Willamette Basin Plan of Study

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U.S. Bureau of Reclamation
Oregon Water Resources Department

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1. Introduction

Purpose of Study - Expected Outcomes
The purpose of this Plan of Study is to build a common understanding among state agencies, federal agencies, and stakeholders in the Willamette Basin (Basin) of existing data, possible data gaps, and associated analyses required for a WaterSMART Basin Study.

An expected outcome of developing this Plan of Study is to determine if a WaterSMART Basin Study can be used to fill critical data needs for an upcoming general investigation study, which is to be undertaken by the Oregon Water Resources Department and the U.S. Army Corps of Engineers (Corps). The *Willamette Basin Reservoir Study* (Reservoir Study) will examine options to reallocate stored water to meet multiple water needs in the Basin including:

Municipal Uses
Agricultural Uses
Hydropower
Recreational Uses
Self-Supplied Industrial Uses
Fish and Wildlife Uses
Water Quality

A major need for the Reservoir Study that has already been identified in previous planning meetings is to better define current and future basin agricultural demands that could be met from the Willamette Valley Project reservoirs. In addition, a better understanding of the depth and breadth of existing water rights is needed and results compiled.

Study Objectives
The Bureau of Reclamation (Reclamation) and Oregon Water Resources Department (OWRD) are considering a WaterSMART Basin Study to further aid comprehensive water resources planning in the Basin. The proposed Basin Study will build upon previous work performed by other parties identified in this POS. In addition, collaboration with the Corps will be significant given their role in the Reservoir Study.

A WaterSMART Basin Study should address the following four study objectives[1]:

1. Projections of water supply and demand, including an assessment of risks to the water supply relating to climate change as defined in 9503(b)(2) of the Secure Water Act.

2. Determine the potential impacts of climate change on the performance of current water delivery systems (e.g., infrastructure and operations). Willamette Basin stakeholders could potentially use the Willamette Water 2100 project for this information.

3. Development of <u>options</u> to improve operations and infrastructure to supply adequate water in the future.

[1] Refer to pages 6 – 7 of the WaterSMART Framework (Feb. 2013) for more detailed description of the Basin Study Requirements.

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4. A trade-off analysis of the options identified, finding and recommendations, as appropriate. Examine appropriate alternatives in terms of their relative cost, environmental impact, risk, stakeholder response, or other attributes common to the alternatives. The analysis can be either qualitative or quantitative in nature.

Developing a set of options (Objective 3) for reallocating stored water and looking at possible trade-offs (Objective 4) are tasks that will occur through the Willamette Basin Reservoir Study. Scoping for that study will occur in Federal fiscal year 2014. If funding is received, it is anticipated that the study will begin in FY15 and continue through FY17.

Description of Study Area

The Willamette River Basin lies in northwestern Oregon and is the largest river basin in Oregon, supporting most of the state's population, larger cities, and many major industries. It also contains some of Oregon's most productive agricultural lands and supports nationally and regionally significant fish, wildlife, and plant species. There are a number of streams in the basin designated as state scenic waterways and Federal wild and scenic rivers. Water-related recreational opportunities in the basin are numerous

The basin is bounded on the east by the Cascade mountain range, on the south by the Calapooya Mountains, on the west by the Coast range, and on the north by the Columbia River. The basin has a drainage area of more than 29,000 square kilometers (11,200 square miles) at its confluence with the Columbia River. At Salem, the capital of Oregon near the middle of the basin, the drainage area is about 18,900 square kilometers (7,300 square miles). The mainstem Willamette River is formed at the confluence of the Coast Fork and Middle Fork Willamette rivers near the cities of Eugene and Springfield. The river flows northward for a total of about 317 kilometers (197 miles). Major cities on the Willamette River downstream of Eugene-Springfield include Corvallis, Albany, Salem, and Portland. Major east side tributaries include the Middle Fork Willamette, McKenzie, Santiam, and Clackamas rivers. Major west side tributaries include the Coast Fork Willamette, Long Tom, Mary's, Luckiamute, Yamhill, and Tualatin rivers.

Organization of the POS

The following sections provide background on the proposed project and details previous work, available data, and current activities. A brief description of available resources to further a Basin Study is also provided.

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Figure 1: Willamette River Basin Study Area

2. Study Description

Project Background

The Willamette River Basin Project (Willamette Project) is a series of thirteen dams and reservoirs located in the Willamette River drainage system. The U.S. Army Corps of Engineers (Corps) owns and operates the Willamette Project for a variety of purposes, including flood control, navigation, generation of hydroelectric power, irrigation, and pollution abatement for public health and fish needs.

The Bureau of Reclamation (Reclamation) holds water right certificates for the entire conservation storage available in the Willamette Project. These certificates authorize 1.64 million acre-feet of stored water for irrigation purposes only. Today, less than 5 percent of this water is contracted by Reclamation for irrigation uses. Other out-of-stream needs, such as municipal and industrial uses, are not able to access this stored water via contracts. Stored water contracts to protect instream flows to support aquatic habitat for fish and wildlife do not exist today.

In 1996, the Corps and OWRD began the Reservoir Study to determine if modifying the operation and storage allocation of the Willamette Project would better serve current and anticipated future water needs. Determining agricultural water needs in the basin is a major study need that could be accomplished through the WaterSMART Basin Study Program.

Funds for the Reservoir Study were authorized by Congress, the State of Oregon, and more than 60 cities, special districts, organizations and commercial and industrial firms. The Reservoir Study was placed on hold in the early 1990s when several fish species were listed under the Endangered Species Act in the Basin. A consultation process among federal agencies (the Corps, Reclamation, Bonneville Power Administration, National Marine Fisheries Service, and the U.S. Fish and Wildlife Service) related to these fish species was completed and in 2008 the Willamette Project Biological Opinion (Willamette BiOp) was completed. Study partners are now interested in re-launching the Reservoir Study. OWRD and basin stakeholders are exploring how a WaterSMART Basin Study could help fulfill some of critical informational needs of the Reservoir Study. The Plan of Study process will help water managers and stakeholders analyze and discuss existing efforts that are occurring throughout the Basin.

A diverse consortium of stakeholders representing municipal water providers, farms, nurseries, irrigation districts, and environmental interests have committed to partnering with the state to complete this Plan of Study. A WaterSMART Basin Study could fulfill some of the goals of the Reservoir Study, and it would help water managers decide how to incorporate climate change risks into the analysis.

The Willamette Basin – Challenges, Needs, and Opportunities

The Willamette Basin supports approximately 75 percent of the state's population, and is the fastest growing area of the state. About six percent of the total basin area is urban land. Approximately 70 percent of the basin is forestland, while about 22 percent of the land area, primarily in the Willamette River Valley, is used for agriculture. Agricultural commodities in the Basin are among the most diverse found anywhere in the United States. In 2011, the Willamette Basin accounted for more than 40 percent of Oregon's gross farm sales. Six Willamette Basin counties (Marion, Clackamas, Washington, Linn, Yamhill, and Polk) are in the

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top 10 counties for gross farm and ranch sales. More than 170 varieties of agricultural crops are grown and sold in the Willamette Basin.

The Willamette Basin is also the richest in native fish in the state, and provides critical habitat for several species listed under the Endangered Species Act, including winter steelhead, spring Chinook salmon, Oregon chub, bull trout, Fender's blue butterfly, Kincaid's lupine, Western pond turtles, red-legged frogs, bald eagles, and migratory songbirds. The Willamette BiOp requires certain actions through 2023 to provide adequate protection of two ESA-listed species on the Willamette River—winter steelhead and Chinook salmon. A Conservation and Recovery Plan for Chinook salmon and steelhead in the Upper Willamette River was finalized in August 2011.

The Willamette River and its reservoirs, particularly Detroit Reservoir, are among the most visited destinations for recreational boaters in Oregon. There are more than 4.3 million recreational visits to the reservoir areas alone, contributing $100 million annually in economic benefits to local communities. Federally designated wild and scenic rivers, such as the McKenzie and Clackamas Rivers, and the state's only designated scenic lake, Waldo Lake, also contribute greatly to the recreational economy of the Basin. The Willamette Basin is truly a special place to live, work, and play.

Challenges

Seasonal water demands already exceed water supplies in many parts of the Basin. The water users of nearly all Coast Range, lower Cascades, and valley tributaries face water shortages in late summer. OWRD regulates users on a number of streams in the Willamette Basin to supply senior water and maintain minimum streamflows. Oregon has established several areas throughout the state where groundwater use has been restricted or limited due to groundwater level declines, with a majority of these areas located in the northern Willamette Valley.

The Willamette Basin contains some of the state's most challenging water quality issues, with 46 percent of stream and river miles considered to be severely biologically impaired. The Willamette Basin total maximum daily load (TMDL) was approved in September 2006 and focuses on the most commonly listed pollutants in the basin (bacteria, mercury, and temperature).

Generally, scientific models project warmer, wetter winters and hotter, drier summers in the Willamette Valley and other areas west of the Cascade Range. Climate change projections show an increase in the average temperature in the Willamette Basin by 2 to 7 degrees Celsius during the next century; a decrease in snowpack in the Cascades by 60 percent; and a decrease in summertime streamflows by 20 to 50 percent. In the critical low-flow summer months, melting snowpack — water coming from elevations higher than 1,200 meters — constitutes up to 80 percent of the volume of the Willamette River. The area's reliance on high-elevation water during summer months highlights the vulnerability of the Willamette Basin to the influences of a warming climate. Water imbalances, disruptions, and conflict are likely to increase due to reduced snowpack and increased periods of drought, especially on a seasonal basis.

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Needs
In 2008, Oregon conducted a statewide look at water supply demands. The demands for the Willamette Basin are projected to increase by 461,000 acre-feet, or 18 percent, by the year 2050. The number of people in the Basin is expected to nearly double during this time, placing tremendous demands on limited resources and creating major challenges for meeting current and future water needs.

Determining agricultural demands, supplied by stored water, is a fundamental need of the Reservoir Study and the focus of this WaterSMART Plan of Study. To meet this goal, water demands for stored water use and demands from natural flow may need to be documented by actual location (e.g, reservoir or location on the river), time of year the diversion is used, quantity or volume (maximum use and actual use) of the diversion, and priority dates (for irrigation demands, fish flows, and other Willamette BiOp requirements) for each diversion. In addition, return flows (flow that returns to the river from irrigation practices) need to quantified and understood including any lag time between infiltration and emergence into the river system. This level of detail provides the necessary information to construct water resource models that allow interaction of these needs along with the operation of the reservoirs in the Willamette Project. This approach also enables understanding of reservoir operation during drought years or years where demands exceed stored water rights.

Instream flow studies are being completed as part of implementation of the Willamette BiOp, and drinking water providers in the Basin are planning to quantify municipal demands in the Basin, likely in 2014. This work, along with determining agricultural water demands and other needs, can be used to model changes to the operational system of the Willamette Valley Project, via the Reservoir Study.

Opportunities
Water stored in the Willamette Basin Corps Reservoirs is viewed as the last remaining supply of water for meeting future needs, both instream and out-of-stream needs. The WaterSMART Basin Study program presents a unique opportunity for state agencies, federal agencies, and stakeholders to work collaboratively on meeting the multitude of water needs in the Willamette Basin. WaterSMART could provide the basin with information and data needed to support the Reservoir Study discussions.

Previous Work and Available Data
Below is a summary of existing data and models that may be applicable to both the WaterSMART Basin Study and the upcoming Reservoir Study. In addition, previous efforts that have been completed in the basin are also documented and summarized.

a) Water Demand Projections – Past Studies
A 2000 Interim Report for the Reservoir Study includes a summary of water use demands (current and projected through 2050) for municipal uses, self-supplied industrial uses, and agricultural uses in the Willamette Basin from stored water. These demands were developed during the mid-1990s and will likely need to be updated as part of the Basin Study/Reservoir Study process to reflect changes in population projections, development, cropping patterns, etc.

In 2008, the Eugene Water and Electric Board, Springfield Utility Board and the cites of Creswell, Junction City, Veneta, Corvallis, and Monroe conducted a study that determined the current and future municipal needs in the southern portion of the Willamette Basin. Estimated long-term demands from the Willamette Project were between 11,000 and 30,000 acre-feet. In 2013, municipalities in the Willamette Basin reviewed existing municipal demand projections, and have identified some preliminary recommendations for reevaluating those demands. It is anticipated that this evaluation would occur as an independent task, but could inform a WaterSMART Basin Study.

Updating demand information for agricultural uses is likely needed. This is one example where a WaterSMART Basin Study could provide the data compilation and subsequent technical analyses needed to support the Reservoir Study goals.

In 2008, water demand projections were developed as part of the Oregon Water Supply and Conservation Initiative for the major water use categories (municipal, domestic, self-supplied industrial and irrigated agriculture) and include information for each county in the Willamette Basin through the year 2050. Climate change and conservation measures were incorporated into the demand analysis. Instream flow demands for ecological benefit were forecast using existing instream water rights and scenic waterway designations. This was an initial assessment, however, that did consider supply systems or constraints.

b) Instream Flows — Existing Protections & Studies

Minimum Perennial Streamflows. There are more than 200 established instream flows in the Willamette Basin via an instream water right. Many of these were developed via the conversion of a minimum perennial streamflow to an instream water right. About two dozen minimum perennial streamflows that call upon stored water from the Willamette Project have yet to be converted. It is envisioned that these will be addressed as part of the Reservoir Study, and instream flow studies conducted under the 2008 Willamette BiOp will inform that process.

TNC Sustainable Rivers Program. The Willamette River is one of eight demonstration sites within the Sustainable Rivers Program (SRP), a national partnership between the Corps and The Nature Conservancy (TNC) aimed at creating a framework for implementing environmental flows downstream of dams. Through the SRP, the Conservancy and the Corps have completed analyses of environmental flow requirements for the Middle Fork Willamette, McKenzie and North and South Santiam Rivers, all of which are major tributaries serving the Willamette Project. The information is currently being included in basin-wide modeling to identify opportunities to integrate environmental flows into system-wide management of the dams.

2008 Willamette BiOp. The Willamette BiOp identifies numerous actions to reduce and minimize the effects of continued operation and maintenance of the Willamette Project on listed species and critical habitat designated under the Endangered Species Act. For instream flow purposes, the BiOp describes minimum and maximum flow releases from the dams on several of the major tributaries in the Willamette Basin (Middle Fork, McKenzie, South Santiam, and North Santiam). Flow targets have also been set on the mainstem Willamette River at Albany and Salem, and maximum ramping rates have also been designated for the Willamette Basin dams.

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Under the BiOp, the Corps, Bonneville Power Administration (BPA), and Reclamation (collectively called the "Action Agencies") are required to complete studies to evaluate the effectiveness of flows, ramping rates, and other flow-related measures to identify any necessary changes to protect Chinook salmon and steelhead.

Under the BiOp's Configurations Operation Plan (COP) Phase II planning process, studies needed for instream flow requirements have been identified for the N. Santiam, S. Santiam, Fall Creek, Middle Fork, S. Fk McKenzie, and the McKenzie River. A report on the N. and S. Santiam River instream flow study was finalized in July 2013, and additional work is being considered for the Middle Fork and the McKenzie, with a key focus on evaluating flow needs for Chinook spawning and incubation.

The WaterSMART Basin Study could be used to compile and reconcile past instream flow studies, those occurring under the Willamette BiOp and other efforts, and identify any data gaps. Bringing information together on <u>all</u> water needs is needed to complete the reallocation of stored water in the Willamette Project under the Reservoir Study.

c) Operational Models

HEC-ResSim Model (and other Corps models). The Corps' Portland District is proposing to use the Hydrologic Engineering Center's (HEC) Reservoir Simulation Model (ResSim) to model the effects of potential operational and structural measures on the authorized uses of the thirteen reservoirs. Other HEC models include HEC-HMS (simulates precipitation events to compute runoff), HEC-RAS (analyzes river hydraulics to compute water depth, velocity, and inundation areas), and HEC-FIA (economic/impact analysis). The Corps intends to use these existing models for the Reservoir Study.

d) Recreational Models

Regional Recreation Demand Model (RRDM). The Regional Recreation Demand Model was used as part of the Willamette Reservoir Study in the late 1990s to evaluate the demand and value of recreation at Corps reservoirs. The Corps also keeps monthly visitation data (day and overnight use), although the completeness and availability of data varies through years and across agencies. The Corps will analyze recreation use as part of the Reservoir Study. It is not needed for a WaterSMART Basin Study.

e) Surface Water & Water Use Information

Water Availability Model (OWRD). Since 1992, OWRD has maintained a database of the amount of surface water available for appropriation for most waters in the state. This database is used to evaluate applications for new uses of water. This model calculates water availability by quantifying the estimated natural streamflow, consumptive rights, and instream water rights. An analysis of water availability has been determined for more than 160 watersheds in the Willamette Basin.

Water Rights Information System (WRIS) & Water Right Mapping Tool. WRIS can generate summary reports as well as detailed information on individual water rights, including applications, permits, transfers, and certificates. There are more than 27,000 water rights in the Willamette Basin, all of which are detailed in the WRIS database. OWRD's Water Right Mapping tool provides a geographical look at water rights and related data. Most of

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the water rights in the Willamette Basin, such as water use permits, transfers, and certificates, have been mapped to the nearest quarter-quarter.

Streamflow Data. There are more than 120 active gage sites located in the Willamette Basin, most of which are owned and operated by the U.S. Geological Survey. Some of these sites also collect water quality data. Half of these gages contain more than 20 years of streamflow information.

Water Use Data & Water Management & Conservation Plans. OWRD collects monthly water use information from governmental entities, such as municipal water providers and irrigation districts, on an annual basis. Water use information dates back to the late 1980s. Municipal water use and demand projections can also be obtained from Water Management and Conservation Plans (WMCPs). More than sixty municipal water providers in the Willamette Basin have undergone this planning process. WMCPs contain information related to water rights and source reliability, conservation and efficiency measures, curtailment plans for drought or emergency-related purposes, and future water supply analysis.

f) Groundwater Information

The Willamette River Basin has been the focus of several regional groundwater studies in the past 20 years. Areas of the basin have experienced declining groundwater levels over time, and there are water quality concerns in some aquifers. These groundwater issues will likely increase the demand for stored water in the future.

It is anticipated that a detailed analysis of the contribution of groundwater to the overall system would not be a component of a WaterSMART Basin Study, but rather would be the focus of another effort currently underway in the Basin (see below). Significant work has been conducted in the Basin and would be used to supplement any additional effort that is undertaken.

A synthesis of the hydrogeology of the Willamette lowland was conducted in the early 1990s as part of the Regional Aquifer-System Analysis (RASA) program of the U.S. Geological Survey. The main products of the RASA study are an extensive bibliography of the hydrogeology of the Willamette Basin, a comprehensive description of the geologic framework, a description of regional hydrogeologic units (including thickness and structure contour maps), and a water table map for the basin-fill sediments (Gannett and Caldwell, 1998; Woodward and others, 1998).

In the mid-1990s, the USGS and OWRD began a cooperative groundwater study of the Willamette Basin. The principal goal of this study was to construct several numerical groundwater models that could be used to evaluate factors that limit the capacity of groundwater systems in the basin and to help resource managers evaluate the impacts of groundwater-management decisions. Primary objectives were to evaluate the depletion of streamflow by groundwater withdrawals and to gain a better understanding of factors causing large seasonal groundwater fluctuations and long-term groundwater-level declines in some areas of the basin. The first portion of the study was completed in 2005 and is described in Conlon and others, 2005. This phase of the study included a refinement of the hydrogeologic framework described in the RASA study, a description of regional

groundwater flow paths, a description of groundwater-level trends throughout the basin, a comprehensive hydrologic budget, and the general construction of the groundwater numerical models. The second phase of the study included the calibration of a regional steady-state groundwater model and a transient groundwater model in the central Willamette Basin in the area between Salem and Wilsonville. The groundwater models have been completed, various simulations have been conducted, and the final report, which describes the model and the simulation results, is nearing its final review and will be published in the near future (Herrera and others, in review).

Other groundwater data sets are available for the Willamette Basin, including several thousand wells that have been field-located by OWRD or the USGS, as well as more than 230 current observation wells (approximately 100 with long-term records and 23 recorder wells), and more than 820 noncurrent observation wells (approximately 170 with long-term records and 50 recorder wells). Water-level data is collected from another 600 wells that are measured by water users as part of a permit or water right condition.

g) Water Quality Data & Information

Ambient Water Quality Sites (DEQ). The Oregon Department of Environmental Quality (DEQ) maintains an ambient water quality monitoring network. Water samples are collected at more than 130 sites across the state. There are 12 ambient sites in the lower Willamette, 15 in the middle Willamette, and 13 sites in the Upper Willamette Basin. This data is used to develop the Oregon Water Quality Index Report, which describes water quality generally in a given basin, based on temperature, dissolved oxygen, biochemical oxygen demand, pH, total solids, ammonia and nitrate nitrogen, total phosphorus, and bacteria. DEQ also maintains a statewide water quality database, known as LASAR, which stores water quality data collected by volunteer organizations. Several watershed councils and other conservation organizations in the Willamette Basin collect and submit water quality data to DEQ.

Willamette Basin TMDL & Modeling. The Willamette Basin TMDL was approved in 2006 by the U.S. Environmental Protection Agency (EPA). The TMDL includes 12 sub-basins in the Willamette and addresses temperature, bacteria, and mercury. The Tualatin, Yamhill, and Molalla/Pudding sub-basins are also covered under separate TMDL's which includes additional pollutants, such as pesticides, metals, and low dissolved oxygen. Several models were used as part of the Willamette Basin TMDL development. For example, CEQUAL- W2 models basic eutrophication processes such as temperature-nutrient-algae-dissolved oxygen-organic matter and sediment relationships. This model was developed under research contracts between the Corps and Portland State University.

Groundwater Quality Studies & Southern Willamette GWMA. Over the last 20 years, many studies and sampling programs have focused on groundwater quality in the Southern Willamette Valley, particularly in portions of Benton, Linn, and Lane counties. Results of these efforts identified nitrate contamination of shallow groundwater in some parts of the Valley, which led DEQ to designate the Southern Willamette Groundwater Management Area (GWMA) in 2004, which requires focused efforts to improve water quality. Monitoring is currently conducted with a mix of 40 domestic and monitoring wells, with synoptic sampling events approximately every 3-4 years. Willamette Basin groundwater

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quality studies are summarized in DEQ's Groundwater Quality Report for the Willamette Basin (March 2004).

Current Activities

a) **Evaluation of Municipal and Self-Supplied Industrial Uses**
On behalf of the Oregon Water Utilities Council, GSI Water Solutions Inc. recently performed a review of the demand projections in the 2000 Interim Report, comparing those projections to current information and projections. New projections for municipal and self-supplied industrial demands were not developed as part of their review. Additional work may be needed to support the Reservoir Study.

b) **Willamette Water 2100 Project –ENVISION Model**
This project is 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. The project seeks to create a transferable method of predicting where climate change will create water scarcities and where those scarcities will exert the strongest impacts on human society. The project will develop or adapt hydrologic, socioeconomic, and ecological models for the Willamette Basin.

The 5-year project began in October 2010, and is a collaborative effort of faculty from Oregon State University, the University of Oregon, and Portland State University. The work is being funded by a $4.3 million grant from the National Science Foundation.

c) **U.S Army Corps of Engineers – Willamette Basin Reservoir Study (Scoping Efforts)**
For FY14, the Corps of Engineers has funding to scope and develop the Project Management Plan for the Reservoir Study. If the Corps receives funding and obtains approval to initiate the Reservoir Study, it is anticipated those efforts would begin in early FY15 (October 2014). The Study would likely occur over a three-year period, with an estimated completion occurring in September 2017. If WaterSMART is used to develop demand information, the work would need to be completed by Fall 2015 (beginning of FY2016) in order to inform the Reservoir Study.

d) **U.S Army Corps of Engineers – Climate Analysis Study**
For Federal FY2013, the Corps' Institute for Water Resources had proposed the Corps' Portland District to perform a pilot study incorporating potential climate change impacts into Corps operations for the Willamette Project. The objective of the pilot study is to be better prepared with operational strategies for flood seasons based on understanding possible climate change impacts. The goal was to address the central question about how Willamette watershed planners, engineers, and regulators could incorporate climate change into an operational strategy that allows the Corps to deal with extreme events (flood risk and drought events) and improves the resiliency of flood control operations and ecosystem restoration projects. To date, funding has not been provided for this pilot study.

e) **University of Washington – Climate Impacts Group**
A comprehensive suite of climate change streamflow scenarios for approximately 300 locations in the Columbia River Basin, 30 of which are located in the Willamette Basin,

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were developed by the Climate Impacts Group (CIG) of the University of Washington. These projections were developed using the International Panel on Climate Change (IPCC) Climate Model Intercomparison Project (CMIP) Phase 3 global climate models (GCM) that were developed to assist with the IPCC Assessment Report 4. The scenarios allow planners to consider how hydrologic changes may affect water resources management objectives and ecosystems, but require some additional refinement to ensure that scenarios function with a specific basin correctly. The data sets were developed in 2008 by CIG with input from several prominent water management agencies in the Pacific Northwest, including the Washington State Department of Ecology, Bonneville Power Administration, Northwest Power and Conservation Council, Oregon Water Resources Department, and the B.C. Ministry of the Environment.

Significant efforts are now underway to complete the IPCC CMIP5 modeling effort, which will provide for a significant number of additional projections that have been generated using state-of-the art GCMs. Future climate change efforts in the Basin should consider incorporation of these latest projections.

3. Study Approach and Interested Parties

The Oregon Water Resources Department will be the primary resource for stakeholder involvement for a WaterSMART Basin Study. Members of the public are welcome to attend meetings and provide input during the meetings. When the stakeholder group is formalized, each stakeholder will have the opportunity to designate one primary and one alternative representative.

Since the early 1990s, stakeholders have been actively engaged and supportive of the USACE/OWRD Reservoir Study. Stakeholders and study partners recognize that a WaterSMART Basin Study could provide crucial information about the myriad of water needs in the basin, and Reclamation's assistance will be critical in determining the optimal reallocation of water from the Willamette Project under the Reservoir Study. The following is an initial list of interested stakeholders identified to date (in no particular order):

Adam Stebbins	Project Coordinator, Willamette Water 2100
Adam Sussman	Consultant, GSI Water Solutions
April Snell	Executive Director, Oregon Water Resources Congress
Bill Ferry	U.S. Bureau of Reclamation
Brad Taylor and Jason Heuser	Eugene Water and Electric Board
Brent Stevensen	Manager, Santiam Water Control District
Dawn Wiedmeier	U.S. Bureau of Reclamation
Gil Riddell	Association of Oregon Counties
Hillary Barbour	Rep. Blumenauer's Office (invited)
Jason Pulley	City of Salem
Jeff Stone	Oregon Association of Nurseries
Jim Johnson	Oregon Department of Agriculture
Joe Hobson	Oregon Farm Bureau
John Valley and Katie Gauthier	Senator Merkley's Office
Katie Fast and Joe Hobson	Oregon Farm Bureau
Kelly Ross	Western Advocates

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Kimberley Priestley	WaterWatch of Oregon
Leslie Bach and Amanda Rich	The Nature Conservancy
Linda Modrell	Benton County
Mark Landauer	Special Districts Association of Oregon
Niki Iverson	Oregon Water Utilities Council/City of Hillsboro
Rick Kepler and Tim Hardin	Oregon Department of Fish and Wildlife
Rob Annear	Consultant, GeoSyntec
Ryan Mann	Rep. Bonamici's Office (invited)
Rich Domingue	NOAA - National Marine Fisheries Service
Stephanie Burchfield	NOAA - National Marine Fisheries Service
Todd Heidgerken	Tualatin Valley Water District
Tracy Rutten	League of Oregon Cities
Trever Sleeman	Rep. Schrader's Office (invited)
Willie Tiffany	Consultant, GeoSyntec

The Corps and the Oregon Water Resources Department are actively involved in stakeholder meetings and discussions.

4. Study Management Requirements

Study Management Structure

TBD

Decision Making Process

All decisions will be made using a consensus approach of the primary members, or alternates in their absence.

Roles and Responsibilities

The Willamette WaterSMART Basin Study will be managed by Reclamation in partnership with Oregon Water Resources Department on a 50/50 cost-share basis. Reclamation's Columbia-Cascades Area Office will serve as lead and, along with Oregon Water Resources Department, will work in collaboration with other stakeholders in the basin.

Major fiscal decisions will be required to receive approval from Oregon Water Resources Department as the fiscal agent for this Plan of Study.

Study Team Coordination

Once the study team is developed, regular meetings will be scheduled to review the status of on-going tasks.

Administrative Record

TBD

Schedule and Cost Control

The 1996 Project Study Plan and Feasibility Cost Share Agreement for the Reservoir Study outlined 19 tasks to be accomplished over a 4 year period (1996 – 1999). Knowing the Reservoir Study would be placed on hold to allow for ESA consultation, an interim report was developed in 2000 to document efforts already completed. OWRD and the Corps will need to

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examine the original study tasks to determine how much additional work is needed and how to incorporate more recent developments in the basin, such as the Willamette Basin TMDL, 2008 Willamette BiOp instream flow requirements, the 2011 Upper Willamette River Conservation and Recovery Plan, and ongoing efforts related to climate change research and analysis. Below is a high level outline of the Reservoir Study tasks, which will likely be revised during the scoping process in 2014, and areas where the Basin Study would complement and inform a comprehensive water management plan for the basin.

{Note: Insert a graphic showing relationship of WaterSMART Basin Study tasks and Reservoir Study tasks, including schedule.}

<u>Tentative Schedule</u>

December 31, 2013
OWRD and their stakeholders determine whether to pursue funding through a WaterSMART Basin Study. If the team agrees to pursue this funding, OWRD will submit a letter of interest in January 2014, and the Plan of Study, with a new proposal, in March 2014.

November 2013 – May 2014 (estimated timeframe)
Scope the Willamette Basin Reservoir Study (Corps/OWRD effort)

November 2013
Initial results of Willamette Water 2100 made available (i.e., demand information; reference forecast).

February 2014
Anticipated discussion of Willamette Water 2100 Reference Forecast with Learning Action Network stakeholders. Determine whether WW2100 meets the WaterSMART Basin Study requirements.

May 2014
Approximate timeline for notification of WaterSMART funding; initiate MOA #2 and obtain signatures.

July 2014
Initiate the WaterSMART Basin Study

October 2014
If Federal funding is allocated for the Reservoir Study, initiate the 3-year effort (Corps, OWRD).

October 2015
Deadline for completion of agreed upon demand information from the WaterSMART Basin Study.

{Note: Need to confirm completion date for WW2100 (2016)}

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May 2016
Anticipated deadline for completion of the WaterSMART Basin Study.

September 2017
Finish the Reservoir Study; seek Congressional approval for identified reallocation of stored water.

Quality Control Plan
Any tasks that Reclamation is responsible for will follow the standard internal review process to insure quality products are delivered. This includes review of any data development, modeling efforts, and other technical tasks related to the Willamette River Basin Study.

Deliverables and Project Documentation Requirements
A detailed budget, schedule, and finalized task list will be developed and agreed upon. All deliverables will be documented and presented to the study team for review before finalizing.

Review Process
All work products and deliverables will be reviewed for accuracy, completeness, and adherence to the Plan of Study requirements. The agencies may also elect to have any deliverable or document reviewed by a third party, if needed. A final decision on the acceptance of a deliverable will be made by consensus of the agencies and stakeholders at a regularly scheduled meeting.

Project Communication Plan
Reclamation and the Oregon Water Resources Department will develop a Project Communication Plan (PCP) as part a WaterSMART Basin Study. The PCP will be updated and reported on regularly. As the agencies prepare and finalize this Plan of Study, communication with stakeholders will occur regularly over the next several months (October – March 2014).

Public Involvement Plan
If awarded a WaterSMART Basin Study, Reclamation and the Oregon Water Resources Department will develop a Public Involvement Plan (PIP). Reclamation will provide monthly written status reports on each task. The Oregon Water Resources Department will provide status updates during stakeholder meetings, and within other venues (e.g., Water Resources Commission meetings, conferences). The Department will also utilize an electronic mailing list to keep stakeholders and members of the public informed of progress, available reports, and upcoming meetings.

Reclamation will provide a website for the Willamette River Basin Study. The website will track group progress, provide current and past meeting agendas and minutes, provide documents related to the project, and provide contact information. Website address will be similar to www.usbr.gov/pn/programs/studies/oregon/willamette. The Water Resources Department will also update and maintain an existing website for Willamette Basin activities.

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5. Study Tasks

Proposed study tasks for the WaterSMART Willamette Basin Study are as follows. *{Note: these tasks will be refined with stakeholder and agency input over the next several months}.*

Task 1 - Define the Plan of Study.
Deliverable: Written Plan of Study for the WaterSMART Willamette Basin Study.

Task 2 - Define roles and responsibilities and develop a study schedule.
Deliverable: Will be defined in the Plan of Study.

Task 3 - Inventory existing data and determine data/information deficiencies.
Deliverable: Will be presented in the written final report.

Task 4 - Assemble data/information to address data/information deficiencies.
Deliverable: Will be presented in the written final basin study report.

Task 5 - Develop analytical models (as needed). Identified areas of analysis by the Oregon Water Resources Department and stakeholders, such as climate change effects.
Deliverable: Tasks 1-4 will be used to inform the Oregon Water Resources Department and stakeholder team as to the need to develop analytical models to meet study objectives.

Task 6 – Analyze current and future water supply and demands, with consideration of potential climate change impacts (Objective 1).
Deliverable: Prepare a written technical report. Key findings/results/conclusions will be summarized in the written final basin study report (see Task 10).

Task 7 – Determine the potential impacts of climate change on the performance of current water delivery systems (WaterSMART Basin Study Objective 2).
Deliverable: Prepare a written technical report. Also key findings/results/conclusions will be summarized in the written final basin study report.

Task 8 – Develop options to maintain and improve water delivery systems for adequate water supplies in the future (e.g., infrastructure and operations) (Objective 3).
Deliverable: Key findings/results/conclusions for Task 8 will be included in the written final basin study report (see Task 13).

Task 9 – Conduct a tradeoff analysis of proposed options and make recommendations (Objective 4).
Deliverable: Key findings/results/conclusions for Task 8 will be included in the written final basin study report.

Task 10 – Write the final technical reports.
Deliverable: Prepare final written technical reports for each area of analysis (e.g., demands, climate change).

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Task 11 – Summarize findings and make proposed recommendations.
Deliverable: Prepare a written and oral (e.g. PPT presentation) summary of findings, recommendations, and conclusions which will also be included in the final the WaterSMART Basin Study report.

Task 12 – Prepare and publish the final WaterSMART Basin Study Report.
Deliverable: Prepare a final written basin study report that has been peer reviewed by the Oregon Water Resources Department and stakeholder team.

Task 13 – Complete the WaterSMART Basin Study closeout procedure.
Deliverable: Reclamation will take the lead working with the Denver Office to complete the closeout steps with the Oregon Water Resources Department and stakeholder team involvement, as needed.

Task 14 – Stakeholder/Public Outreach and Participation
Deliverable: The Oregon Water Resources Department and stakeholder team will coordinate, as necessary, public outreach efforts, with assistance from Reclamation.

Task 15 – Program Management
This task acknowledges the Oregon Water Resources Department's management of the OWRD grant.

6. Milestones, Study Schedule, and Costs

TBD

7. Available Resources

The Oregon Water Resources Department was selected to complete a Plan of Study with Reclamation in Federal FY14. The total awarded was $100,000, with OWRD contributing a 50 percent cost-share match.

OWRD will be responsible for facilitation, data management, and fiscal management including tracking all in-kind contributions. Individual stakeholders will be providing input, attending meetings, reviewing documents, and building consensus on Basin Study outcomes. OWRD staff can also contribute in the areas of water rights & water use research, hydrologic modeling, and water resource planning, and are available to research, draft, and review various work elements of a WaterSMART Basin Study.

{*Note: seek additional input from stakeholders and other agencies.*}

8. Study Products

TBD

DRAFT

9. References and Appendices (if any)

Oregon Water Resources Department. Determining Surface Water Availability in Oregon. Open File Report SW 02-002.

Oregon Water Resources Department and U.S. Army Corps of Engineers. January 2000. Willamette Basin Reservoir Study Interim Report. http://www.oregon.gov/owrd/docs/2000_01_Willamette_Interim_Report.pdf

U.S. Bureau of Reclamation. December February 2013. Basin Study Framework: WaterSMART Program. http://www.usbr.gov/WaterSMART/bsp/docs/Revised%20Framework%202.26.13.pdf

U.S. National Marine Fisheries Service. 2008 Willamette Project Biological Opinion. http://www.salmonrecovery.gov/BiologicalOpinions/WillametteBiOp.aspx

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WaterSMART Discussion Questions
September 30, 2013

Answers to these questions will allow us to finish preparing the plan of study, and outline some initial tasks.

1. **Study Area:**
    a. For an agricultural demand study, do we want to examine the entire Willamette basin?

2. **Tasks: Agricultural Demand Study**
    a. What is your sense about the previous agricultural demand work? (i.e. 1994 Agricultural Reservation Request, 2008 OWSCI Study). Are these sufficient, or is additional work needed?
        i. It's been stated that determining agricultural demands, supplied by stored water and natural flow, is a fundamental need of the Reservoir Study and the preliminary focus of this WaterSMART Plan of Study. To meet this goal water demands for stored water use and directly from the river needs to be documented by
            1. Actual location (e.g, reservoir or location on the river)
            2. Time of year the diversion is used
            3. Quantity or volume (maximum use and actual use) of the diversion,
            4. Priority dates (for irrigation demands, fish flows, and other Willamette BiOp requirements) for each diversion.
            5. In addition, return flows (flow that returns to the river from irrigation practices) need to quantified and understood including any lag time between infiltration and emergence into the river system.
        ii. This level of detail provides the necessary information to construct water resources models that allow interaction of these needs along with the operation of the reservoirs in the Willamette Project. This approach also enables understanding of reservoir operation during drought years or years where demands exceed stored water rights.
    b. If we chose to refine or update these demand figures, how should we approach it?
    c. What water users should we be talking to? What irrigation districts should we connect with? Any other associations?
    d. What organizations can help with outreach?

3. **Tasks: Municipal Demands**
    a. The Oregon Water Utilities Council recently completed an evaluation of municipal and self-supplied industrial demand projections that date back to the early 1990's. Is additional work needed? If so, is WaterSMART the program we should use?

4. **Tasks: Instream Needs**
    a. Knowing that instream flow studies are currently underway through the Willamette BiOp, is additional work or analysis needed in the meantime? Should this work occur through WaterSMART, a state agency effort, or some other means? Is funding available to support such a task, or is the WaterSMART Program a good source?

5. **Tasks - Climate Change:**
    a. How should we address climate change?
    b. What level of detail do we want to analyze climate change?
    c. Will Willamette Water 2100 fit our needs? Does it fit the requirements of WaterSMART and the Water Secure Act?

6. **Options and Tradeoffs.** The WaterSMART Framework has four required study elements, two of which may duplicate efforts under the reallocation study. Can we meet the requirements of the WaterSMART objectives?

Methodology for Water Demand Forecast for Irrigated Agriculture
Oregon Water Supply and Conservation Initiative (2008)

This "fact sheet" summarizes the methodology used to develop the water demand forecast for the irrigated agricultural water use sector completed as part of the *Oregon Water Supply and Conservation Initiative – Statewide Water Needs Assessment Study* completed in 2008. For purposes of the study, water demand for irrigated agriculture water used to irrigate farm land and for stock watering. Water demand is not limited by source availability (groundwater or surface water).

Methodology

1. Estimate acreage [A] for each irrigated crop group by county.
2. Multiply acres of each crop group by the county-specific, average irrigation [I] requirement for that crop group. This provides estimated consumptive use for each crop group in each county.
3. Divide consumptive use by estimated irrigation efficiency [Ei] and estimated conveyance efficiency [Ec] (these are fractional values, so division increases the quantity of water). This provides an estimate of total water diverted or pumped by crop group for each county.
4. Total agricultural water use in each county is estimated by summing water use for all of the crop groups grown in that county.

Expressed as an equation: $Dc = [(A \times I) \div Ei] \div Ec$

Data Sources for Irrigated Agriculture

- U.S. Geological Survey (USGS) 2005 Water Use Compilation (Fisher 2008)
- Oregon Crop Water Use and Irrigation Requirements (Cuenca, et al. 1992)
- National Land Cover Database (NLCD) Land Cover Layer (USGS 2001)
- 2002 U.S. Census of Agriculture (USDA 2004)
- Project Survey

Data Analysis

- Range of crops grown in Oregon consolidated into 14 "crop groups" that have similar irrigation requirements.
- Monthly irrigation requirements based on the *Oregon Crop Water Use and Irrigation Requirements Report* (Cuenca et al, 1992)
- Geographic variation in monthly irrigation patterns based on eight climate zones defined by Oregon Climate Service (OCS 2008).

Results Presentation

- Model allocates total water use to months in the irrigation season using a monthly distribution pattern developed from crop specific regional data. Results presented by county or by Water Administrative Basins.

Methodology for Water Demand Forecast for Irrigated Agriculture
Oregon Water Supply and Conservation Initiative (2008)

- "Reference forecast" represented a "best estimate" of future agricultural demands based on professional judgment and analysis of information collected.
- Forecasting scenarios and uncertainty analysis were used to capture the range of outcomes that can reasonably be expected through the planning period.
    - Scenario analysis explored alternative futures based on assumptions about increased water use efficiency (conservation scenario) and potential effects of climate change (climate change scenario).
    - Changing crop mixes allows indirect way of understanding how relative crop prices may influence water consumption.
    - Changing irrigated acreage accounts for how land-use changes (i.e., the conversion of agricultural land to urban land, or vice versa) affect agricultural water use.

Results for Willamette Basin

- 2015: 726,400 acre-feet
- 2050: 737,200 acre-feet
- Change in water demand is driven by the change in total irrigated agriculture (i.e., the rate of increase or decrease).
    - Data shows an overall increasing trend in irrigated acreage in the state since the early 1960's, with the past 10 years showing a slight declining trend.
    - Rate of change in irrigated acreage is applied to every crop group uniformly, which assumes that counties will tend to continue to grow their current primary crop groups. While market forces could cause a statewide shift to certain crop types, it was beyond the scope of the project to do such an economic analysis.

Limitations, Uncertainties and Data Gaps

- Agricultural water use data is typically incompletely recorded, e.g. compared to municipal water use data.
- Representative (assumed) data was used where data was incomplete or not readily available (i.e., irrigation efficiency, conveyance efficiency) to establish per acre water usage for agricultural irrigation.
- The estimation of future water demand for agricultural irrigation (and fluctuations in irrigated acreage) is dependent on a variety of factors that were not applied explicitly in the model:
    - Social and economic factors (e.g., commodity prices and demand for specific crop types). For example, water "demand" estimates do not reflect future assumptions regarding the price of agricultural products or water.
    - Water availability limits (i.e., hydrologic limits) and climatic conditions (e.g., drought)
    - Political and regulatory constraints (e.g., water rights and Endangered Species Act), and land use policies (e.g., expansion of development and impacts on land value).

Summary of Willamette Water 2100
Methodology and Status of Modeling Water Demands
Agriculture and Urban (Residential, Commercial and Industrial Uses)

Synopsis of WW2100 Project

In 2010, Oregon State University (OSU), Portland State University, and University of Oregon researchers were awarded a competitive National Science Foundation (NSF) grant under the Water Sustainability and Climate funding category. The "Anticipating Water Scarcity and Informing Integrative Solutions" or "Willamette Water 2100" (WW2100) project was funded at $4.3 M (total over 5-6 yr. period) to develop a unique Willamette Basin model using the *Envision*™ computer platform integrated with climate, hydrology and economic models The computing framework developed at OSU is being utilized to evaluate how climate change, population growth, and economic growth alter the availability and the use of water in the Willamette Basin. The research allows analysis of the potential impacts of changes in the availability and use of water on water scarcity, land use, water temperature, fisheries, and society's ability to meet diverse demands.

Summary Methodology for Developing Water Demands

Agricultural

The Economics Research Team led development of the agricultural models of crop choice, water use, irrigation decisions, and economic returns with input provided by WW2100 Learning Action Network and Broader Impacts Team.

Methodology

Crop choice, irrigation decisions, and economic returns are estimated with statistical models based on agricultural land characteristics, historical cropping data and a survey of irrigators. Data for agricultural characteristics includes irrigation decision model collected by the National Agricultural Statistics Service (USDA) in a survey of over 500 farmers based on last seven years of irrigation practices/decision making processes.

Current Status

The agricultural characteristics models have been completed, including irrigation decisions survey (significant response rate) and estimated irrigation/water demands using Penman Monteith equation; includes assumptions for determining ET and water needs for current/future crop choices. The model will run in a probabilistic form, meaning that crop choices and irrigation decisions will vary year to year based on empirically estimated probabilities. The model represents all agricultural lands, irrigated and non-irrigated, groundwater and surface water rights.

These models of farmer decisions will be coupled with water rights and hydrology models. In some modeled scenarios and in some years, a farmer's desired choice (e.g., to irrigate) may not be allowed in the model if there is insufficient water available for all water rights holders, and where a given parcel of land has a junior water right priority date.

Municipal & Industrial

The Economics Research Team led development of the Urban Water Demand methodology with input provided by WW2100 Learning Action Network and Broader Impacts Team.

Methodology
Urban water demand is estimated as a function of water price, population, income, urban density, and the composition of the urban economy. The relationship is estimated based on a large empirical economics literature on urban water demand, as well as local information on water use, pricing, population, income and density obtained from the basin, US Census, Bureau of Economic Analysis. Model was calibrated to include two separate components for residential and non-residential (commercial and industrial) water demand within water demand model. The statistically estimated model is as follows (where ln is the natural logarithm):

Residential:

$$\ln Q = -(2.931236 + 0.609114\ IBR) - 0.6 \ln p + \ln Pop + (0.13 + 0.05\ IBR) \ln I - 0.048 \ln D$$

Non-Residential:

$$\ln Q = -2.727616 - 0.6 \ln p + 0.11 \ln Ind.I + 0.04 \ln Comm.I + 0.85 \ln Pop$$

Q = daily water use (ccf).
p = price ($/ccf).
Pop = population.
I = median household income
D = density (persons per mile^2)
IBR = 1 if Increasing Block Rate pricing structure, = 0 otherwise.
Ind. I = industrial (manufacturing) income
Comm. I = commercial income

Seasonal adjustments: Summer demand 25%-33% higher than annual average. Winter demand 80% of annual average. Seasonal adjustment will rise with higher summer temperatures and need for residential irrigation.

Current Status
Completed

Concluding Statements
The "Reference case" or "business as usual" scenario should be completed by November 2013. This will provide a prediction of when, where and how water scarcity is expected to arise in the future. With the results of this initial scenario in hand, we can modify the model to then represent alternative policy scenarios where "policy interventions" are tested in the model to see if they are effective in mitigating or lessen the impacts of future water scarcity.

A range of alternative scenarios, some with individual "interventions" and then some with multiple combined interventions will be introduced in the model. This will allow 'what if' testing of model components in single or coupled approaches

Analysis of outputs at various scales (ongoing, resource intensive): Reviewing the data from model runs can occur at a range of resolutions and can be time intensive depending on the specific data needs.

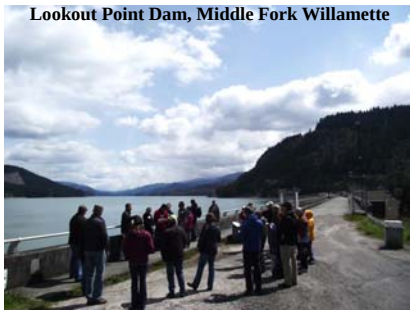
Contact Information
Adam Stebbins, WW2100/Benton County Water Projects Coordinator
adam.stebbins@co.benton.or.us
541-766-6085 (office)

Willamette Water 2100

Anticipating Water Scarcity and Informing Integrative Water System Response

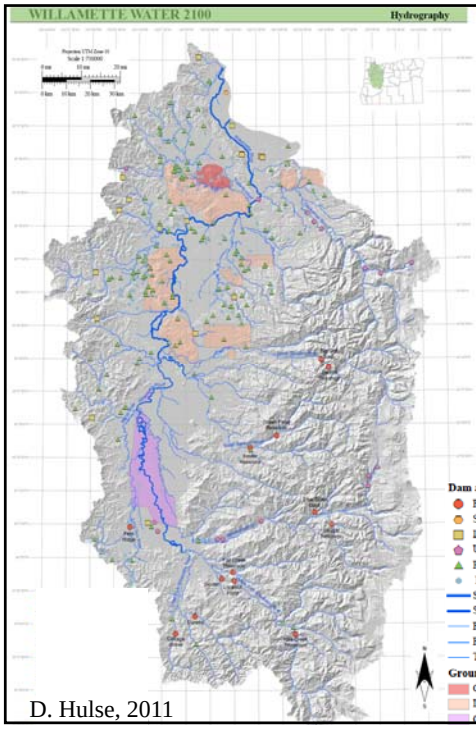
Broader Impacts Team: Adam Stebbins, Dr. Anita Morzillo, Dr. Dave Hulse, Linda Modrell, Dr. Mary Santelmann, Maria Wright, Dr. Sam Chan

OWRD/USBOR WaterSmart Workshop Discussion 9/30/13


Lookout Point Dam, Middle Fork Willamette

Outline

- The Willamette Basin
- "Willamette Water 2100"
- Learning Action Networks
- Water Demand Specifics
- Current Status of Project
- Questions



D. Hulse, 2011

- **11,500 square miles**
- **~2.5 million people or 75% of Oregon's population**
- **~1.2 million acres of farmland**
- **13 federal reservoirs**
- **31 native fish species**

Willamette Water 2100 Overview

- 5 year (2011–2016), $4.3 million project supported by National Science Foundation
- Large research team with diverse expertise (hydrology, fisheries, economics, civil engineering, land use, computational models)
- 'Transdisciplinary' – encourage and incorporate diverse participation at all stages of the project
- Develop 'tools' that are transferrable

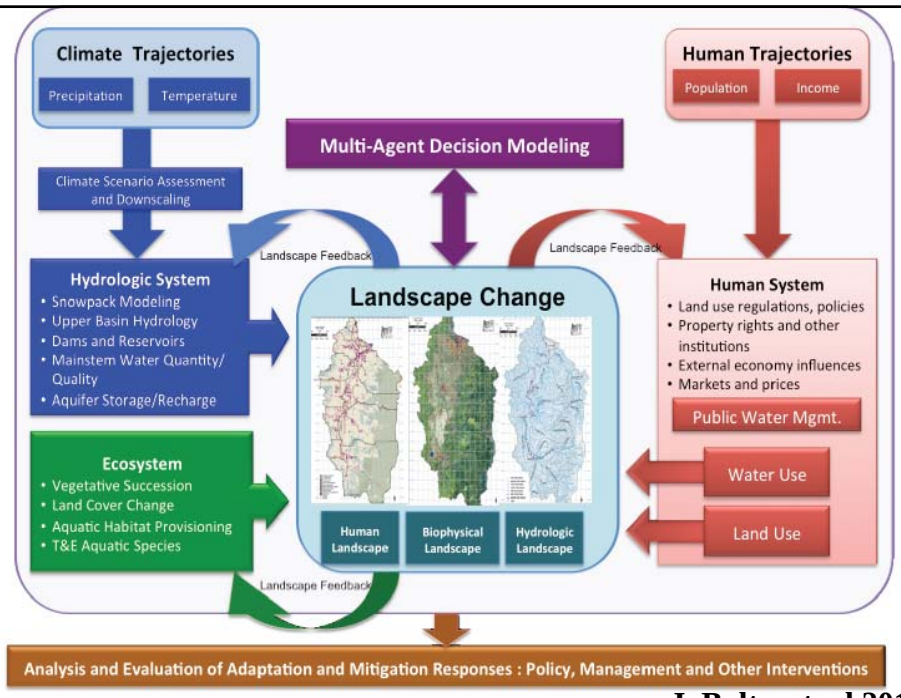
Green Island, Eugene

Talking Water Gardens, Albany

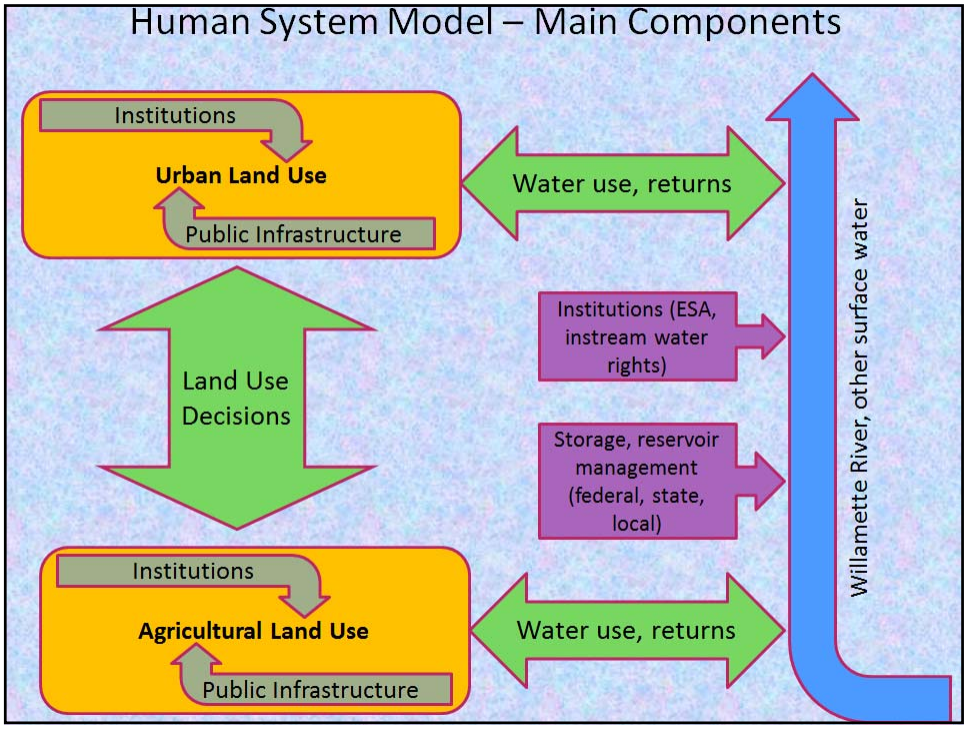
Santiam Water Control District

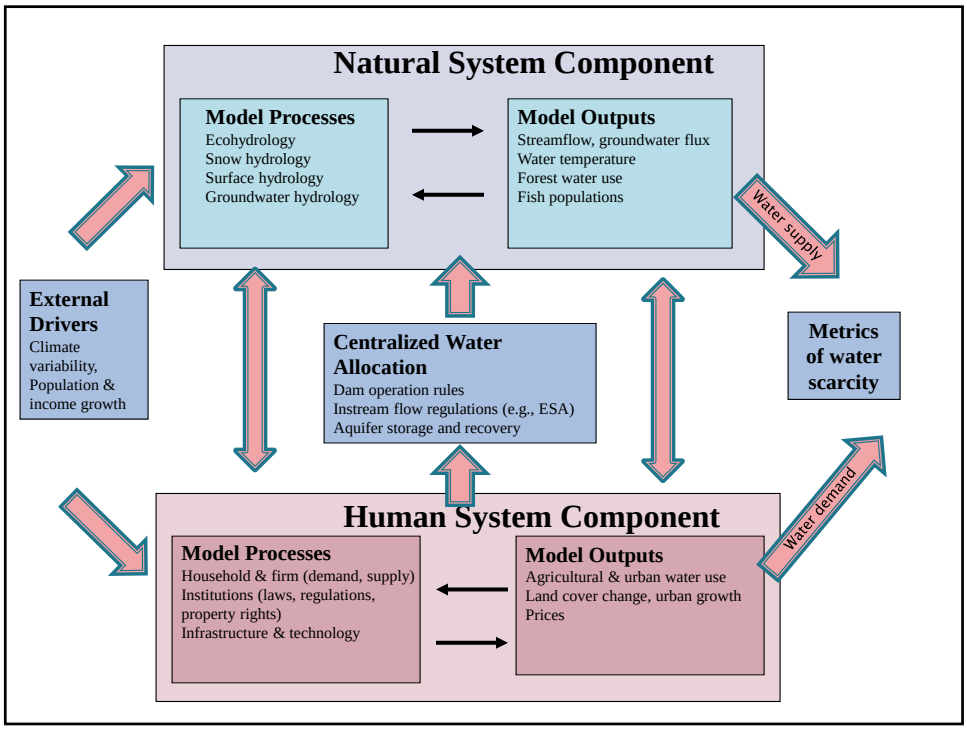
Research Questions

- Where are climate change and human activity most likely to create conditions of water scarcity?
- Where is water scarcity most likely to exert the greatest impact on ecosystems and communities?
- What strategies would allow communities to prevent, mitigate, or adapt to scarcity most successfully?



J. Bolte, et. al 2011


Human System Model – Main Components
Institutions
Urban Land Use
Public Infrastructure
Water use, returns
Institutions (ESA, instream water rights)
Land Use Decisions
Storage, reservoir management (federal, state, local)
Willamette River, other surface water
Institutions
Agricultural Land Use
Public Infrastructure
Water use, returns


Natural System Component
Model Processes
Ecohydrology
Snow hydrology
Surface hydrology
Groundwater hydrology
Model Outputs
Streamflow, groundwater flux
Water temperature
Forest water use
Fish populations
Water supply
External Drivers
Climate variability, Population & income growth
Centralized Water Allocation
Dam operation rules
Instream flow regulations (e.g., ESA)
Aquifer storage and recovery
Metrics of water scarcity
Water demand
Human System Component
Model Processes
Household & firm (demand, supply)
Institutions (laws, regulations, property rights)
Infrastructure & technology
Model Outputs
Agricultural & urban water use
Land cover change, urban growth
Prices

Ex.) Envision supported projects

- Exploring trajectories of change in the Puget Sound Region of Washington**.**
- Broad analysis of the region focused on understanding impacts of alternative growth and development strategies on nearshore ecosystem processes and services.
- Study area contains a mixture of agriculture, forest, urban, and rural residential lands. It was funded by the Washington Department of Fish and Wildlife

http://envision.bioe.orst.edu/StudyAreas/PugetSound/

Status Quo, Managed Growth, Unconstrained Growth (3:32)

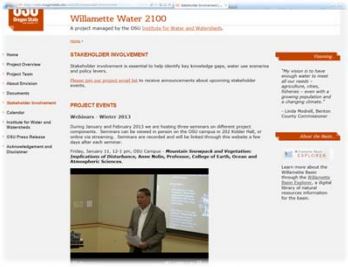
Broader Impacts Research Team

Developing diverse stakeholder involvement to support and inform project research, *Envision* model development, and translate the results of Willamette Water 2100 Project into stakeholder planning and decision making processes.

Learning Action Networks

Stakeholder Workshops

Field Trips



Cyber Seminars

Broader Impacts

- Fieldtrips (2011)
  - 'View of the water system'– from headwaters to Portland
  - 90+ Public, private, non-profit professionals involved
  - 20 Student researchers
- Workshops (2011–2013)
  - Topics: definition of water scarcity, model development and data sources, reference scenario assumptions, reporting metrics
  - 80 participants, most repeating
- Cyberseminars (2013)
  - Topics: Snow monitoring and modeling, climate scenarios, reservoir operations, land use models
  - 30–65 participants each seminar online and in class with over 400 views

Green Island, Eugene

Leaburg Dam

June 2011 Stakeholder Workshop

Defining 'water scarcity'

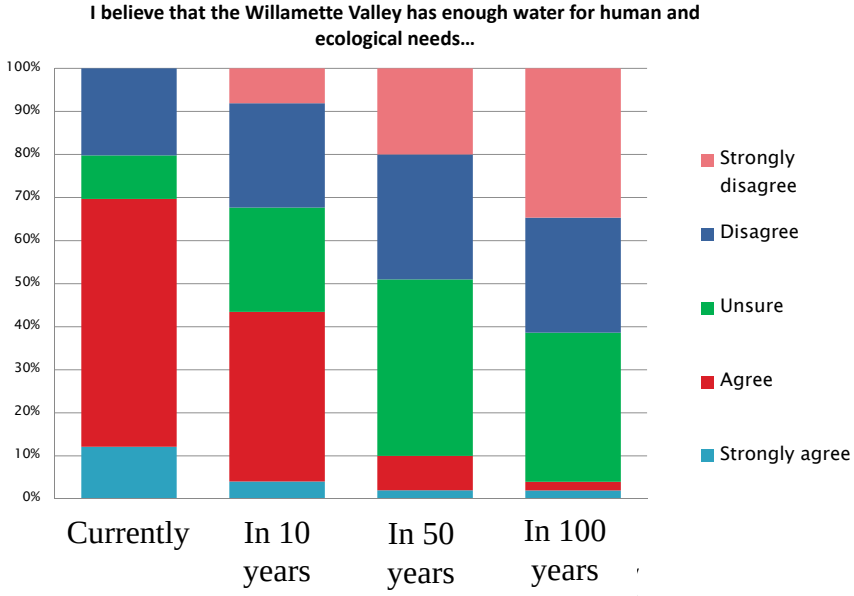
"There is not an affordable, attainable and reliable source of clean water when and where it is wanted or needed by humans, animals and plants, currently and into the future."

1. Economics
2. Laws govern distribution
3. Consistency
4. Water Quality
5. Timing/Seasonality
6. Location
7. Attitudes shape demand
8. Diverse groups and uses
9. Ecological and environmental services
10. Security and Risk

May 2012
Learning Action Network Workshop

- Pre and post workshop surveys
- Facilitated focus groups
- Plenary and Poster Sessions
- Policies and Actions Analysis

May 2012 Workshop Survey



February 2013
Small Group Learning Action Network Workshop

- Participants had attended other meetings and previous project workshops, helping to providing constructive feedback to project scientists
- Provided feedback on elements and assumptions of the "reference scenario" (the initial modeling scenario)
- Reviewed metrics that will be used to evaluate and compare modeling scenarios

Current Status of WW2100

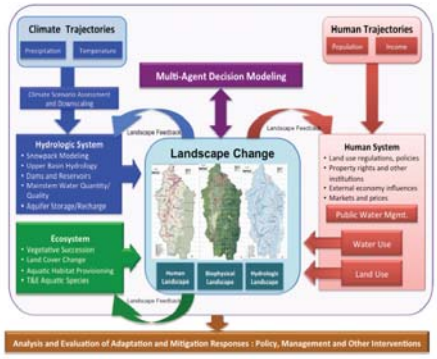
- Reference scenario or 'business as usual' (to be completed by October 2013)
- Analyze initial results and inform development of 'alternative scenarios'
- Present results to Learning Action Network (to be completed by February 2014)

Henry Hagg Lake, 9/23/11

Next Steps

- Develop Alternative Scenarios (single parameter and multi parameter) changes to year 2050, 2100
- Learning Action Network informs single or combined changes in model components
  - Ex.) Alternative Scenario (single): Change operations management of federal reservoirs
  - Ex.) Alternative Scenario (combined): Change operations management of federal reservoirs **AND** change land use policies **AND ??? AND….**

Questions?



City of Salem, Woodmansee Park & Aquifer Storage and Recovery Field (8/4/11)

Adam Stebbins, Broader Impacts Research Team
http://water.oregonstate.edu/ww2100

Willamette Basin MPSF conversion

1) Current and scheduled instream flow studies

-North and South Santiam

-Middle Fork below Dexter; Fall Creek(?)

-McKenzie above Leaburg; SF McKenzie below Cougar

2) Data gaps / new studies needed

-Lower reaches of main tributaries

-Mainstem Willamette (several reaches)

-IFIM, interdisciplinary team approach : OAR 635-400-0015, (14a)

-Use existing / additional data; on fish use, water quality, connectivity, etc.

-Not scheduled yet

3) Willamette MPSF reaches : issues

-Low monthly flow values; live flow only

-IWR will have live flow and stored flow per month

-Some reaches have no minimum flow

4) Steps needed

-Schedule/budget new studies

-Use studies (existing/planned/future) to quantify instream flow needs

-Work with Corps modelers to determine live vs. stored flow per month

-Incorporate Environmental Flows

-Balance mainstem flow vs. sum of tributary flows

-Convert MPSF to ISWR; apply for additional flow as determined