jobs in the field of water. It also contains recruiting resources for businesses and agencies to use. The Oregon Department of Community Colleges and Workforce Development also provides a listing of colleges that offer water-related courses, degrees, and programs throughout Oregon.

Community-Based Education and Outreach

Two public surveys were recently conducted by Oregon State University to assess citizen attitudes and opinions toward water issues in Oregon. About 800 Oregonians responded to the surveys, answering questions about their level of knowledge, resources they use for information, and a number of factors that potentially pose a risk to Oregon's water resources—quality and quantity.

According to the surveys, most Oregonians prefer (and are using) television news programs or specials to learn about the state's water situation. Oregonians use local newspapers, radio programs, and online resources to gather information as well. Unfortunately, only 5 percent of Oregonians consider themselves very well informed about water issues in Oregon.

Stronger partnerships with news outlets would help educate the public about water issues.

Through the OSU surveys, Oregonians ranked drinking water as the most important use of water in Oregon. With drinking water ranked as the highest priority, it is not surprising that a separate survey by DHM Research in November 2011 found that water quality protection to be the number one environmental concern of residents in the Pacific Northwest.

Interestingly, the OSU survey found that only 1 in 5 Oregonians were familiar with the term "non-point source pollution," which U.S. states report as the leading remaining cause of water quality problems, according to the U.S. Environmental Protection Agency.

Recommended Action 8.C
Promote Community Education and Training Opportunities

How to implement this action:

- Continue to promote education and outreach through actions required in local Water Management and Conservation Plans
- Promote technical training for public and private partners 🕮
- Promote access to water-related recreational opportunities through the use of the Water Trails Program

Opportunities to Expand Efforts

Oregon is home to an extensive network of community-based organizations that offer technical assistance and knowledge on water quantity, water quality, and watershed-related issues. With more than 45 soil and water conservation districts, and about 85 watershed councils located throughout the state, Oregon is well positioned to advance education and outreach efforts. Oregon should continue providing technical training to soil and water conservation district staff, watershed councils, and other on-the-ground organizations.

Examples of education and outreach opportunities that should be promoted include:

- farmer-to-farmer tours to demonstrate water conservation and efficiency techniques;
- water quality testing of private wells for homeowners (well owners need information about how to test wells, how to interpret the results, and what course of action is needed to address the contaminants);
- proper care/maintenance for septic systems;
- graywater use;
- rainwater harvesting;
- pharmaceutical take back programs, hazardous waste collection events; and
- streamflow restoration programs and opportunities.

Children's Clean Water Festival

The Clean Water Festival is a community-supported event, organized by public, private, and non-profit organizations committed to water and environmental education in Oregon. The festival's goal is to teach children that they are capable of having real, long-lasting, positive impacts on water resources, and to equip them with the information they need to do that in a fun and engaging way.

Responsible use and protection of Oregon's water resources can be done by promoting water-related recreational opportunities as well. The Water Trails Program at the Oregon Parks and Recreation Department, for example, helps to increase access to water-based outdoor recreation and stewardship of the state's waterways. Water trails are highlighted through the use of comprehensive trail guides, signage, public outreach, and informative classes to encourage awareness of the natural, cultural, and historical attributes of a waterway. This gives water users an opportunity to learn about the value of water resources, while gaining boating skills and connecting with waterways through an outdoor experience. The Water Trails Program, and other outdoor water-related recreational opportunities, should be promoted and encouraged in Oregon.

Recommended Action 8.D
Identify Ongoing Water-Related Research Needs

How to implement this action:

- Continue to identify ongoing research needs at the local and state level 🕮
- Partner with public and private researchers

Water Related Research Needs
The water resources sector will need to continue identifying on-going informational needs that could use assistance from undergraduate and graduate students, as well as public and private research institutions and partners. Examples of identified research needs are marked throughout the Strategy with the book (🕮) symbol.

Recommended Actions at a Glance

Objective 3: Understand the Coming Pressures That Affect Our Needs and Supplies

Water & Energy	4.A. Analyze the effects on water from energy development projects and policies 4.B. Take advantage of existing infrastructure to develop hydroelectric power 4.C. Promote strategies that increase/integrate energy & water savings
Climate Change	5.A. Support continued basin-scale climate change research efforts 5.B. Assist with climate change adaptation and resiliency strategies
Water & Land Use	6.A. Improve integration of water information into land use planning (& vice versa) 6.B. Update state agency coordination plans 6.C. Encourage low-impact development practices
Infrastructure	7.A. Develop and upgrade water and wastewater infrastructure. 7.B. Encourage regional (sub-basin) approaches to water and wastewater systems
Education & Outreach	8.A. Support implementation of Oregon's K-12 Environmental Literacy Plan 8.B. Provide education and training for Oregon's next generation of water experts 8.C. Promote community education and training opportunities. 8.D. Identify ongoing water-related research needs