Water Briefing Notebook

City of Bend

2012

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RESOLUTION NO. 2867

A RESOLUTION SETTING FORTH A MODIFIED PLAN TO RETAIN BEND'S DUAL WATER SOURCE AT REDUCED COST TO RATEPAYERS, DIRECTING A LIMITED RE-EVALUATION OF CERTAIN ASPECTS OF THE SURFACE WATER IMPROVEMENT PROJECT, AND INSTITUTING A PROGRAM TO INCREASE FLOWS IN TUMALO CREEK

Findings:

A. Certain assumptions and values have formed the basis of the City Council's decision related to the Surface Water Project, and the Council finds that it is beneficial to document those values so that citizens fully understand the reason for its judgment and the decisions Council has made. These have been stated in numerous prior council meetings and resolutions but are worth restating (*see* Resolutions 2814, 2817, 2846 and 2853).

B. The City Council is fully aware that the project has generated controversy. This can be normal for large and costly infrastructure projects, but Council desires to be responsive to the community's concerns related to the timing, economics and environmental impacts of the project.

C. The City Council is especially aware of the rate impacts of large infrastructure projects at a time when the Bend economy continues to struggle.

D. The Bridge Creek source has been studied and evaluated many times, including in the 1980 Water System Master Plan, the Bridge Creek Pipelines Evaluation (2009), the Brown and Caldwell Water Supply Alternatives Study (2009), the HDR Surface Water/ Ground Water Cost Comparison (2010), the Value Engineering Study (March 2011), the Optimization Study (2011), and the HDR Technical Report Timing of Hydro Project (August 2011). The City Council has held numerous public work sessions and other public meetings related to the proposed project. In addition, the City's Infrastructure Advisory Committee held a more recent public forum, receiving input from the public and City consultants, and indicated its firm support of the project. The IAC is made up of members of the public that have expertise in engineering, water utilities, geology, environmental law, as well as representatives of the public and business interests. Over-studying a project may not serve the community well in terms of time, expense and resources. Still, Council values the importance of a thorough risk/benefit assessment, and desires to ensure that its approach to the problem remains the most viable in light of current economic and regulatory conditions.

E. The City Council also must be cognizant that it is currently under a regulatory obligation to meet the requirements of the Safe Drinking Water Act, and the requirements of the Long Term 2 Enhanced Surface Treatment Rule ("LT2 rule"), that it has received a two year extension through October of 2014, and that the extension is dependent on meeting a tight project schedule that will be put in jeopardy by much more delay in the project. Nonetheless, the Council believes that pausing design and delaying construction of the treatment aspect of the project is in the best interest of the community for the reasons set forth in this Resolution.

F. This Resolution is intended to again articulate the City Council's values and assumptions related to the Surface Water Project, and to describe a new approach with the goals of reducing cost, improving stream flows in Tumalo Creek and the Deschutes River, and continuing to provide exceedingly high-quality drinking water for the City's residents..

Values and Assumptions:

G. The City of Bend is extremely fortunate and prior councils were farsighted and perceptive in securing and protecting two sources (a dual source) of water, especially a high quality and pristine source such as the Bridge Creek surface water supply. Bend has used water from Bridge Creek for approximately 85 years. It gets half of its water, annually, from Bridge Creek, which flows from the flank of Broken Top through a protected watershed, owned by the USDA Forest Service ("Forest Service"). It would be irresponsible of this Council to forsake half of the City's water supply.

H. A dual source is an especially valuable asset in the modern era—other communities are paying a high price to find a second or multiple source of water due to climate change/drought risks, water quality concerns, regulatory requirements, and water rights uncertainty. Specifically in Oregon, the City has received letters from the Tualatin Valley Water District, the Oak Lodge Water District, and the Eugene Water and Electric Board, all confirming that a second source of water supply brings invaluable flexibility and reliability into the future, and that as water utilities, they have relentlessly been pursuing strategies to develop a second source of water. Those letters are attached to this Resolution.

I. The City has received the attached letter of support from EDCO for a similar reason—the recognition that a high quality surface water source is the envy of communities that do not have it, that it is in the best interest of Bend residents and businesses to keep the surface water source, longtime water rights, and the transmission system to deliver surface water to Bend residents and businesses. EDCO mirrored the Council's view that dual system provides valuable reliability for future needs, that a gravity system is cost effective long term, and that without such a system, the City's infrastructure could be hampered, limiting job growth and economic development.

J. Gravity flow provides a reliable, energy efficient, lower operation and maintenance cost water supply with low carbon footprint into the future. Groundwater, while also a valuable water source and beneficial to the City, requires pumping from 400-700 feet below surface, which is an energy intensive activity and highly likely to be more expensive in the long run (however, electricity costs fluctuate over the years).

K. A dual source provides operational flexibility and gives high confidence in water availability as demand changes with season and population growth into the future.

L. A dual source provides environmental flexibility so that if quantity, quality or regulatory problems with one source occur, the other can still be used. Equally important, in the event that something happens to one source, the second source gives the City potential for lower cost solutions to enable the City to maintain two sources. A recent study by DEQ found that out of 253 wells for drinking water systems within the Deschutes Watershed, 101 of them have had contamination events. The EPA has indicated it is "likely" to further regulate groundwater in a manner that could require costly filtration of that source. A dual source also maximizes potential for renewable energy.

M. The surface water source is secured by water rights, including senior and certificated rights, the value of which cannot be underestimated or lightly put at risk. This is especially true in light of the complexities of Oregon water law, further complicated by the intricacies of the Deschutes Groundwater Mitigation Program and its requirements to provide for offsets to impacts to the Lower Deschutes Scenic Waterway flows caused any newly permitted groundwater withdrawals within the upper basin's defined study area. The Deschutes Groundwater Mitigation Program is itself a temporary and, in some circles, controversial program, without which newly permitted groundwater withdrawals in the upper basin would be impossible. In the event the Mitigation Program's detractors are successful in further limiting it or preventing its reauthorization in the future, a sole reliance upon groundwater would significantly hamper the City's ability to meet water demand.

N. As stewards of Bend's infrastructure and long term water system and community and economic growth, the time frame the City Council has determined is appropriate to consider in making long term water infrastructure decisions is at least 50 years in Bend's future. The City Council recognizes that the existing water infrastructure related to the surface water source is over 80 years old and that any replacement of this infrastructure will utilize materials and design that will last in excess of 100 years.

O. There are three primary threats to the continued use of Bridge Creek:

a. The EPA LT2 was implemented by the federal government to address real problems with surface water in some parts of the country. The deadline is currently October 1, 2014;

b. The risk of wildfire in the watershed which would potentially increase long term turbidity and sedimentation issues to the water source; and

c. Deteriorating pipe infrastructure, including a pipe that was constructed in 1926, the tar lining of which is currently fragmenting and traveling down the pipe (*see* photo exhibits showing lining in bottom of tank). 1926 and 1950s pipes, both of which are subject to tree and root encroachment further increasing risk failure.

P. Environmentally, the project will not alter the upper diversion at the source springs which has operated continuously since the 1950's, and therefore will cause no change to the existing flow regime established to minimize turbidity into Bridge Creek by keeping diverted flows constant. The proposed project will have an environmental benefit in that the City's existing system has lacked flow control so that the City has diverted water at a constant rate of 18.2 cfs, even when actual city use is lower. The new system will have flow controls so that only water needed will be diverted, eliminating downstream return flows and related turbidity events and now passing unused flow beginning at the intake location through 9.5 miles of stream.

Q. The City Council has considered changing the point of diversion to farther downstream on Tumalo Creek, as a cost saving measure in that it would result in a shorter pipe which would create a new intake upstream of Shevlin Park. However, as in the past, the City rejected this idea due to water quality concerns (possibility of water pollution due to upstream development, vehicle traffic and human activity, increased fire probability, turbidity issues further downstream, etc.), legal risks to water rights in changing the point of diversion, environmental concerns in moving the diversion through the rocky/steep canyons further down the river, and uncertainties as to constructing a new diversion on/across Forest Service lands.

R. The City received the attached letter of support from Central Oregon Irrigation District in which they state, "... perfected and certificated water rights in the Deschutes Basin are not held by many entities, and are rarely if ever voluntarily relinquished. COID would only consider relinquishment of its water rights if there was a 100% guarantee of replacement of that supply...and Bend has only the promise of future supply..."

S. The City has received the attached letter of support from Tumalo Irrigation District and through ongoing discussions throughout the project development with Tumalo Irrigation District, and as evidenced by its State approved 2005 update to its Water Management and Conservation Plan (WMCP), that it has identified estimated annual water losses of over 31,000 acre feet, much of it within its delivery system, which it intends to reduce by completing conservation projects.

T. It is the City's understanding that Tumalo Irrigation District has completed the following projects to date:

   a. Completed the Bend Feed Canal that returned 5.82 cfs of senior water, and 11.3 cfs of junior water (State project CW-9);
   b. Completed two phases of the Tumalo Feed Project (State project CW-37), which when fully completed is estimated to return an additional 20 cfs of water for instream purposes (depending on funding). Phase 3 is underway this winter, expected to be completed by start of irrigation season; and
   c. Completed annual instream leases over the past ten years averaging approximately 5.4 cfs of senior water placed instream (Source DRC).

   The district expects to continue this trend of conserving water and increasing the instream flows within Tumalo Creek.

U. The City Council also finds it fortunate to have an existing 1926 agreement with the Forest Service which created the Bend Municipal watershed and laid the basis for subsequent special use permits and memorandums of agreement that continues the protection and management of the watershed today with a recognized priority for the production of municipal drinking water.

V. At the request of this City Council, Bend sought successful inclusion and assisted in creation of the Deschutes Skyline Collaborative Forest Landscape Restoration Project with the potential for up to $10 Million dollars of additional funding for this collaborative with the Deschutes National Forest through the Collaborative Forest Landscape Restoration Act of 2009, and that the Bend Municipal Watershed is included in the study area with the goal of finding additional cost effective methods of reducing the risk of fire that work in conjunction with the surface water project and continuing to assist agencies and organizations who continue to work towards improving water quality (temperature), enhancing riparian and aquatic habitat, and improving stream bank stability in Tumalo and Whychus Creeks.

Based on these findings, the Bend City Council resolves as follows:

<u>Section 1</u>. The Council is committed to continuing with the pipeline and intake facility design/construction on schedule, and obtaining the Special Use Permit from the Forest Service (including the National Environmental Policy Act (NEPA) process), to coincide with the Federal Highway Administration and Deschutes County rebuild of the existing Skyliners Road occurring in 2013. Council reaffirms its commitment to retaining the current diversion point because it minimizes potential contamination, and legal risk of

environmental compliance costs and risk to water rights, as further set forth in the above Findings.

<u>Section 2</u>. Council is equally committed to retaining the Bridge Creek source at the lowest possible cost. The City is currently seeking to delay compliance with the treatment requirement of the LT2 rule, thereby significantly reducing water rate increases. To this end, the City has initiated aggressive efforts on behalf of its constituents, by working with:

- The Oregon Health Department to seek an Alternative Compliance Schedule for treatment under a negotiated administrative order; and
- The EPA and Congressional delegation to seek flexibility in the LT2 treatment rule, including delaying treatment improvements as the EPA reviews the LT2 rule, and rebalancing the costs and benefits of rule compliance as applied to Bend and other similarly situated cities with high quality water sources.

Because of the risk of fire, City staff is directed to work with the Forest Service to mitigate the fire risk to the greatest extent possible, as the City works through the issues related to the staging of the surface water treatment improvements.

<u>Section 3</u>. By Resolution No. 2817, the City Council directed staff to proceed with design and construction of the Membrane Filtration Treatment for the City's Surface Water Reinvestment Project. The engineering design of the treatment facility is currently at about 75%. City staff has recently worked with its design consultant, HDR, to reduce monthly expenditures by slowing down the pace of design, so that the tasks that were scheduled for completion by March, are now scheduled for completion by June, at no corresponding increase in cost.

The City Council continues to find that it is in the best interest of the City to continue to 90% design for the Membrane Treatment Facility in order to avoid significant work stop/start charges. However, prior to proceeding to 100% design, the City desires to "pause" to take the actions set forth in Section 6 below. Council believes that 100% design is likely desirable to show good faith progress with its obligations under the LT2 rule, to have a ready design in the event of a wildfire in the watershed, and to receive the full benefit of the City's investment to date, but it believes further community input on this decision would be valuable.

Council directs staff to delay construction of the Membrane Treatment Facility as it works through the issues identified in Section 2 above. A delay in construction costs is expected to reduce the immediate need for significant rate increases. A recognized risk is that it could increase project construction costs in the future, compared to the costs projected currently.

Section 4. The City Council holds open the possibility of opting for UV or another treatment type as a less costly measure given economic problems in Bend. Council continues to recognize the benefit of membrane treatment as a superior treatment method in the event of turbidity from a wildfire in the watershed.

Section. 5. By Resolution No. 2846, the City Council directed staff to proceed with the construction of the hydroelectric facility as part of the Surface Water Improvement Project. The Hydro portion of the project was to operate on water used by Bend for beneficial use, based on current demand and its water rights—in other words, no additional water would be diverted for hydroelectricity other than what is needed to serve utility customers.

The design of the Hydro project and permitting has been stopped pending further direction from Council. The City Council desires to re-evaluate Hydro at this time, and delay the cost of design, turbine procurement, construction and permitting, in order to reduce the up-front cost of the surface water project.

The City Council understands that the trade-off in doing so is that a hydroelectric facility produces a valuable revenue stream which would provide ratepayer relief as well as the potential for investment in stream flow improvement efforts, offsetting operational and construction costs in relatively few years, and produces clean, green energy. However, the City Council is willing to defer construction to a future date, and further explore private investment.

Section 6. As part of its commitment to being responsive to community questions about the project, the City Council is willing to take an additional third party, independent look at the treatment methods, timing and hydro aspects of the project, with a neutral and knowledgeable third party facilitating the discussion. The City Council does not intend to review the underlying values and assumptions for the Council decisions to retain the dual source and to replace the transmission line.

Section 7. In taking the steps described in Sections 1 through 4, it is Council's intent to reduce project costs so that rate increases in fiscal year 2012-2013 will be reduced from 15% to no more than 5%, with corresponding reduction in rates in the years thereafter. The estimated rate increase for a fiscally constrained surface water project would equate to an additional monthly charge ranging from $.85-$1.70 each year for the average Bend household.

Section 8. The Council directs the formation of a Tumalo Creek restoration subgroup, at first comprised of at least one council member, supported by city staff, to create a collaborative dialogue with the Tumalo Irrigation District board and staff, to establish a mutually agreeable flow restoration target; identify a mutual list of priority projects; determine related funding requirements and potential partners; and seek other mutually beneficial projects, processes or agreements that may be necessary to meet restoration and long term water supply goals of each entity.

Adopted by roll call vote on March 7, 2012.

YES: Tom Greene
Scott Ramsay
Mark Capell
Jodie Barram
Kathie Eckman
Mayor Jeff Eager

NO: Jim Clinton

Jeff Eager, Mayor

ATTEST:

Robyn Christie, City Recorder

Approved as to form:

Mary A. Winters, City Attorney

Tualatin Valley Water District

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Gregory E. DiLoreto
Chief Executive Officer

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Debra Erickson
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Manager, Operations & Field Services

Todd Heidgerken
Manager, Community & Intergovernmental Relations

Mark Knudson, P.E.
Chief Engineer

Brenda Lennox
Manager, Customer & Support Services

November 2, 2010

Mayor Kathie Eckman and Bend City Councilors
City of Bend
710 NW Wall Street
Bend, Oregon 97701

TRANSMITTED VIA EMAIL

Dear Mayor Eckman and Bend City Councilors:

It is my understanding that you are soliciting feedback from other water providers regarding the City of Bend's water supply options and, more specifically, our experience with our water supplies. Obviously the approach that the City of Bend takes is ultimately up to you, however, we are pleased to share our experience in the hope that it will assist you in making an informed decision that considers the various risks associated with water supply and water rights.

As background, the Tualatin Valley Water District (TVWD) serves more than 200,000 people in parts of Washington County. Our service area covers more than 45 square miles and includes portions of Beaverton, Hillsboro, and Tigard. Approximately 70 percent of our water is used by residential customers and the other 30 percent used for business and industrial needs. Our water supply is comprised of water purchased from the Portland Water Bureau (includes water from the Bull Run Watershed and the Columbia South Shore Wellfield) and our ownership in the Joint Water Commission (includes water from Barney Reservoir, Hagg Lake and the Tualatin River). As you can see, we have a number of sources that are used to meet our needs and provide the reliability our customers have come to expect.

For a number of reasons, TVWD has deliberately pursued a water supply strategy that involves the use of multiple sources of water. This approach has served us well in periods of short supply (drought) or when a source might not be available due to mechanical or quality issues. Prior to this approach, residents served by TVWD (and its predecessor) were saddled with water restrictions due to limitations of relying on a single source of supply. The drought of 1992 was a clear example of some of the unfortunate consequences and impact of a sole source strategy. It was during this period that TVWD customers experienced mandatory water restrictions that prevented the watering of established lawns, car washing and other normally allowed uses of water. Enforcement included the imposition of penalties ranging from $100 to $500. Interestingly, that drought only affected one source in the Portland Metro area, Portland's Bull Run System. It was as a result of that drought that the TVWD Board of Commissioners instructed staff to develop a second source of supply for the District.

I hope the information I have provided regarding TVWD's experience is helpful and provides some background on how and why we have approached the issues of water supply, reliability and value of water the way we have. Good luck in your water supply planning process and implementation. Please let me know if I can be of any assistance or provide additional information that you might find useful.

Sincerely,

Gregory E. DiLoreto
Chief Executive Officer

Cc: Eric King, Bend City Manager

To: Tom Hickman, City Engineer/Assistant Public Works Director

From: Dan Bradley, General Manager

Date: October 27, 2010

Subject: Abandonment of Existing Water Supply

I would like to offer my perspective of the discussions occurring at the City of Bend regarding the abandonment of the Bridge Creek surface water supply. I have actually visited the site and am familiar with the supply source.

I can, without hesitation, say that I would never recommend let alone consider abandoning a source of such high quality water as the Bridge Creek source. It is an asset not only of huge value today but of untold value in the future.

The Oak Lodge Water District currently receives its source water from the Clackamas River. The Clackamas River is fully allocated and is no longer available for summer appropriation. As a result, Oak Lodge currently has a contract with MSA/GSI to develop a groundwater source not only for emergency purposes but also as an additional source of supply. Quite the opposite of what is being proposed in Bend.

I know some parts of the Deschutes Mitigation Plan but certainly not enough to comment with much certainty. But from what I know of the Plan I wonder why anyone in the area would even consider abandoning a pristine source that provides so many opportunities especially with the addition of adding hydroelectric generation that will provide a sizeable income for decades.

I mentioned this to some of my Board Members who were essentially shocked at the concept. Some of the comments I received are "What are they thinking?" "Why would they do something like that?" Is there any chance we could get access to the water if they give it away?" Based on these comments I think it is clear the Oak Lodge Water District Board would never consider abandoning a water source.

In conclusion, possessing water rights to any water supply sources in Oregon is an asset that I could not put a price on today and certainly not into the future. I strongly recommend the City of Bend not abandon this wonderful source.

EWEB

Eugene Water & Electric Board
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www.eweb.org

October 28, 2010

City Manager/City Council
City of Bend
710 NW Wall Street
Bend, OR 97701

RE: Feedback on Upcoming Water Supply Planning Decision

Dear Mr. Eric King and City Council Members:

It is with the unpleasant distinction as the largest water provider in the Pacific Northwest without a second source of supply that we are writing you to encourage maintaining both your surface water source and your ground water source for future water supply for your community. Having a single source of supply may be common in small towns and rural communities in Oregon, but the majority of larger communities rely on diversity to meet the growing needs of their communities (both residential growth and industrial/commercial growth). Some examples of diversified water supply sources in Oregon are: Portland Water, Medford Water Commission, City of Albany, Springfield Utility Board, Clackamas River Water, City of Lake Oswego, City of Wilsonville, City of Beaverton, City of Tigard, Tualatin Valley Water, City of Salem, City of West Linn, Oak Lodge Water District, City of Hillsboro, and City of Milwaukie. It is our Board directed goal for staff to add the Eugene Water & Electric Board (EWEB) to this list.

We recognize and acknowledge the economic factors in your decision. The unquantifiable cost to your community of **not being able** to provide water reliably in the future should cause you great pause while considering the cost differences (short and long term) between a single source of supply and dual source of supply. In addition to providing the flexibility of a second source, your surface water system provides gravity flow of water to most of your city (an extremely valuable asset in itself for public health and public safety). Furthermore, it provides a renewable energy supply to be used locally for electric power. Being the largest publicly owned utility in Oregon we recognize the value of renewable energy sources to our northwest power customers. We believe you will find benefits and additional pride in adding power generation to the services you provide to your community. As a water provider we rely on our electric utility for reliable power (the water utility is our 7th largest customer on the electric side). Having a power source that you control will provide a degree of increased reliability if you choose to utilize this electric resource to supply some of your water infrastructure.

We are envious of your current position as a dual source of supply water system. EWEB serves the second largest city in Oregon (170,000+ people). We have been working relentlessly to bring viable options to our Board to consider adding a second source of supply to our water supply portfolio. Because of the difficulty with obtaining legal access to new supplies we have yet to realize this Board supported objective. I highly encourage you to not underestimate the challenges of acquiring legal access to new water supplies, especially in light of the complexities of our Oregon water right laws, which are further compounded in the Deschutes basin because of the designation of the Deschutes River as a wild and scenic river and the mitigation rules for ground water withdrawals.

The city of Bend is fortunate to have many things that attract visitors, residents and businesses to it: mountains, the endless recreational opportunities, the micro-brews, and a diverse water supply. It is our professional judgment that it would be in your city's best interest to maintain this water supply diversity to meet the needs of your community now and into the future. It will be a decision that future generations will grow to appreciate.

If we can provide you or your staff with any additional information or testimony we would be glad to participate as needed.

Regards,

Tom Buckhouse
Director of the Water Division
EWEB
tom.buckhouse@eweb.org

Brad Taylor
Water Resource and System Planner
EWEB
brad.taylor@eweb.org

cc: Roger Gray, General Manager, EWEB
Tom Hickmann, City Engineer/Assistant Public Works Director, City of Bend

CENTRAL OREGON
IRRIGATION DISTRICT

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A MUNICIPAL CORPORATION OF THE STATE OF OREGON

2 November. 2010

Mayor Kathie Eckman
City Council Members
City of Bend – City Hall
710 NW Wall Street
Bend, OR 97701

Re: Project to Replace the City's Surface Water Supply System

Mayor Eckman and City Council Members,

Central Oregon Irrigation District (COID) is providing these comments out of respect for your process of deliberation on this issue and under the objectives stated in our joint Memorandum of Understanding (MOU) signed in 2003.

The MOU was approved and executed by both of our governments recognizing that cooperative and creative efforts are going to be needed in meeting current and future water supplies. A foundational element of Bend's current water supply is the perfected and certificated water right on Bridge Creek. Perfected and certificated surface water rights in the Deschutes Basin are a precious item not held by many entities and are rarely if ever voluntarily relinquished. COID would only consider relinquishment of its water rights if there was a 100% guarantee on replacement of that supply. That situation does not currently exist for the City of Bend as the Deschutes Ground Water Mitigation Program is due for legal sunset in 2014 and the chances of that program to be extended by the state legislature is not known. While many informed voices may advocate for an all groundwater supply, the fact remains that the City of Bend already has a perfected water right in hand and only a promise of additional groundwater rights in the future.

In addition, as with COID's water delivery system, the Bridge Creek water supply is fully provided by gravity and a sustainable and affordable delivery independent of mechanical or electrical failures. While the infrastructure may require repair and maintenance over time the fundamental delivery is provided by gravity at no additional expense.

Thank you for your attention to these comments and trust they are of benefit in your deliberations.

Sincerely yours,

Steven C Johnson

Steven C Johnson
District Secretary - Manager

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December 11, 2010

To: Members of the Bend Infrastructure Advisory Council

Subject: Letter of support for combined surface and groundwater option for the City of Bend.

I regret that I will not be able to attend the IAC meeting on December 13th regarding the Bend water upgrade option. Please accept this memo in my absence.

Securing an adequate water supply to meet Bend's population projections will involve substantial infrastructure decisions that will impact City residents for decades. I strongly support a combined surface and groundwater system, including the proposed upgrade of the Bridge Creek facility that the City Council recently approved.

The existing dual-source system is the most cost-effective option over time given the energy required for an all-groundwater system and inevitable increases in energy costs. The Northwest Power Planning Council, PGE and Pacific Corp, the Bonneville Power Administration and the Oregon Department of Energy all anticipate steady increases in the cost of electricity. These costs will be exacerbated by the fact that Oregon currently faces a bottleneck in transmission capacity. Whether Oregonians choose to meet additional electricity demand through the existing coal based system or through development of renewable energy sources, capacity must be added to the transmission system. This is an expensive undertaking and it will be reflected in increased electricity costs.

Pumping water is a very energy-intensive activity. The gravity-fed surface water system will save Bend residents significant money by reducing electricity costs associated with groundwater pumping.

Another point to consider is that, in an effort to reduce greenhouse gas emissions and increase energy security, the Pacific Northwest region will likely expand policies and incentives for development of renewable energy sources. Designing the upgraded surface water system so that it provides opportunities to develop small-scale hydro-electric facilities will give the City flexibility to benefit from programs supporting renewables. In addition, at some point it is likely that we will see regional, and eventually national, regulations on greenhouse gas emissions. It is possible that the increased greenhouse gasses associated with groundwater pumping will be a liability under those regulations.

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Finally, climate change is a real concern and there is great uncertainty about the impacts it will cause. The best way to safeguard against such uncertainty is to add diversity to our systems. Climate change will likely affect surface water flows, and this further supports the case for reinvestment in the Bridge Creek system, which is groundwater fed and will be less affected. If climate change becomes severe enough to significantly affect surface water and snowpack fed streams and rivers, it will reduce the hydropower capacity on the Columbia system, further driving up electricity costs.

I urge the IAC to consider these points and support the City Council's decision to move forward with a combined surface and groundwater system.

Sincerely,

Cylvia Hayes

Cylvia Hayes
CEO, 3EStrategies

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TUMALO IRRIGATION DISTRICT
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November 3, 2010

Mr. Eric King, City Manager
City of Bend
710 NW Wall Street
Bend, Oregon 97701

SUBJECT: LETTER OF SUPPORT, CITY OF BEND WATER SUPPLY PROJECT

Dear Mr. King:

It is the understanding of the Tumalo Irrigation District that the City of Bend is currently in the investigative and design stages of renovating its surface water supply from the Bridge Creek/Tumalo Creek watershed. The supply has been in use for over 80 years and we understand that the project includes the replacement of aged, failing pipe and the addition of water treatment to address new EPA rules. We also understand that the City is investigating the addition of renewable energy production through hydroelectric power generation.

As you know, the City and the Tumalo Irrigation District have been long time stewardship partners on Tumalo Creek requiring continuing cooperation to facilitate the proration of the various water rights held by both entities (according to the State water right certificates). We understand the proposed project to enhance control, use and delivery of the City's water through the addition of measurement devices for intake water and elimination of routine operational return flows at the Outback site. This will serve to facilitate better tracking and evaluation of water use and insure the proper allocation of water to the City and Tumalo Irrigation District as called for in the State water rights held by each party. We perceive this as a benefit of the project. We also note that a portion of the City's water rights include assessment payments to the District (for 692 equivalent acres). Preserving and upgrading its surface water right insures the continuing beneficial value of these specific rights.

We understand that the City's historical and proposed supply of surface water is through gravity and based upon the natural "fall" from the diversion point to the Outback site. Additionally, the City may implement hydroelectric power generation if practical. The Tumalo Irrigation District supports the idea of sustainable and energy efficient operations.

The District shares the City's desire to upgrade its systems and is in the process of upgrading its century-old delivery systems as well and appreciates the support of the City in the District's endeavors to further enhance the Tumalo Creek watershed and provide additional conserved water instream through such projects as its Tumalo Feed Canal piping project.

Based upon our current understanding of the project and our continued input and involvement in the City's process, the Tumalo Irrigation District supports the City of Bend's efforts to renovate its surface water supply system, implement and share the data results of complete water diversion measurement and associated telemetry, implement water treatment as required by law, and to investigate the implementation of renewable energy.

Should you have any questions on this letter of support, please call.

Sincerely,

TUMALO IRRIGATION DISTRICT

Elmer G. McDaniels

Elmer G. McDaniels, Manager

ECONOMIC DEVELOPMENT FOR CENTRAL OREGON

February 22, 2012

City of Bend
City Councilors
710 NW Wall St.
Bend, OR 97701

Dear Councilors:

On behalf of our Board of Directors, I would like to express support from Economic Development for Central Oregon (EDCO) for the City of Bend to maintain its dual source water system and preserve its current surface water rights. At its February 9th meeting, the EDCO Board of Directors unanimously approved a motion to write a letter of support for this critical infrastructure asset. A high quality surface water source such as the one Bend possesses is the envy of those communities that do no have it. Any effort or campaign to eliminate it is not in the true best interests of the City of Bend, its residents and businesses.

We understand that there are a number of issues currently being publicly debated – whether to have a hydroelectric component to the surface water source as well as the cost, timing and method of treatment required by federal laws. To be clear, EDCO is not weighing in on these issues with this letter, rather our support is specific to keeping the surface water source, longtime water rights, and the transmission system to deliver surface water to Bend residents and businesses. It is our understanding that the aging transmission line is at risk of failure or is already experiencing problems in sections. Modernization and replacement of such transmission lines are common in the region, and consequently are a very straightforward project for EDCO to support.

As you know, EDCO has been the tri-county region's lead economic development organization for the past 30 years. Water supply is frequently an important element of our business and industry recruitment efforts as well as work we do to help local manufacturers, high technology and other traded-sector companies to grow and prosper. During that time Bend has experienced tremendous growth that was supported by the City's abundant and high quality water supply.

Evaluations conducted throughout the years have confirmed time and again that the City's dual source water system (surface water from Bridge Creek and ground water) is by far the most reliable arrangement for future needs. With gravity delivering the needed pressure to make the system work, it is also the most cost effective alternative, long term. Without such a system, the City's infrastructure could be hampered, limiting future growth and development.

Water rights and mitigation credits in the high desert climate of Central Oregon are very limited, so to consider forfeiting those the City already has would be—in the opinion of our Board—shortsighted. EDCO relies on assets such as a high quality workforce, low cost power and worker's compensation rates, in addition to quality of life and other amenities when it comes to job creation. With the competition fierce for such projects it is critical that the City's water supply not be a concern for potential employers.

Thank you for your considerable efforts on this issue. We know it has been a project that has consumed a very large amount of time and with it some controversy, however it really is a critically important aspect of what a city provides. EDCO encourages the City of Bend to stay the course and protect its surface water supply.

Should you have any questions about our support, please don't hesitate to contact me or any of our Board of Directors.

Best Wishes,
Roger J. Lee
Executive Director

Jeff Staudenmaier, Region Manager, Cascade Natural Gas Corporation

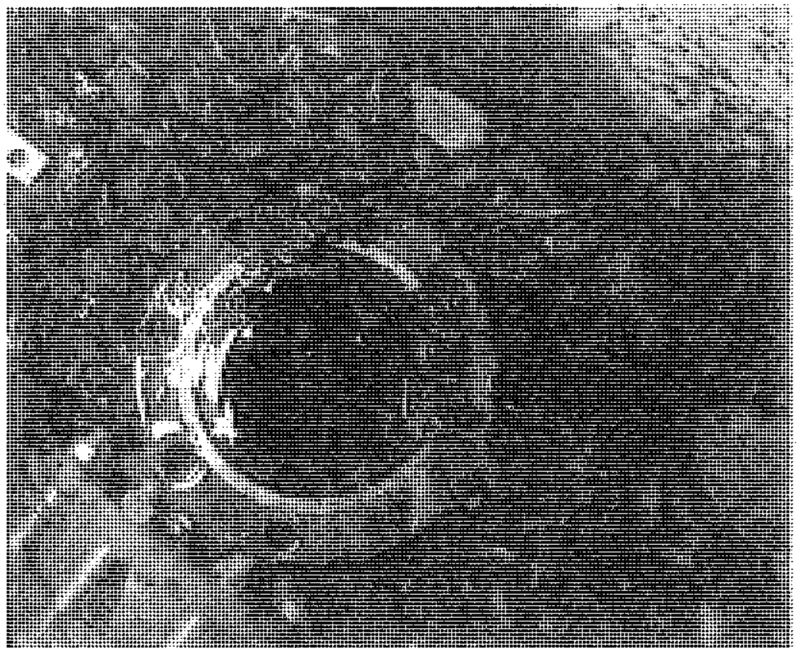


Figure 1. An accumulation of pipe lining material (black material) with sand and gravel in one of the Outback reservoirs

Figure 7. A 30-inch conifer within 4 feet of the 1926 pipeline

Significant damage from trees is expected in several sections of the upper portions of the pipelines. The pipelines are at risk of failure due to trees overturning for much of the upper sections of the 1926 and 1957 pipelines. Reduction in the risk of damage could be accomplished by cutting the trees, if that can be reasonably done. Tree removal on public land will likely require permits from the land manager. This process may be lengthy and will likely require some form of environmental assessment. Where the trees are now holding the road bank in place above Tumalo Creek and where the trees are major landscape elements in the Skyline subdivision, permission for tree removal may be very difficult to obtain.

Easement Intrusions

The pipeline routes run through the Skyline subdivision and then through several large private holdings east of the subdivision. These large lots create some access problems for maintenance of the pipelines. Certainly the owners would have concerns with major ground-disturbing work, but they are likely to be manageable and a major pipe failure in those areas is not an overt life-safety issue. However, within the Skyline subdivision, several major concerns are apparent, including the following:

- **Structures:** Many structures have been placed in the easements, at least four of which are immediately above the 1926 pipeline (see Figure 8 for examples).

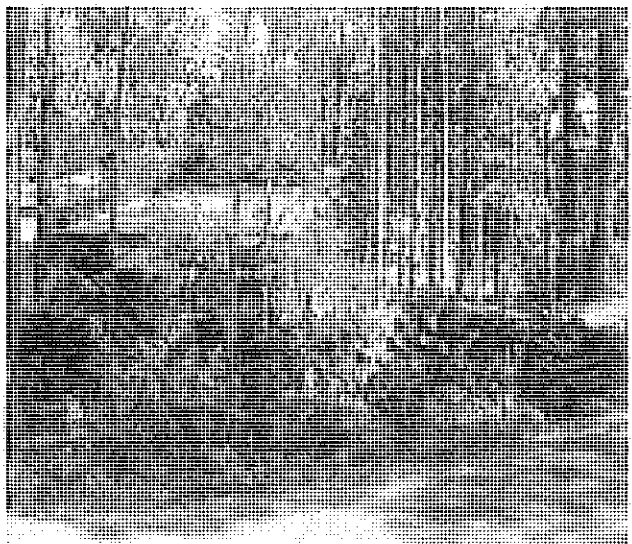
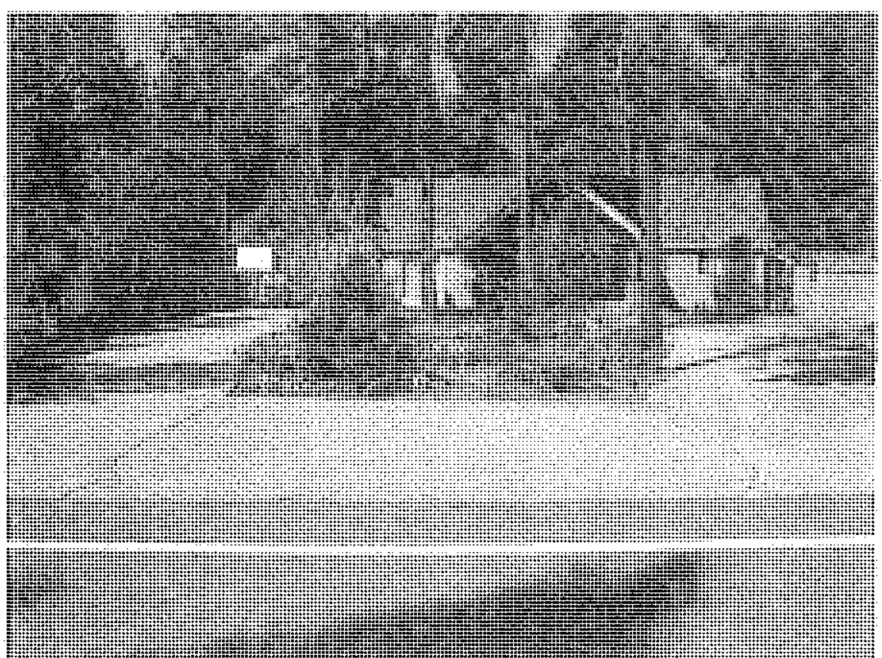


Figure 8. Pipeline route is under right edge of building (left); pipeline route (blue stake) directly under large RV shelter (right)

- **Large trees:** Many large conifers are located near or immediately above the two pipelines. Trees with 24-inch-diameter trunks are not uncommon.
- **Landscaping:** Some of the homes have installed extensive landscaping in the easement and above the 1926 pipeline. See Figure 9 for an example.

Figure 9. Landscaping above pipelines; 1957 pipeline is under concrete in foreground, 1926 pipeline is under trees in planted island



- **Wells:** A number of wells are located in the easement; four were observed. Two were within 1 foot, if not inches, of the 1926 pipeline. One well house was constructed above the pipeline (see Figure 10).

Figure 10. Well house directly above 1926 pipeline; another well can be seen in background that is less than 1 foot from the pipeline

All of this intrusion in the subdivision puts the pipeline at risk from the following:

- localized corrosion due to stray current from power lines to buildings and wells
- accidental damage to the pipeline from further construction
- crushing of the shallow, old pipeline from wheel loads and building foundation pressures.

Failure of the pipeline in this area is both a life/safety issue for those living in the subdivision and a damage liability issue for the City.

Maintenance of this section of the pipeline route will be very difficult at best. The property owners have a lot of land value to lose by the City clearing the easements. They will likely fight any attempt to maintain the easement and argue for at least the 1926 line to be relocated into Skyliners Road. Given the likely poor condition of the pipeline in this area, that will be a hard argument to overcome.

Hydraulic Condition

The two pipelines are not designed to withstand the pressures that would build if a valve near the end of the pipeline was closed. Pressures in such an instance would build to more than 400 psi; the pipe walls would rupture under that much pressure. Therefore, the pipelines were designed to use a small diameter to create friction within the pipelines that will reduce the pressure as the water flows through the pipes. The 1926 and 1957 pipelines have 21 and 28 air valves, respectively, to help relieve the lines of air and prevent vacuum damage. They are shown to also have four interconnections and up to five mainline valves to help control pressures in the lines.

Memorandum

To: Paul Rheualt, Mary Winters

From: Tom Hickmann P.E.

Subject: Condition of the Surface Water Transmission Pipes

Date: August 31, 2009

The purpose of this memorandum is to identify the risks currently facing our two transmission lines. This is intended to identify what staff has discovered over past years through observation and provide an engineering perspective of those observations.

Encroachment - Lines are not under an existing roadway, allowing numerous encroachments of structures on, or near, the pipes.

Shallow Bury - The current lines typically have less than 12-inches of cover, but can vary from above ground to 18-inches below ground. Current standards require a minimum of 36-inches from top of pipe.

Vegetation Growth - There is significant tree growth on top of the pipes and the pipes are root entangled.

Pipe Velocities - 11 feet per second in each pipe, nearly double the design standard for modern pipe materials.

Pipe Bedding - The pipe is laying directly on rock, in some cases sharp rock, putting additional strain on the pipe.

Wall Lining Material Failing - Coal tar lining of the pipe is found across the floor of the first treatment tank where it settles out.

Inadequate Vacuum Release - The line could potentially suffer an extensive catastrophic collapse if a small hole or break in the line developed.

New and Illegal Connections - The City staff have had conversations with individuals who live in the Skyliner subdivision area and were told that some homes in that area may be illegally connected to the existing lines. Requests for new connections to the existing lines have also been made. Under DHS rules, the City can not deliver untreated water.

Historical Attempts to Fix and Maintain the Pipe - Little written and documented information exists on historical issues regarding the pipe maintenance, or correction of identified problems.

1980 Water Master Plan – The City of Bend 1980 Water Master Plan identified that these pipes needed to be replaced.

The Washington Standards also discuss how a system could be equipped with excess supply capacity to help offset equalizing and potentially fire suppression storage requirements. Using wells to offset equalizing storage is likely to increase system operating costs, and also places a higher reliance on groundwater pumping. Relying on wells to offset fire suppression storage could be feasible for Bend, but is not recommended due to the system size and complexity.

Table 3 – Summary of Groundwater Well Capacity, SCADA capability and Back-up Power (April 2011)

Groundwater Production Facility	Zone Supplied	Capacity (MGD)	SCADA Present	Capacity With SCADA	Back-up Power	Capacity With Back-up Power	Redundant Capacity Back-up & SCADA
COPPERSTONE_W	3	1.4	N	0	N	0	0*
OUTBACK_W1	3	1.0	N	0	Y	1.0	0
OUTBACK_W2	3	1.1	N	0	N	1.0	0
OUTBACK_W3	3	1.7	Y	1.7	Y	1.7	1.7
OUTBACK_W4	3	1.7	Y	1.7	Y	1.7	1.7
OUTBACK_W5	3	1.8	Y	1.8	N	1.8	0*
OUTBACK_W6	3	1.8	Y	1.8	Y	1.8	1.8
OUTBACK_W7[1]	3	1.8	Y	1.8	Y	1.8	1.8
OUTBACK_W8	3	*Future*					
WESTWOOD_W	4A	1.0	Y	1.0	N	0	0
BEAR_CREEK_W1	4B	1.5	Y	1.5	N	0	0
BEAR_CREEK_W2	4B	1.6	Y	1.6	N	0	0
ROCK_BLUFF_W1	4B	1.2	Y	1.2	Y	1.2	1.2
ROCK_BLUFF_W2	4B	0.0[2]	N	0	N	0	0
ROCK_BLUFF_W3	4B	1.2	Y	1.2	Y	1.2	0*
PILOT_BUTTE_W1	5	1.2	N	0	N	0	0
PILOT_BUTTE_W2	5	*Decommissioned*					
PILOT_BUTTE_W3	5	1.3	N	0	N	0	0
PILOT_BUTTE_W4[3]	5 (4B emerg)	1.6	Y	1.6	Y	1.6	0*
RIVER_W1	5	2.7	N	0	N	0	0
RIVER_W2	5	3.0	N	0	N	0	0
SHILOH_W1	3D	0.0	N	0	N	0	0
SHILOH_W2	3D	0.0	N	0	N	0	0
SHILOH_W3[4]	3D/4B	2.0	Y	2.0	Y	2.0	0*
HOLE_10_W1	2B	0.8	Y	0.8	Y	0.8	0*
HOLE_10_W2	2B	0.8	Y	0.8	Y	0.8	0.8
Total Groundwater Capacity		**32.3**		**20.5**		**18.5**	**9.0**

Notes * Although these wells have back-up power and are connected to SCADA, they are not redundant

1) Outback 7 online by April 2011
2) Rock Bluff 2 is out of service, not expected to be returned to service
3) Pilot Butte 4 online by April 2011 - Generator confirmed but well is not redundant without Pilot Butte 1 or 3
4) Out of service; online April 2011 with portable generator plug in facilities following upgrade, not redundant

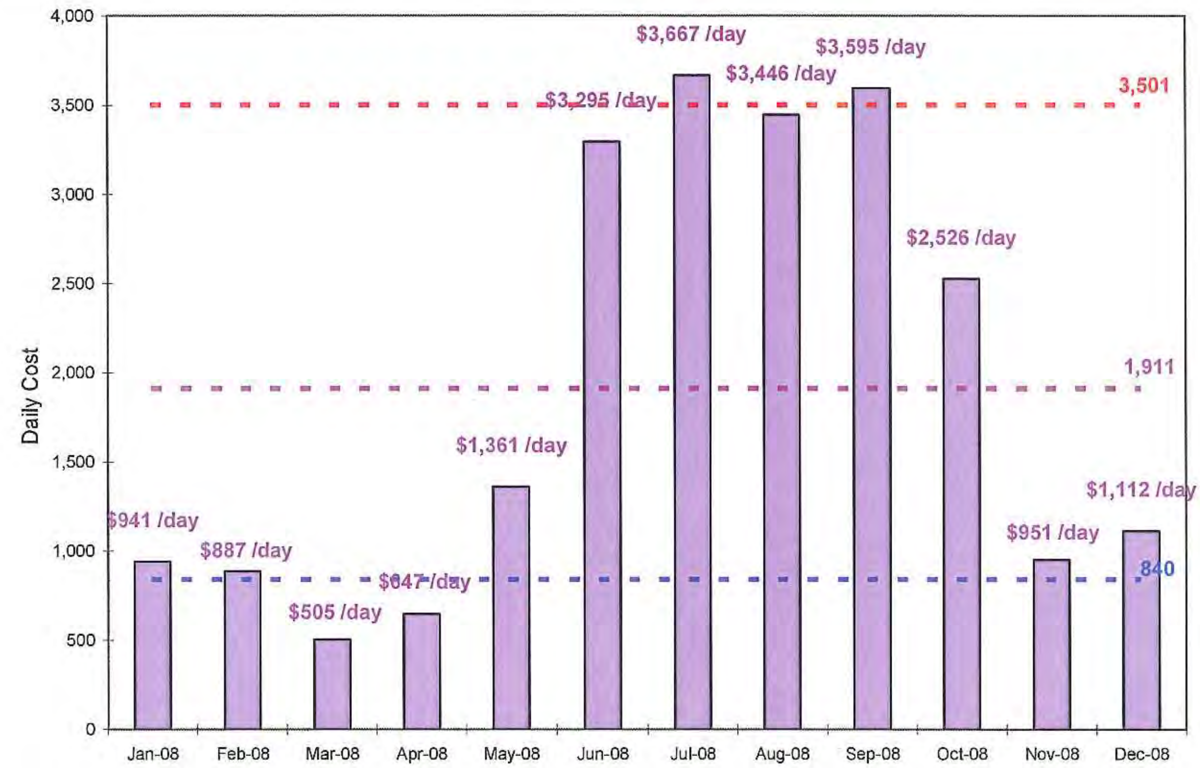


Figure 3.3 – System-wide power costs per day and winter, summer and annual averages – 2008

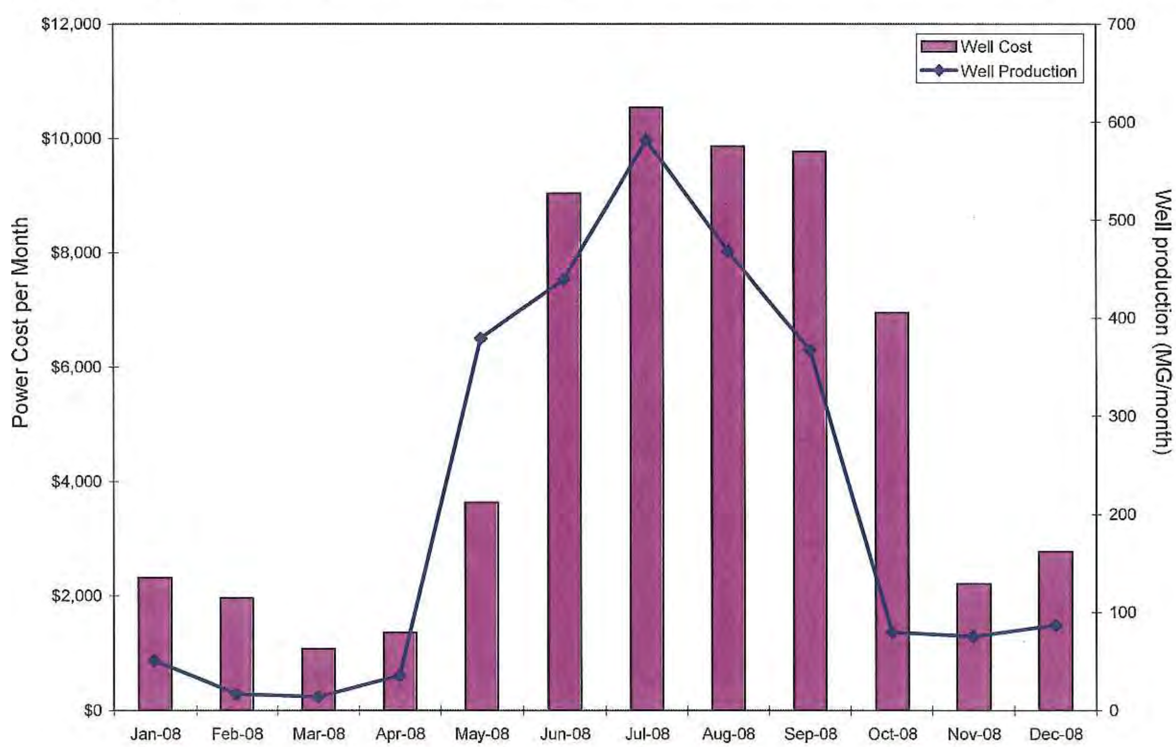
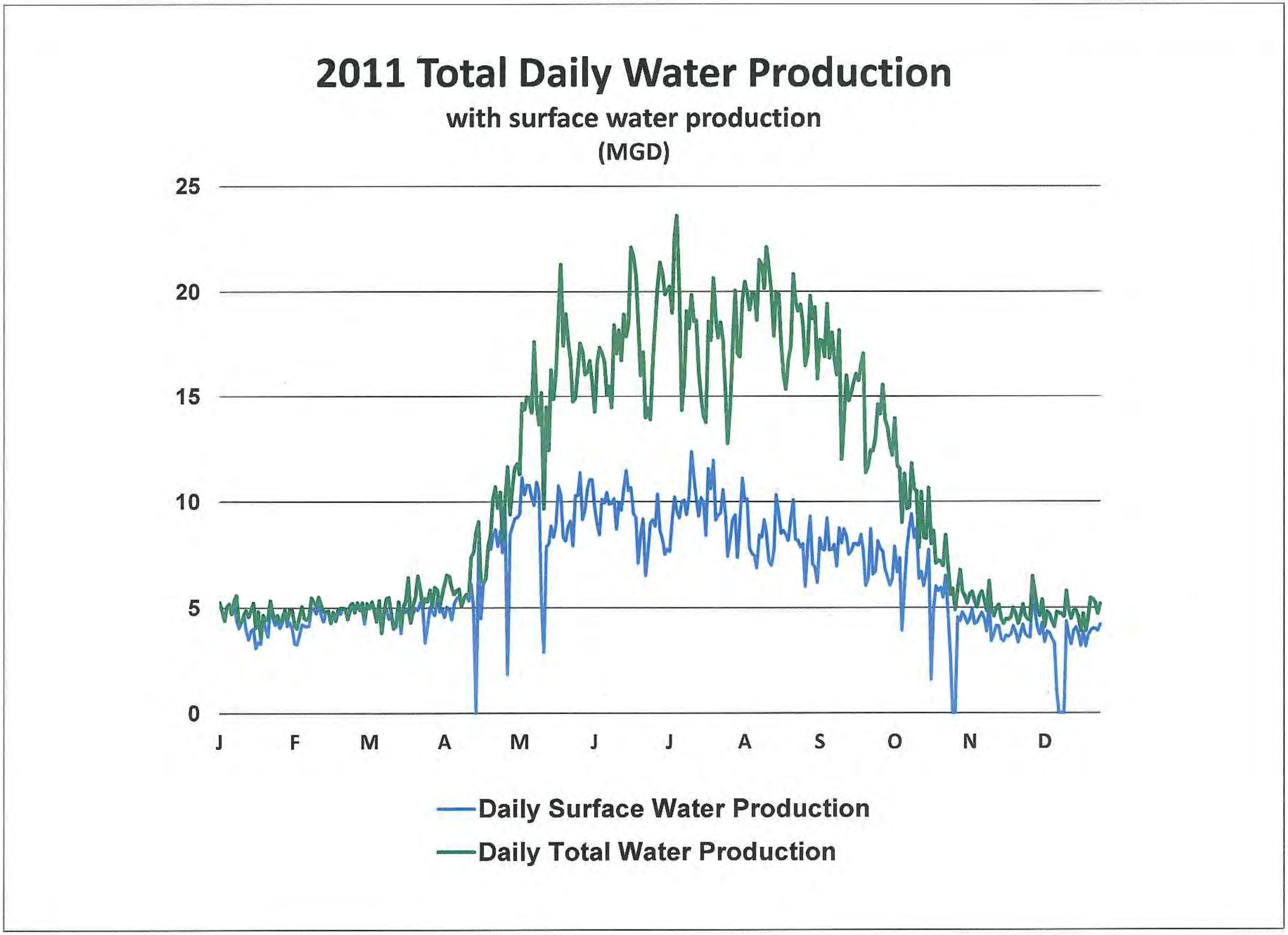
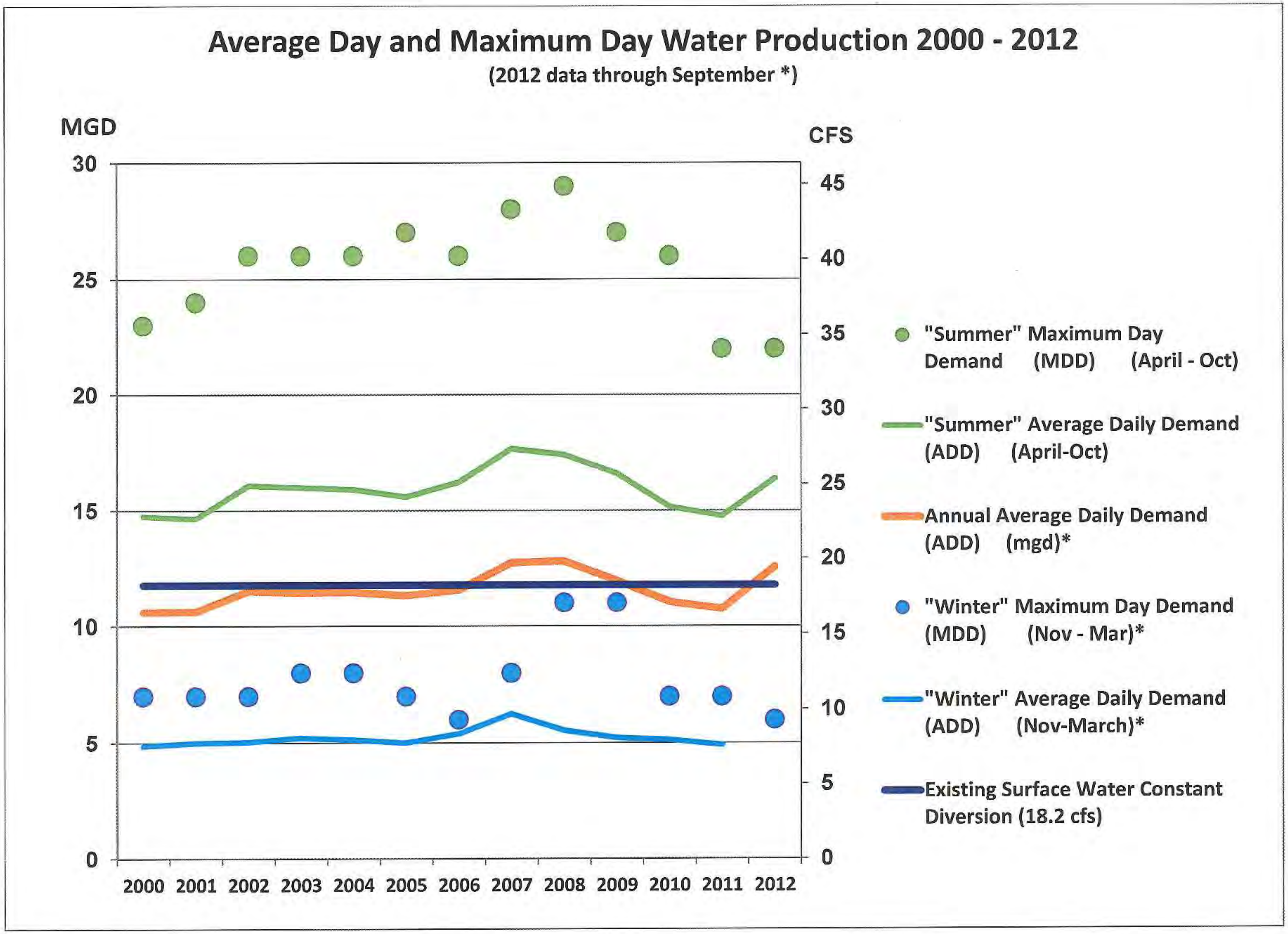
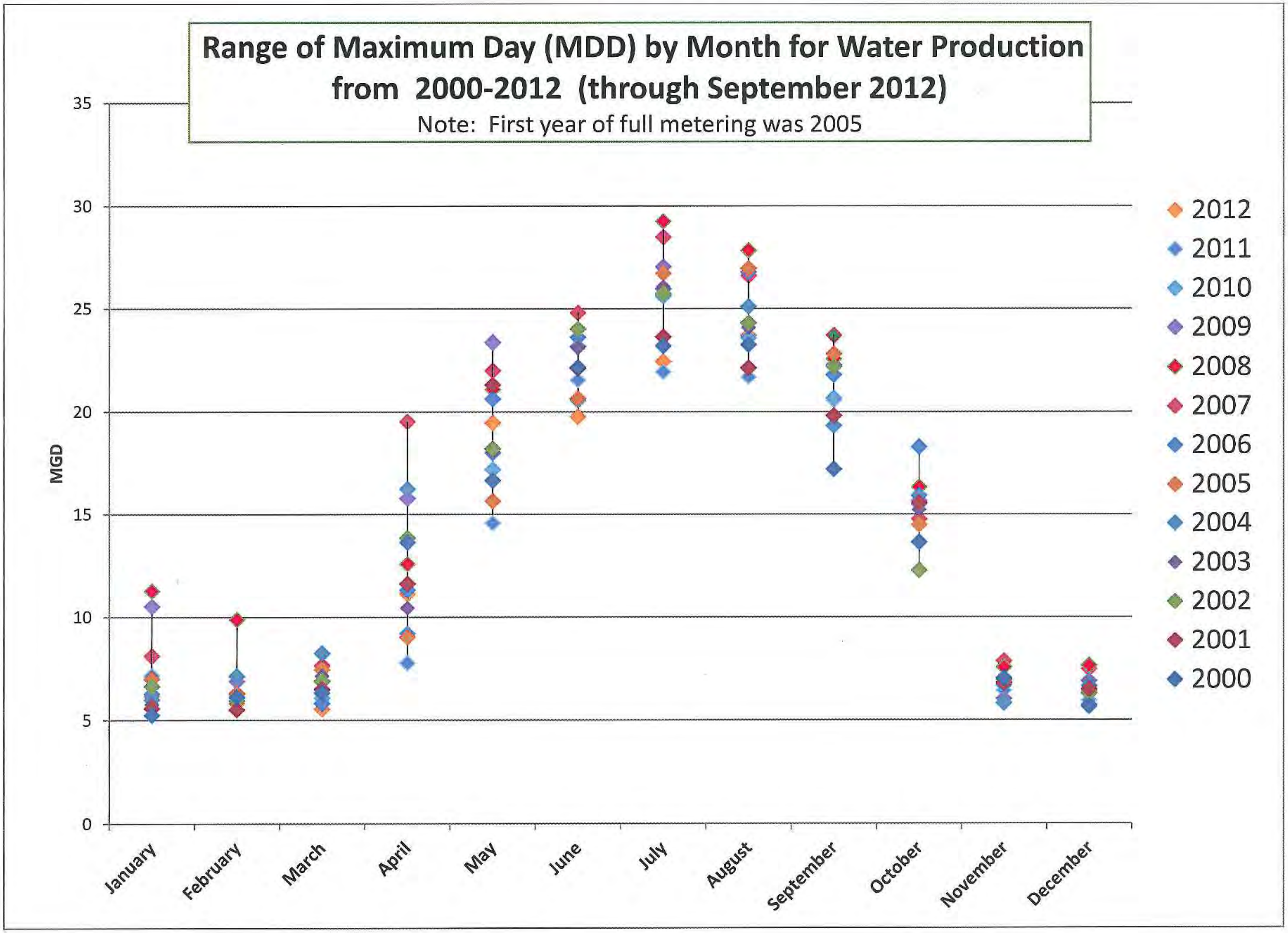


Figure 3.4 – Comparison of well production and associated power costs – 2008


2011 Total Daily Water Production
with surface water production
(MGD)
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
O
N
D
Daily Surface Water Production
Daily Total Water Production


Average Day and Maximum Day Water Production 2000 - 2012
(2012 data through September *)
MGD
CFS
30
25
20
15
10
5
0
45
40
35
30
25
20
15
10
5
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
"Summer" Maximum Day Demand (MDD) (April - Oct)
"Summer" Average Daily Demand (ADD) (April-Oct)
Annual Average Daily Demand (ADD) (mgd)*
"Winter" Maximum Day Demand (MDD) (Nov - Mar)*
"Winter" Average Daily Demand (ADD) (Nov-March)*
Existing Surface Water Constant Diversion (18.2 cfs)



Range of Maximum Day (MDD) by Month for Water Production from 2000-2012 (through September 2012)
Note: First year of full metering was 2005
MGD
35
30
25
20
15
10
5
0
January
February
March
April
May
June
July
August
September
October
November
December
2012
2011
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
2000

CHAPTER 2
ALTERNATIVE OPTIONS SELECTION

Prepared for
City of Bend, Oregon
October 23, 2009

Prepared by

Jack Warburton, Brown and Caldwell

BROWN AND CALDWELL

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CHAPTER 2

ALTERNATIVE OPTIONS SELECTION

2.0 Introduction

In the near future, the Bridge Creek Supply System (BCSS) may not be able to continue to meet the City of Bend's (City) potable water demand reliably. Its aging infrastructure, risk of fires in its watershed, and new regulations will require the system to be upgraded. To address these issues, the City retained the services of a consultant team led by Brown and Caldwell to identify and develop the best alternative that will satisfy these impending demands.

This chapter documents the alternative identification and screening process that led to the selection of a preferred alternative: the construction of a water treatment plant and a hydropower facility at the Outback site and the replacement of the existing intake mains with a penstock. This alternative will be the object of further refinement in the subsequent efforts of this project.

2.1 Background: Existing Conditions

The City depends on surface water from the BCSS and locally developed groundwater to meet its potable water demands. To meet the future projected demands, the City Master Plan contemplates increasing the capacity of the groundwater supply.

The BCSS currently provides half the annual water supply to the City. In general, the BCSS is used to meet all of the City's winter water demand, which currently averages 6 million gallons a day (mgd) and peaks at about 26 mgd. As demand increases in the spring season, wells are used to provide additional flow beyond what is available from the BCSS.

The components of the BCSS are described in the following sections.

2.1.1 BCSS

The existing BCSS includes a diversion works that captures pure spring flows and a canal that diverts the spring into the headwaters of Bridge Creek; an intake works on Bridge Creek; the Intake Mains from the Bridge Creek Intake to Outback; and the Outback Chlorination and Storage Facility. The system conveys water from elevation 4,992 feet at the Bridge Creek Intake to the elevation 3,980 foot elevation at the chlorine contact basin (see Figure 2-1).

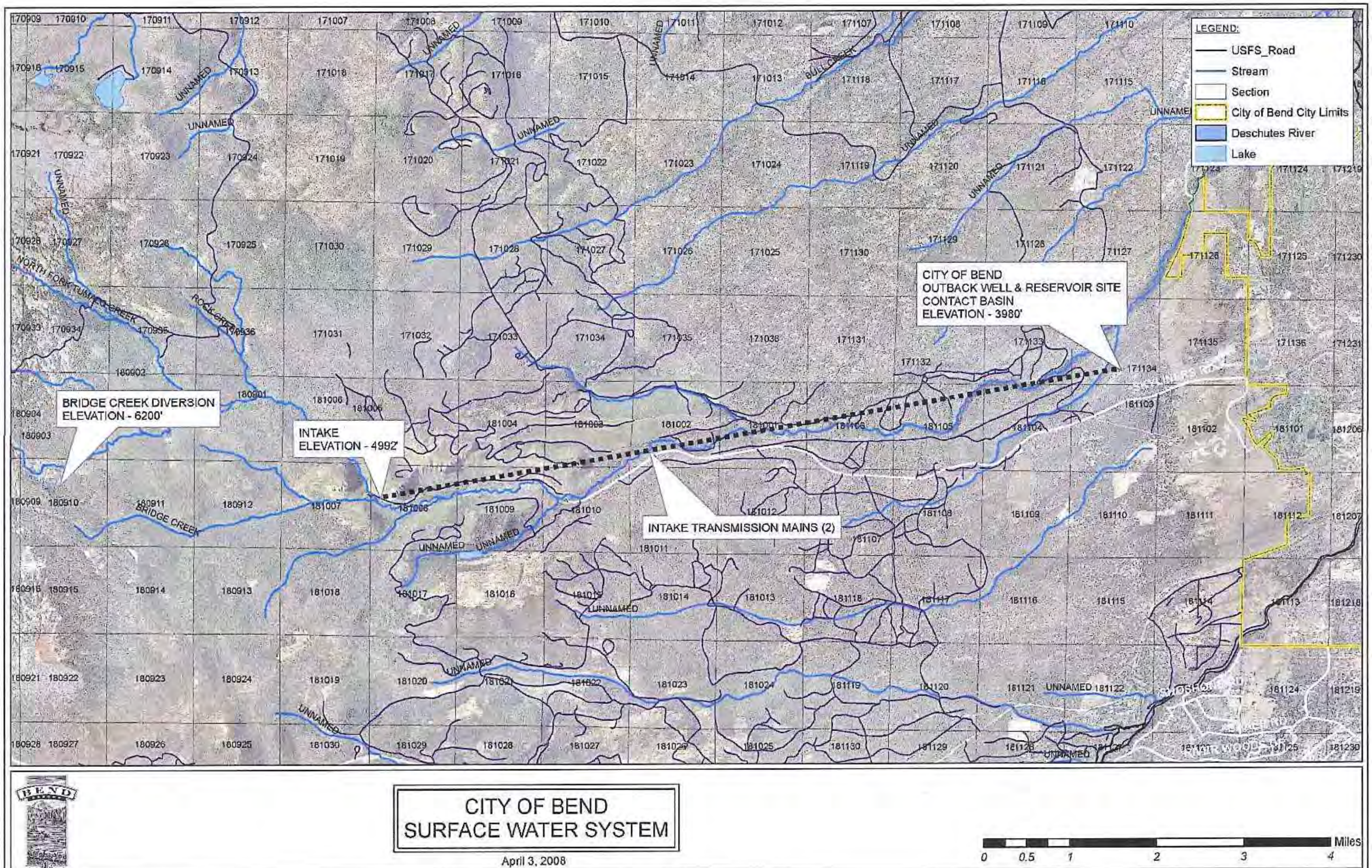


Figure 2-1. BCSS Site Map

Each of the key components is described in additional detail in the following subsections.

2.1.1.1 Bridge Creek Intake

Built in 1926, the Bridge Creek Intake facility includes a dam, overflow, debris screen, and caretaker's building. The intake consists of a small concrete gravity dam with a side channel intake from the pond created by the small dam. Inside the diversion structure is a series of screens that filter out leaves and other debris. Water entering the intake is diverted into two conduits that convey the water to the Outback Storage and Treatment Facility.

A small wood frame structure, originally constructed as the caretaker's residence, sits on top of the intake structure. The building has been updated several times, though much of its original structure, including its metal siding, still remains. The building is now used to house water monitoring equipment and is the focus of limited seasonal tours.

2.1.1.2 Intake Mains

Welded steel pipes, 14 and 16 inches in diameter, run 10 miles to connect the Bridge Creek Intake facility with the Outback site. The pipelines were installed in 1926 and 1956, respectively, and have been repaired several times. Some of their reaches have been replaced with larger sections, up to 20 inches in diameter.

Most of the pipes' alignment lies within heavily forested areas, on U.S. Forest Service (USFS) land. The pipelines also cross several private properties on City easements. In several easements, structures encroach the conduits' alignments. Tree roots and structure loading have contributed to the accelerated deterioration of the pipes and the development of leaks.

The conduits were designed with small diameters to develop high flow velocities that burn the excessive potential energy associated with the drop from the 4,992-foot elevation at Bridge Creek Intake to the 3,980-foot elevation Outback site overflow. The original capacity of the pipelines is not known.

2.1.1.3 Background

The Outback site contains the terminal storage tanks for the BCSS. The conduits discharge into a steel tank, retrofitted as a Chlorine Contact Basin, where the BCSS water is chlorinated. The chlorinated water then overflows to other storage tanks at the site, which feed by gravity into the City's distribution system.

The site also contains groundwater wells that pump to a dedicated storage tank. These groundwater wells, in addition to others in the City, supplement the BCSS whenever the system demands exceed the BCSS capacity or during periods when the BCSS is too turbid to use.

2.1.2 Challenges to the Bridge Creek Supply

The City has identified three primary challenges to the continued use of the BCSS.

- Meeting 2012 U.S. Environmental Protection Agency (USEPA) regulations
- Addressing aging infrastructure
- Mitigating the water quality impacts from a large wildfire in the watershed

The magnitude of these challenges will be explained further in the following paragraphs.

2.1.2.1 Meeting 2012 Regulations

The BCSS is an approved unfiltered water system. Per USEPA, unfiltered public water systems that use surface water or groundwater under the direct influence of surface water serving 50,000 to 99,999 people must have started 24 months of source water monitoring for Cryptosporidium by April 2007. In addition, these systems must report their average of all Cryptosporidium sample results to USEPA or to the state by September 2009 to determine treatment requirements listed in Table 2-1. The required treatment systems must be installed and in operation by September 30, 2012.

Table 2-1. Inactivation Requirements for Unfiltered Systems

Cryptosporidium concentration, oocysts per liter	Required Cryptosporidium inactivation
<0.01	2-log
>0.01	3-log

Under certain circumstances, which may include a system with active capital improvements intended to achieve regulatory compliance, USEPA can extend the compliance deadline by 24 months.

2.1.2.2 Addressing Aging Infrastructure

Essential components of the BCSS are 50 to 80 years old. Inspection by the City of the two 10-mile-long intake mains that convey the surface water to the Outback Storage and Treatment Facility revealed many areas with severe overgrowth of trees in the easements and over the pipelines. Evidence of root intrusions in the pipelines has been found as root debris in the storage reservoirs at the Outback facility. The level of service of other components is uncertain. Designed and constructed to 1926 standards, the reliability of the Bridge Creek Intake Dam may not meet the standards of a lifeline facility, as defined by the American Society of Civil Engineers.

Subsequent chapters will evaluate the condition of Bridge Creek Intake and determine pipe replacement alternatives.

2.1.2.3 Mitigating Fire Danger in Watershed

A large fire in the Bridge Creek watershed would result in a high sediment loading in Bridge Creek. This would cause the water quality of the system to exceed the drinking water standards for one to several years. The water quality impact of fires was already witnessed by the City in past events. The BCSS is essential to meet the City's daily summer demands; its unavailability would create a serious water shortage.

The likelihood of a wildfire is currently increased by the large amount of dead trees in the Bridge Creek watershed. The USFS has estimated that dead trees amount to 40 percent of the tree inventory in the watershed.

2.2 Alternative Description

The alternatives considered to address the challenges facing the continued use of the BCSS are outlined in this section. Figure 2-2 provides a summary of the alternatives that are described in detail below.

Though the actual quantity of available BCSS water varies throughout the year, this evaluation assumes its capacity to be 13.5 mgd.

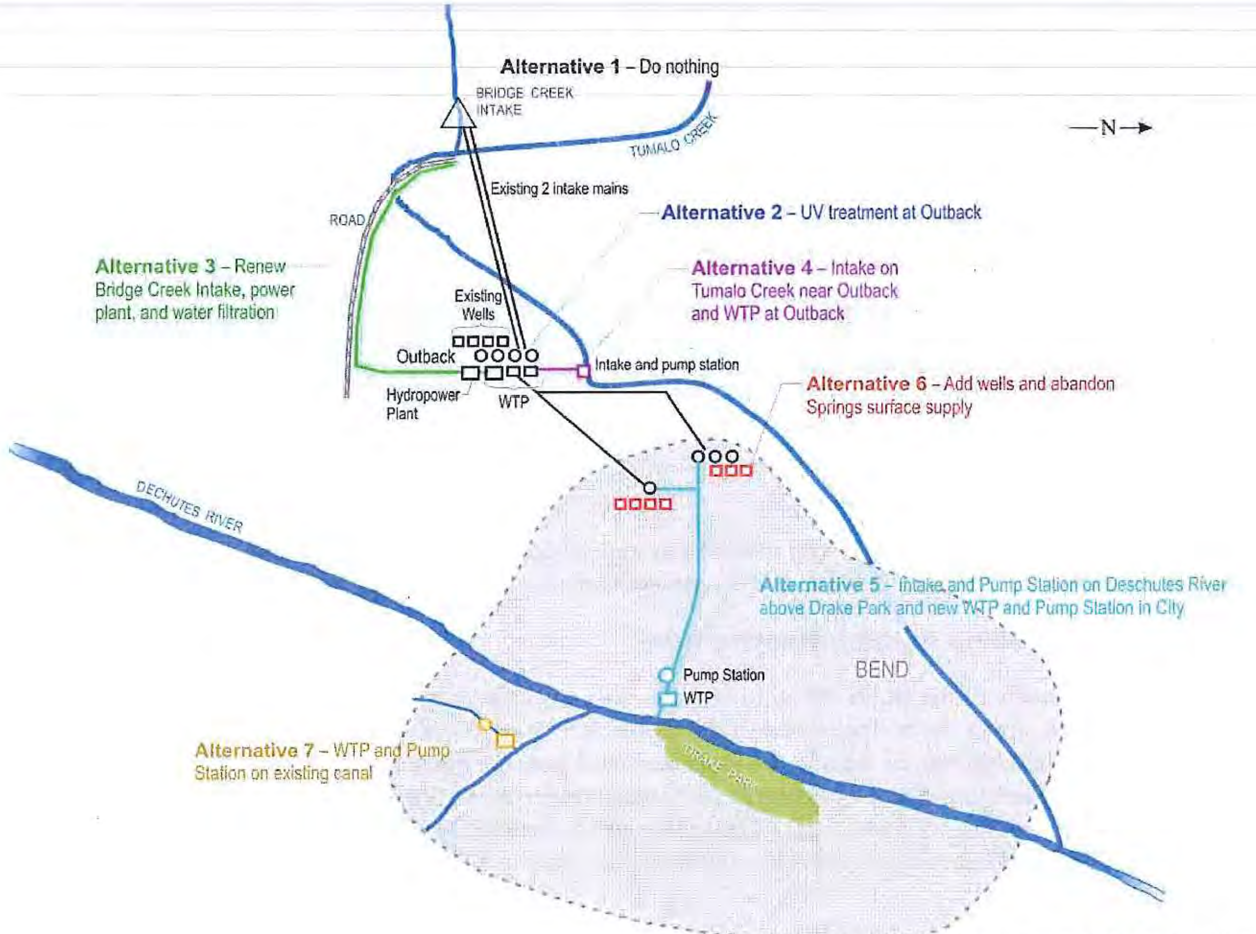


Figure 2-2. Alternative Summary

2.2.1 Alternative 1—Do Nothing

As the title implies, Alternative 1 will leave the existing system of structures and pipelines as is and will not make any major improvements to them. This option will result in abandonment of the BCSS in 2012 when it will no longer be in compliance with USEPA regulations.

2.2.2 Alternative 2—No Upgrades to Springs WSS but Add Ultraviolet (UV) Disinfection

Similar to Alternative 1, Alternative 2 does not make major capital improvements to the existing BCSS. However, this option includes the addition of UV disinfection at the Outback facility. The addition of UV disinfection will keep the Springs Water Supply System (WSS) in compliance with USEPA beyond 2012 when regulations require additional disinfection on unfiltered supplies. It does not reduce the risk of water quality impacts from fire in the Bridge Creek Watershed or failure of the 1926/1956 pipelines.

2.2.3 Alternative 3—Renew Bridge Creek Intake and Filter Water

Alternative 3 will provide major capital upgrades to the BCSS, including the following:

- Seismic and structural upgrade to the Bridge Creek Dam, Intake, and caretaker's structure
- Installation of a new fish/debris screen at the Bridge Creek Intake
- Replacement of the intake mains with a new penstock to the Outback site
- Installation of new hydropower facilities at the Outback site
- Installation of a new water filtration plant at the Outback site that will be designed to treat water in the event of degraded water quality associated with impacts from a local forest fire and will meet the 2012 USEPA requirements

The improvements will tie into the existing system at the Outback site and will continue to use the other infrastructure for the City's distribution system.

2.2.4 Alternative 4—Intake on Tumalo Creek near Outback Site

Alternative 4 will abandon the BCSS and will install an intake and pump station on Tumalo Creek near the Outback site. Alternative 4 will include a new water filtration plant, similar to Alternative 3, but will not include the hydropower facilities. The Tumalo Creek facilities will require a sophisticated, wild-river intake and will be installed in an environmentally sensitive area with protected aquatic species.

2.2.5 Alternative 5—Intake and Pump Station on Deschutes River

Alternative 5 will abandon the BCSS and will include installation of a new intake and pump station on the Deschutes River near Drake Park. Alternative 5 will require a fish screen at the intake on the Deschutes River and will include a new water treatment plant. The treatment plant will be more sophisticated than the filtration plant for Alternatives 3 and 4. Additional treatment processes will be needed to remove organic carbon, taste, and odor. The Deschutes River supply will also require an additional pump station after the treatment plant to pressurize the water for the distribution system. The supply location will make mixing with the local groundwater supply more problematic unless the supply has a direct pipeline to the Outback site.

2.2.6 Alternative 6—Increase Well Capacity and Abandon Bridge Creek Supply System

Alternative 6 will abandon the BCSS and will expand the City's use of local groundwater. The City will need to replace the Springs WSS with additional well capacity. The local wells will be located at the Outback site and throughout Bend and will be in addition to the wells that are already planned to meet the City's future growing water demands.

2.2.7 Alternative 7—New Supply on Existing Canal

Alternative 7 will be similar to Alternative 5 but will take advantage of the existing fish screens at the inlet to a canal from the Deschutes River. This alternative will avoid the direct intake on the Deschutes River. The treatment requirements will be similar to that of Alternative 5, but will need to address the potential water quality degradation associated with flow in the open irrigation canal. In addition, the pumping requirements likely will be more extensive than those required for Alternative 5, since the treatment plant will be located farther from the major storage for the City's distribution system and will likely require a new major river crossing pipeline.

2.3 Alternatives Screening

This section describes the evaluation and screening process for selecting the preferred alternative. The screening was conducted in two phases. Phase 1, conducted during the workshop kick-off meeting, identified the alternatives that merited more detailed development. Phase 2, as documented below, performed the selection of the preferred alternative.

The evaluation and screening process used is built upon identifying the full life-cycle cost or full cost of ownership of an alternative. The full cost of ownership is composed of the capital cost; the operational, maintenance, and refurbishment costs; the environmental and community costs; and the risk inherent to each one of these elements. The alternative that delivers and maintains the required level of service with the lowest cost of ownership as measured by its net present value (NPV) is by definition the preferred alternative.

The initial screening that was conducted as part of the January 7 and 8, 2009 project initiation meeting, was based on a combination of preliminary capital and operational costs developed by Brown and Caldwell for the meeting, a qualitative assessment of the overall project risks, and the specific risks for potential alternatives. The process was used to select the preferred alternative.

2.3.1 Business Case Evaluation (BCE)

We used the BCE process to identify the full cost of ownership. A BCE consists of the following steps:

1. Appoint a BCE expert team
2. Define the problem and set the level of service (LOS)
3. Collect data on the current situation
4. Identify alternatives based on meeting the LOS
5. Screen alternatives and eliminate those that do not meet the required LOS
6. Develop cost information for viable alternatives
7. Compare viable alternatives based on NPV

The BCE differs from a conventional engineering evaluation because it includes the assignment of a multi-disciplinary team with knowledge of all aspects of the life-cycle of the alternatives and clear definition of the problem in LOS terms and the consideration of environmental, community, and risk costs. Additional description of the BCE process is provided in Appendix A.

2.3.2 Initial Screening Workshop

The initial screening workshop was conducted in Bend on January 7 and 8, 2009. The workshop participants are listed in Appendix B. During the workshop, the problem was defined, risk categories were identified, a qualitative score was assigned, potential mitigation measures were identified, and the risks were ranked.

Subsequent to the workshop, the initial alternatives were screened for fatal flaws based on meeting the required LOS. The remaining alternatives were ranked based on the combination of cost and the qualitative risk score. The problem statement, LOS fatal flaw analysis, and risk quantification are presented below.

2.3.2.1 The Problem Statement

Following is the problem statement developed at the workshop.

The City is not able to assure current and future surface water supply quality and quantity and to meet regulatory requirements.

Expressed in LOS terms, potential alternatives must accomplish the following:

- Provide water capacity equivalent to current surface water supply
- Comply with regulatory requirements
- Deliver high level of water quality reliably

The underlying root cause of the problem was identified as follows:

- Compliance with USEPA Surface Water Rules is projected to be imposed by September 30, 2012
- There is a risk of contamination of the surface water source
- There is a risk of a forest fire in the watershed which could degrade the raw water quality
- There is increased risk of structural failure due to the aging infrastructure.
- With continued urbanization of Bend, there is a risk to water quality from increased human activity in the watershed

2.3.2.2 Alternative LOS Fatal Flaw Screening

The results of the fatal flaw analysis of the seven alternatives identified earlier are illustrated in Table 2-2.

Table 2-2. Fatal Flaw Analysis

Alternative number	Alternative description	Meets LOS objectives		
		Capacity of surface supply	Regulatory compliance	Reliable high quality water
1	Do nothing	No	No	No
2	No upgrades to BCSS but add UV disinfection	Yes	Yes	No
3	Renew Bridge Creek intake and filter water	Yes	Yes	Yes
4	Intake on Tumalo Creek near Outback site	Yes	Yes	Yes
5	Intake and pump station on Deschutes River	Yes	Yes	Yes
6	Increase well capacity and abandon BCSS	Yes	Yes	Yes
7	New supply on existing canal	Yes	Yes	Yes

The alternatives remaining after the LOS fatal flaw screening are as follows:

- Alternative 3–Renew Bridge Creek Intake and filter water
- Alternative 4–Intake on Tumalo Creek near Outback site
- Alternative 5–Intake and pump station on Deschutes River and abandon BCSS
- Alternative 6–Increase well capacity and abandon BCSS
- Alternative 7–New supply on existing canal and abandon BCSS

2.3.2.3 Risk Assessment and Quantification Process

Risk is defined as the product of the likelihood and the consequence of a risk occurrence. For the qualitative analysis, a scale of 1 to 5 was utilized to score the probability of the risk event occurring. A similar 1 to 5 scale was used to assign the magnitude of a scope and schedule increase. The specific values utilized in the risk assessment are listed in Table 2-3.

Table 2-3. Qualitative Risk Assessment Basis of Scoring			
Score	Probability, percent	Scope increase, percent	Schedule increase, percent
1	<10	Insignificant	Insignificant
2	11-25	<10	<20
3	26-50	11-20	21-40
4	51-75	21-40	41-80
5	>75	>40	>80

The risk assessment process consists of the following steps:

1. Identify potential areas of risk
2. Develop specific risks and their potential mitigation
3. Organize the information in a risk register
4. Undertake the qualitative analysis and apply 1 to 5 points to the probability, scope and schedule impacts
5. Assign specific risks to the evaluated alternatives

The risk score of a risk category is the aggregate of the risk of scope increase and schedule increase. It is computed per the following formula:

$$\textit{Probability} \times \textit{Scope Increase} + \textit{Probability} \times \textit{Schedule Increase}$$

A higher score corresponds to a higher risk.

2.3.2.4 Potential Risk Area Categories

The following risk categories were identified:

- Regulatory/permitting water rights
- Potable water supply
- Forest service
- Hydropower implementation
- Natural disasters
- Construction and operational costs
- Financial viability
- Stakeholders

Table 2-4 lists the output of the risk assessment process by risk category and overall ranking.

add new wells	5	4	5	Exchange surface - for additional groundwater rights >1:1?	Water rights, 200 cubic feet per second (cfs) cap upper basin, hydrogeologic, permits, science, land procurement
rmit for new water rights	5	3	5	Agreement with stakeholders, section D mitigation	Up-front dollars
rmit FERC	5	3	5	Agreement with stakeholders, section D mitigation, USFS relationships	Endangered Species Act (ESA) Nexus
time, mitigation, public, operational constraints	5	3	5		
ed fire	5	3	5		Question of when and how big—accelerate schedule. Different approaches if W
ion for in-stream water	4	4	5	Temperature Model no impact on reach B?	Cold water take water away from generation
support	3	5	5		Potential no project
n ongoing initiatives with other local agencies	3	4	5	DWA signed	
rmit for existing water rights	4	2	4	Agreement with stakeholders, section D mitigation	Upfront $
on of 15 cfs permit to water right	4	2	3		Reaches B and D. Have to get extension before 'prove' up. Issue of prior grou applications
vater regulations, i.e., requires treatment	2	5	5		Gordon Grant Study EWEB, timing of surface water, most of the resource is gr
raise rates	5	1	3		
ke	2	3	5	County? City has done analysis that requires fixing specific breaks.	Take out Bridge Creek and pipeline, bolted tanks
onomic recovery delayed	4	1	3		Ability to get increased rates
st fluctuations up wells	5	2	1		Negative
failure	5	2	1		Accelerate
on of surface water to groundwater injection torage and recovery recharge	4	2	1	Critical factor in economic analysis	Not on critical path, trigger full groundwater studies
Easements disagreement	2	3	3		
limate	3	3	1		
ty and cost of project financing	2	3	3		Stimulus package
d public response	3	1	3		Gets more negative as economy. Green initiative is a plus.
er Quality Standards	1	5	5		Issues beyond what we know
pportunity for joint road investment	1	5	5		
ntive changes	2	3	2		High probability of improving
hen power can be produced	2	3	2		
es Tier II watershed	3	2	1	Addressed by mitigation	Reach B
o flexibility to adjust 2012 schedule	3	2	1	Maintain current staff relationships, proactive friendly compliance order	Portland strategy to have exemption in Oregon Administrative Rules, stretches
tion material inflation	3	2	1		
Conditional Use	2	2	2	Early communication	USFS
g for new distribution	1	3	4		Connecting new wells in the system
Green tags	1	5	2		Currently low expect to increase
egulatory, total maximum daily load	2	2	1	Addressing D segment, i.e., wet, run water quality model	
g of National Environmental Policy Act ents (creek crossings, new alignment)	3	1	1	Avoid creeks (go under), relocate out of wetland	Impacts can be avoided
st fluctuations down hydro	1	5	1		Positive
rastructure failure ,wells, tanks diversion	2	2	1		
ns staff challenge of new facilities (wells)	3	1	1		Bigger issue if all wells. City has standby power. Can plant operations be 24-h
ty of infrastructure for interconnects to grid	1	2	1		
permits/conditional use (City, county, federal)	1	1	1		City involved in well permitting
from other water agencies, potable and irrigation	1	1	1	Already have agreements with irrigation districts	
change impacts on flows	1	1	1		Climate change a high probability however impact on Springs

Allocation of identified risks to the screened alternatives is presented in Table 2-5. The alternative assigned the highest risk is Alternative 7, followed in descending order by Alternatives 3, 6, 4, and 5. The highest risk categories carried by Alternative 3 are related to the risks of implementing the hydropower element of the project.

Table 2-5. Risk Matrix–Prioritized by Risk Category

Risk number	Risk description	Risk score	Alternative risk allocation				
			3 BCSS	4 Tumalo Creek	5 Deschutes River	6 GW	7 Canal
1	Ability to add new wells	45	0	0	0	45	0
2	Hydropower permit for new water rights	40	40	0	0	0	0
3	Hydropower permit for Federal Energy Regulatory Commission	40	40	0	0	0	0
4	Unknown time, mitigation, public, operational constraints	40	0	40	40	40	40
5	Watershed fire	40	0	0	0	0	0
6	Competition for in-stream water	36	36	36	36	0	36
7	Council support	30	0	30	30	30	30
8	Impact on ongoing initiatives with other local agencies	27	27	27	27	27	27
9	Hydropower permit for existing water rights	24	24	0	0	0	0
10	Conversion of 15 cfs permit to water right	20	20	20	20	20	20
11	Groundwater regulations, i.e., requires treatment	20	0	0	0	20	0
12	Ability to raise rates	20	0	20	20	20	20
13	Earthquake	16	0	0	0	0	16
14	Local economic recovery delayed	16	0	16	16	16	16
15	Power cost fluctuations up wells	15	15	0	0	15	0
16	Pipeline failure	15	0	0	0	0	0
17	Conversion of surface water to groundwater injection aquifer storage and recovery recharge	12	12	12	12	12	12
18	Existing easements disagreement	12	12	12	0	0	12
19	Bidding climate	12	12	12	12	12	12
20	Availability and cost of project financing	12	0	12	12	12	12
21	Ill defined public response	12	12	12	12	12	12
22	USEPA water quality standards	10	0	0	0	10	0
23	Missed opportunity for joint road investment	10	0	10	10	10	10
24	Tax incentive changes	10	10	0	0	0	0
25	Timing when power can be produced	10	10	0	0	0	0
Cumulative risk score			270	259	247	268	275

2.3.2.5 Combining Preliminary Cost Data with Qualitative Risk Scores

The net present value of the alternatives and the risk scores are combined in Table 2-6. Alternative 3 is clearly the alternative with the lowest adjusted NPV that meets the LOS requirements, followed by Alternatives 4, 6, 5, and 7, respectively. As identified in the risk assessment, Alternative 3 carries the unique risks related to obtaining regulatory approval for the hydropower portion of the alternative. In the further evaluation of the preferred alternative in this phase and subsequent phases, the specific risks and mitigation strategies to manage the regulatory risks will be developed.

Table 2-6. Final Alternative Ranking

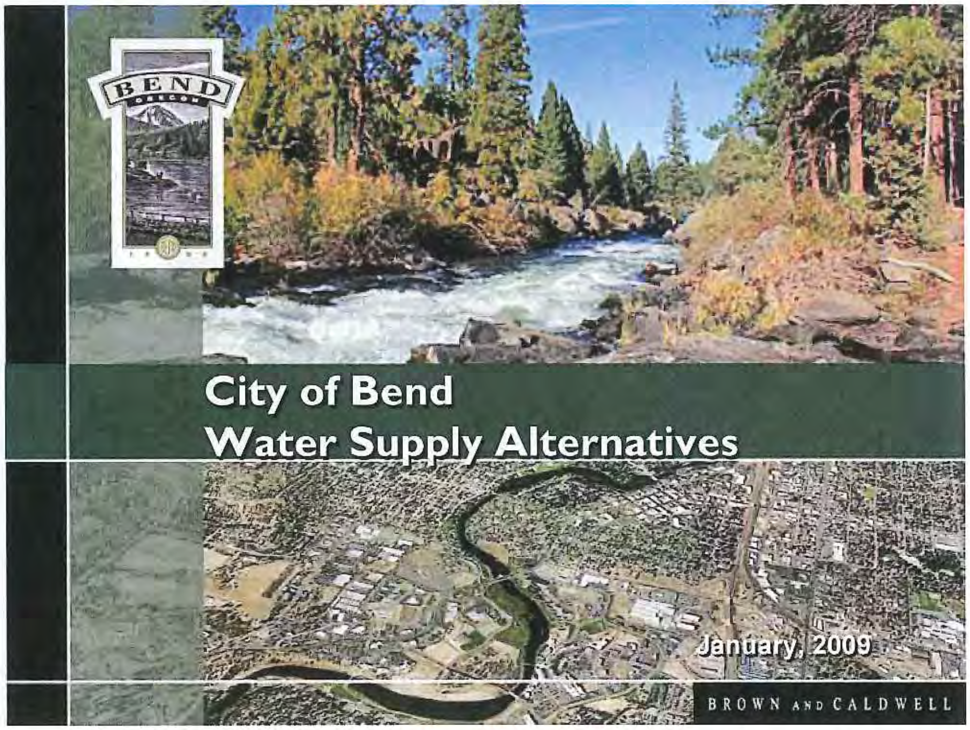
Alternative number	Alternative description	NPV, $ millions	Relativ e NPV	Risk score	Risk cost adjustment factor	Combined NPV/risk relative score	Alternative ranking
3	Renew Bridge Creek intake and filter water	23.00	1	270	1.09	1.09	1
4	Intake on Tumalo Creek near Outback site	(70.40)	(3.06)	259	1.05	(3.21)	2
5	Intake and pump station on Deschutes River	(94.20)	(4.10)	247	1	(4.10)	4
6	Increase well capacity and abandon BCSS	(88.10)	(3.83)	268	1.09	(4.16)	3
7	Intake and pump station on existing canal	(104.60)	(4.55)	275	1.11	(5.06)	5

Notes:

1. The NPV numbers for this analysis were developed from preliminary estimates of cost and revenue generated for this purpose by Brown and Caldwell. They are included in Appendix C.
2. The Relative NPV is the NPV of an alternative divided by the NPV of the lowest cost alternative. As an example for alternative the Relative NPV of Alternative 6 is negative $88.10 million divided by positive $13.00 million or negative 3.83.
3. Risk cost adjustment factor is the normalized risk score relative to the lowest risk alternative. In this case, the specific alternative risk score divided by 247.
4. Combined NPV/risk relative score is the product of the relative NPV multiplied times the risk cost adjustment factor. As an example, for Alternative 6 the value is negative 3.83 X 1.09 = (4.16).

APPENDIX 2-A

Description of the Business Case Evaluation Process



BCE Process for Selecting the Preferred Alternative

- Identifies the Full Cost of Ownership by Considering and Monetizing:
  - Capital
  - O&M
  - R&R
  - Community
  - Environment
  - Risk
- Preferred Alternatives Defined by Lowest Cost of Ownership that meets the Level of Service.

BROWN AND CALDWELL

The Business Case Evaluation Process

1. Form Expert Team
2. Describe Service Level Required of System
3. Document Problem Statement
4. Identify Alternative Solutions
5. Eliminate Fatally Flawed Alternatives
6. Develop Total Cost-of-Ownership for Each Alternative
7. Select Preferred Alternative
8. Document Decision

BROWN AND CALDWELL

Form Expert Team

1. Form Expert Team
2. Describe Service Level Required of System
3. Document Problem Statement
4. Identify Alternative Solutions
5. Eliminate Fatally Flawed Alternatives
6. Develop Total Cost-of-Ownership for Each Alternative
7. Select Preferred Alternative
8. Document Decision

- Experience in Operating System
- Experience in Maintaining System
- Experience in Planning System
- Experience in Financing / Budgeting
- Experience in Engineering
- Knowledge on Project Objectives
- Utility-wide Perspective
- 'Subject' Expertise

BROWN AND CALDWELL

Describe Service Level Required of System

Form Expert Team
Describe Service Level Required of System
Document Problem Statement
Identify Alternative Solutions
Eliminate Fatally Flawed Alternatives
Develop Total Cost-of-Ownership for Each Alternative
Select Preferred Alternative
Document Decision

Describing the service level requirement identifies what is expected.

Expectations for alternatives can be summarized in categories:

- •Performance (e.g. capacity, efficiency, water quality, etc.)
- •Reliability (e.g. expected O&M activities, redundancy, etc.)
- •Sustainability (eCO_2, fossil fuel)
- •Financial (bonding, rates)

BROWN AND CALDWELL

Document Problem Statement

Form Expert Team
Describe Service Level Required of System
Document Problem Statement
Identify Alternative Solutions
Eliminate Fatally Flawed Alternatives
Develop Total Cost-of-Ownership for Each Alternative
Select Preferred Alternative
Document Decision

- Define the problem in terms of level of service
- Understand the root cause for the project
- Document the Problem

BROWN AND CALDWELL

Identify Alternative Solutions

- Form Expert Team
- Describe Service Level Required of System
- Document Problem Statement
- **Identify Alternative Solutions**
- Eliminate Fatally Flawed Alternatives
- Develop Total Cost-of-Ownership for Each Alternative
- Select Preferred Alternative
- Document Decision

Potential solutions include:

- Do nothing new –retain existing system
- Water Treatment
- New Intakes
- Investment of R & R of existing assets
- New water sources
- Water rights transfer
- Maximizing hydro-electric potential

Each alternative should include:

- Description of solution and the system elements
- Potential O&M issues
- Community Impacts
- Environmental Impacts
- Risk

BROWN AND CALDWELL

Eliminate Fatally Flawed Alternatives

- Form Expert Team
- Describe Service Level Required of System
- Document Problem Statement
- Identify Alternative Solutions
- **Eliminate Fatally Flawed Alternatives**
- Develop Total Cost-of-Ownership for Each Alternative
- Select Preferred Alternative
- Document Decision

- Eliminate from consideration any solutions that are fatally flawed.
- Inability to solve problem or meet level of service requirement.
- Document fatal flaws
- Only viable solutions are subject to detailed evaluation.

BROWN AND CALDWELL

Compare Cost-of-Ownership for Each Alternative

- Form Expert Team
- Describe Service Level Required of System
- Document Problem Statement
- Identify Alternative Solutions
- Eliminate Fatally Flawed Alternatives
- **Develop Total Cost-of-Ownership for Each Alternative**
- Select Preferred Alternative
- Document Decision

Cost-of-ownership includes:

- Capital Costs (permits, engineering, construction, mitigation)
- Ongoing base O&M/R&R Costs
- Community Costs
- Environmental Costs
- Risk Costs (Risk is defined by identifying potential failure modes, assigning a probability to each failure mode, and identifying the cost of a failure.)The product of the annual probability of a failure and the cost of a failure is the annual risk cost.
- Adding these costs and reformulating all costs into net present value (NPV) allows for comparing alternatives

BROWN AND CALDWELL

Select Preferred Alternative

- Form Expert Team
- Describe Service Level Required of System
- Document Problem Statement
- Identify Alternative Solutions
- Eliminate Fatally Flawed Alternatives
- Develop Total Cost-of-Ownership for Each Alternative
- **Select Preferred Alternative**
- Document Decision

The preferred alternative is the alternative with the lowest total cost-of-ownership in terms of NPV that meets the Level of Service

BROWN AND CALDWELL

Document Decision

Form Expert Team
Describe Service Level Required of System
Document Problem Statement
Identify Alternative Solutions
Eliminate Fatally Flawed Alternatives
Develop Total Cost-of-Ownership for Each Alternative
Select Preferred Alternative
Document Decision

- The Team
- The Problem Statement
- Alternatives Considered
- Evaluation Outcome
- Preferred Alternative

BROWN AND CALDWELL

Draft Problem Statement

Form Expert Team
Describe Service Level Required of System
Document Problem Statement
Identify Alternative Solutions
Eliminate Fatally Flawed Alternatives
Develop Total Cost-of-Ownership for Each Alternative
Select Preferred Alternative
Document Decision

Unable to assure current and future surface water supply quality and quantity requirements

Root Cause:

- Comply with EPA Surface Water Rules 2012
- Risk of contamination of source water
- Risk of watershed fire impacts
- Forest Service Window Opp.
- Aging infrastructure (pipeline, intake)
- Increased human activity in watershed

BROWN AND CALDWELL


Level of Service
Form Expert Team
Describe Service Level Required of System
Document Problem Statement
Identify Alternative Solutions
Eliminate Fatally Flawed Alternatives
Develop Total Cost-of-Ownership for Each Alternative
Select Preferred Alternative
Document Decision
• Maintain City Control
• Maintain dual source of supply
• Maximize existing assets
• Minimize energy consumption
• Minimize cost (capitol, O&M)of supply
• Maintain current water aesthetics
• Meet regulatory requirements
• Provide flexibility for future
• Achieve environmentally sound projects
• Maximize potential for renewable energy
• Maintain ability to provide community safety (serve peak during power outage, fire)
BEND
BROWN AND CALDWELL

APPENDIX 2-B

List of Workshop Participants

Bend Water Supply Alternatives Kick-Off Meeting List of Attendees, January 7, 2009	
Attendee	**Company**
Tom Hickmann	City of Bend
Heidi Lansdowne	City of Bend
Patrick Griffiths	City of Bend
Michelle Cheek	Black & Veatch
Kevin Crew	Black Rock Consulting
Jim Doane	Brown and Caldwell
Ed Olson	Brown and Caldwell
Phil Roppo	Brown and Caldwell
David Prull	David Evans and Associates
Adam Sussman	GSI Water Solutions
Karen Swirsky	David Evans and Associates
Pat Van Duser	Black & Veatch
Jack Warburton	Brown and Caldwell
Bob Willis	Brown and Caldwell

APPENDIX 2-C

Net Present Worth Value Calculations for Various Alternatives

Alternative	Construction Costs Power	Construction Costs Water Supply	Capital Costs Total	O & M Costs	Revenue	Net Present Surplus or (Net Present Cost)
Alternative 1 – Do Nothing	$0	$0	$0	$0	$0	0
Alternative 2 – No Upgrades to Spring Supply but Add UV	$0	$2,400,000	$3,200,000	$9,100,000	$0	(12,300,000)
Alternative 3 – Renew Bridge Creek Intake & add filtration	$41,400,000	$27,700,000	$56,100,000	$7,900,000	$87,000,000	23,000,000
Alternative 4 – Intake on Tumalo Creek near Outback Site & add filtration	$0	$30,300,000	$40,500,000	$29,900,000	$0	(70,400,000)
Alternative 5 – Intake and Pump Station on Deschutes River & add filtration +	$0	$40,000,000	$53,500,000	$40,700,000	$0	(94,200,000)
Alternative 6 – Add Well Capacity to Replace Bridge Creek Supply	$0	$21,200,000	$28,400,000	$59,700,000	$0	(88,100,000)
Alternative 7 – Intake on Existing Canal & add filtration ++	$0	$44,300,000	$59,200,000	$45,400,000	$0	(104,600,000)

Project Cost	
Costs/Power	$ -
Costs/Water	$ -
	$ -
ant	$ -
d Capital Costs	$ -

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

12	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
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'39	0.0781	0.0826	0.0873	0.0922	0.0975	0.1031	0.1089	0.1151	0.1217	0.1286	0.1360
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69	0.069	0.071	0.074	0.077	0.078	0.080	0.071	0.081	0.081	0.081	0.081
10	0.011	0.011	0.012	0.012	0.013	0.014	0.015	0.016	0.016	0.017	0.018
20	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	-
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1	**0.97087**	**0.94260**	**0.91514**	**0.88849**	**0.86261**	**0.83748**	**0.81309**	**0.78941**	**0.76642**	**0.74409**	**0.72242**
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Project Cost	
Costs/Power	$ -
Costs/Water	$ -
	$ -
ant	$ -
d Capital Costs	$ -

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

26	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	
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06	0.1697	0.1794	0.1896	0.2004	0.2119	0.2239	0.2367	0.2502	0.2645	0.2795	0
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90	0.095	0.101	0.106	0.112	0.119	0.126	0.133	0.140	0.148	0.157	(
22	0.023	0.024	0.026	0.027	0.029	0.030	0.032	0.034	0.036	0.038	(
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112	**0.64186**	**0.62317**	**0.60502**	**0.58739**	**0.57029**	**0.55368**	**0.53755**	**0.52189**	**0.50669**	**0.49193**	**0.**
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Project Cost	
Costs/Power	$ -
Costs/Water	$ -
	$ -
ant	$ -
d Capital Costs	$ -

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

39	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
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	0	0	0	0	0	0	0	0	0	0	
301	0.3489	0.3688	0.3898	0.4121	0.4356	0.4604	0.4866	0.5144	0.5437	0.5747	0
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85	0.196	0.207	0.219	0.231	0.244	0.258	0.273	0.288	0.305	0.322	(
45	0.047	0.050	0.053	0.056	0.059	0.062	0.066	0.070	0.074	0.078	(
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-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
019	**0.43708**	**0.42435**	**0.41199**	**0.39999**	**0.38834**	**0.37703**	**0.36604**	**0.35538**	**0.34503**	**0.33498**	0.
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$

Project Cost

Costs/Power	$	-
Costs/Water	$	-
	$	-
ant	$	-
d Capital Costs	$	-

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

52	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	0	0	0	0	0	0	0	0	0	0
'86	0.7173	0.7582	0.8014	0.8471	0.8954	0.9464	1.0004	1.0574	1.1177	1.1814
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
81	0.402	0.425	0.449	0.475	0.502	0.531	0.561	0.593	0.627	0.662
92	0.097	0.103	0.108	0.115	0.121	0.128	0.135	0.143	0.151	0.160
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
656	**0.29763**	**0.28896**	**0.28054**	**0.27237**	**0.26444**	**0.25674**	**0.24926**	**0.24200**	**0.23495**	**0.22811**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

Cost	
ower	$ -
/ater	$ 2,385,000
	$ -
	$ -
al Costs	$ 2,385,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

	2013	2014	2015	2016	2017	2018	2019	2020	2021
0	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,8
0	$ 103,000	$ 106,090	$ 109,273	$ 112,551	$ 115,927	$ 119,405	$ 122,987	$ 126,677	$ 130,4
	514104	514104	514104	514104	514104	514104	514104	514104	514104
	0.0781	0.0826	0.0873	0.0922	0.0975	0.1031	0.1089	0.1151	0.1217
2	$ 40,158	$ 42,447	$ 44,866	$ 47,424	$ 50,127	$ 52,984	$ 56,004	$ 59,196	$ 62,5
2	**$ 320,958**	**$ 326,337**	**$ 331,939**	**$ 337,775**	**$ 343,854**	**$ 350,189**	**$ 356,792**	**$ 363,674**	**$ 370,8**
	0.069	0.071	0.074	0.077	0.078	0.080	0.071	0.081	0.081
	0.011	0.011	0.012	0.012	0.013	0.014	0.015	0.016	0.016
	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	-	-	-	-	-	-	-	-	-
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
2)	**$ (320,958)**	**$ (326,337)**	**$ (331,939)**	**$ (337,775)**	**$ (343,854)**	**$ (350,189)**	**$ (356,792)**	**$ (363,674)**	**$ (370,8**
1	**0.97087**	**0.94260**	**0.91514**	**0.88849**	**0.86261**	**0.83748**	**0.81309**	**0.78941**	**0.76642**
0	**$ 172,622**	**$ 167,594**	**$ 162,712**	**$ 157,973**	**$ 153,372**	**$ 148,905**	**$ 144,568**	**$ 140,357**	**$ 136,2**
2	**$ 138,988**	**$ 140,010**	**$ 141,059**	**$ 142,135**	**$ 143,240**	**$ 144,373**	**$ 145,536**	**$ 146,730**	**$ 147,9**
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
2)	**$ (311,610)**	**$ (307,604)**	**$ (303,771)**	**$ (300,108)**	**$ (296,612)**	**$ (293,278)**	**$ (290,104)**	**$ (287,087)**	**$ (284,2**
0	**$ 350,422**	**$ 518,016**	**$ 680,728**	**$ 838,701**	**$ 992,073**	**$ 1,140,978**	**$ 1,285,546**	**$ 1,425,903**	**$ 1,562,1**
2	**$ 276,980**	**$ 416,991**	**$ 558,050**	**$ 700,185**	**$ 843,425**	**$ 987,798**	**$ 1,133,335**	**$ 1,280,065**	**$ 1,428,0**
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
2)	**$ (627,402)**	**$ (935,006)**	**$ (1,238,778)**	**$ (1,538,886)**	**$ (1,835,498)**	**$ (2,128,776)**	**$ (2,418,880)**	**$ (2,705,968)**	**$ (2,990,1**

3

1

Cost	
ower	$ -
ater	$ 2,385,000
	$ -
	$ -
l Costs	$ 2,385,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

	2025	2026	2027	2028	2029	2030	2031	2032	2033
0	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,800	$ 177,8
6	$ 146,853	$ 151,259	$ 155,797	$ 160,471	$ 165,285	$ 170,243	$ 175,351	$ 180,611	$ 186,0
	514104	514104	514104	514104	514104	514104	514104	514104	514104
	0.1519	0.1606	0.1697	0.1794	0.1896	0.2004	0.2119	0.2239	0.2367
2	$ 78,103	$ 82,555	$ 87,261	$ 92,235	$ 97,492	$ 103,049	$ 108,923	$ 115,132	$ 121,6
8	**$ 402,757**	**$ 411,614**	**$ 420,858**	**$ 430,506**	**$ 440,577**	**$ 451,093**	**$ 462,074**	**$ 473,543**	**$ 485,5**
	0.085	0.090	0.095	0.101	0.106	0.112	0.119	0.126	0.133
	0.021	0.022	0.023	0.024	0.026	0.027	0.029	0.030	0.032
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8)	$ (402,757)	$ (411,614)	$ (420,858)	$ (430,506)	$ (440,577)	$ (451,093)	$ (462,074)	$ (473,543)	$ (485,5
	0.68095	0.66112	0.64186	0.62317	0.60502	0.58739	0.57029	0.55368	0.53755
5	$ 121,073	$ 117,547	$ 114,123	$ 110,799	$ 107,572	$ 104,439	$ 101,397	$ 98,444	$ 95,5
6	$ 153,185	$ 154,579	$ 156,009	$ 157,478	$ 158,984	$ 160,531	$ 162,117	$ 163,746	$ 165,4
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2)	$ (274,258)	$ (272,126)	$ (270,133)	$ (268,277)	$ (266,556)	$ (264,969)	$ (263,514)	$ (262,189)	$ (260,9
4	$ 2,068,697	$ 2,186,244	$ 2,300,368	$ 2,411,167	$ 2,518,739	$ 2,623,178	$ 2,724,575	$ 2,823,018	$ 2,918,5
0	$ 2,032,745	$ 2,187,324	$ 2,343,333	$ 2,500,811	$ 2,659,795	$ 2,820,326	$ 2,982,443	$ 3,146,189	$ 3,311,6
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
5)	$ (4,101,442)	$ (4,373,568)	$ (4,643,701)	$ (4,911,978)	$ (5,178,534)	$ (5,443,504)	$ (5,707,018)	$ (5,969,207)	$ (6,230,2

Cost		
ower	$	-
/ater	$	2,385,000
	$	-
	$	-
al Costs	$	2,385,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

	2037	2038	2039	2040	2041	2042	2043	2044	2045
0	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
9	$ 209,378	$ 215,659	$ 222,129	$ 228,793	$ 235,657	$ 242,726	$ 250,008	$ 257,508	$ 265,2
	514104	514104	514104	514104	514104	514104	514104	514104	514104
	0.2955	0.3123	0.3301	0.3489	0.3688	0.3898	0.4121	0.4356	0.4604
3	$ 151,904	$ 160,563	$ 169,715	$ 179,389	$ 189,614	$ 200,422	$ 211,846	$ 223,921	$ 236,6
2	**$ 361,282**	**$ 376,222**	**$ 391,844**	**$ 408,181**	**$ 425,270**	**$ 443,148**	**$ 461,854**	**$ 481,429**	**$ 501,9**
	0.166	0.175	0.185	0.196	0.207	0.219	0.231	0.244	0.258
	0.040	0.042	0.045	0.047	0.050	0.053	0.056	0.059	0.062
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
2)	**$ (361,282)**	**$ (376,222)**	**$ (391,844)**	**$ (408,181)**	**$ (425,270)**	**$ (443,148)**	**$ (461,854)**	**$ (481,429)**	**$ (501,9**
	0.47761	**0.46369**	**0.45019**	**0.43708**	**0.42435**	**0.41199**	**0.39999**	**0.38834**	**0.37703**
6	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
7	**$ 172,550**	**$ 174,452**	**$ 176,404**	**$ 178,407**	**$ 180,462**	**$ 182,571**	**$ 184,736**	**$ 186,957**	**$ 189,2**
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
3)	**$ (172,550)**	**$ (174,452)**	**$ (176,404)**	**$ (178,407)**	**$ (180,462)**	**$ (182,571)**	**$ (184,736)**	**$ (186,957)**	**$ (189,2**
3	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,9**
5	**$ 3,990,875**	**$ 4,165,328**	**$ 4,341,731**	**$ 4,520,138**	**$ 4,700,600**	**$ 4,883,171**	**$ 5,067,906**	**$ 5,254,863**	**$ 5,444,1**
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
8)	**$ (7,179,819)**	**$ (7,354,271)**	**$ (7,530,674)**	**$ (7,709,081)**	**$ (7,889,543)**	**$ (8,072,114)**	**$ (8,256,850)**	**$ (8,443,806)**	**$ (8,633,0**

Cost	
ower	$ -
/ater	$ 2,385,000
	$ -
	$ -
al Costs	$ 2,385,000

Financial Parameters

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

	2049	2050	2051	2052	2053	2054	2055	2056	2057
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
8	$ 298,523	$ 307,478	$ 316,703	$ 326,204	$ 335,990	$ 346,070	$ 356,452	$ 367,145	$ 378,1
	514104	514104	514104	514104	514104	514104	514104	514104	514104
	0.5747	0.6074	0.6421	0.6786	0.7173	0.7582	0.8014	0.8471	0.8954
8	$ 295,440	$ 312,280	$ 330,080	$ 348,895	$ 368,782	$ 389,802	$ 412,021	$ 435,506	$ 460,3
6	**$ 593,963**	**$ 619,759**	**$ 646,783**	**$ 675,099**	**$ 704,772**	**$ 735,872**	**$ 768,473**	**$ 802,652**	**$ 838,4**
	0.322	0.341	0.360	0.381	0.402	0.425	0.449	0.475	0.502
	0.078	0.082	0.087	0.092	0.097	0.103	0.108	0.115	0.121
	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
6)	**$ (593,963)**	**$ (619,759)**	**$ (646,783)**	**$ (675,099)**	**$ (704,772)**	**$ (735,872)**	**$ (768,473)**	**$ (802,652)**	**$ (838,4**
	0.33498	**0.32523**	**0.31575**	**0.30656**	**0.29763**	**0.28896**	**0.28054**	**0.27237**	**0.26444**
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
9	**$ 198,967**	**$ 201,562**	**$ 204,224**	**$ 206,956**	**$ 209,760**	**$ 212,637**	**$ 215,590**	**$ 218,620**	**$ 221,7**
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
9)	**$ (198,967)**	**$ (201,562)**	**$ (204,224)**	**$ (206,956)**	**$ (209,760)**	**$ (212,637)**	**$ (215,590)**	**$ (218,620)**	**$ (221,7**
3	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,943**	**$ 3,188,9**
0	**$ 6,225,058**	**$ 6,426,620**	**$ 6,630,844**	**$ 6,837,800**	**$ 7,047,560**	**$ 7,260,197**	**$ 7,475,786**	**$ 7,694,406**	**$ 7,916,1**
	$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
3)	**$ (9,414,001)**	**$ (9,615,563)**	**$ (9,819,787)**	**$ (10,026,743)**	**$ (10,236,503)**	**$ (10,449,140)**	**$ (10,664,729)**	**$ (10,883,349)**	**$ (11,105,0**

Cost

ower	$	-
/ater	$	2,385,000
	$	-
	$	-
ıl Costs	$	2,385,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

	2061	2062
	$ -	$ -
5	$ 425,622	$ 438,391
	514104	514104
	1.1177	1.1814
9	$ 574,605	$ 607,358
4	$ 1,000,227	$ 1,045,748
	0.627	0.662
	0.151	0.160
	-	-
	-	-
	$ -	$ -
	$ -	$ -
	$ -	$ -
	$ -	$ -
4)	$ (1,000,227)	$ (1,045,748)
	0.23495	0.22811
	$ -	$ -
5	$ 235,004	$ 238,543
	$ -	$ -
5)	$ (235,004)	$ (238,543)
3	$ 3,188,943	$ 3,188,943
5	$ 8,835,809	$ 9,074,351
	$ -	$ -
8)	$ (12,024,752)	$ (12,263,294)

ed in Flows

ont Project Cost	
ital Costs/Power	$ 41,400,000
ital Costs/Water	$ 27,700,000
and BETC Grants	$ 23,020,000
Grant	$ 4,140,000
isted Capital Costs	$ 41,940,000

Financial Parameters

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2012	2013	2014	2015	2016	2017	2018	2019	2020	
3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$
125,000	$ 128,750	$ 132,613	$ 136,591	$ 140,689	$ 144,909	$ 149,257	$ 153,734	$ 158,346	$
200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	
0.0739	0.0781	0.0826	0.0873	0.0922	0.0975	0.1031	0.1089	0.1151	
14,780	$ 15,622	$ 16,513	$ 17,454	$ 18,449	$ 19,501	$ 20,612	$ 21,787	$ 23,029	$
3,266,380	**$ 3,270,972**	**$ 3,275,725**	**$ 3,280,645**	**$ 3,285,738**	**$ 3,291,010**	**$ 3,296,469**	**$ 3,302,121**	**$ 3,307,975**	**$**
0.069	0.069	0.071	0.074	0.077	0.078	0.080	0.071	0.081	
0.022	0.023	0.025	0.026	0.027	0.029	0.031	0.032	0.034	
0.044	0.047	0.049	0.052	0.055	0.058	0.061	0.065	0.069	
5,910,000	11,820,000	11,460,000	11,460,000	11,460,000	11,740,000	12,020,000	12,020,000	12,020,000	
407,790	$ 817,944	$ 818,244	$ 850,332	$ 881,274	$ 918,068	$ 957,994	$ 855,824	$ 972,418	$
130,020	$ 274,862	$ 281,681	$ 297,737	$ 314,708	$ 340,773	$ 368,788	$ 389,809	$ 412,028	$
260,040	$ 549,725	$ 563,362	$ 595,473	$ 629,415	$ 681,547	$ 737,576	$ 779,618	$ 824,057	$
797,850	**$ 1,642,531**	**$ 1,663,286**	**$ 1,743,542**	**$ 1,825,397**	**$ 1,940,388**	**$ 2,064,359**	**$ 2,025,252**	**$ 2,208,503**	**$**
(2,468,530)	**$ (1,628,441)**	**$ (1,612,439)**	**$ (1,537,103)**	**$ (1,460,341)**	**$ (1,350,622)**	**$ (1,232,110)**	**$ (1,276,870)**	**$ (1,099,472)**	**$**
1	**0.97087**	**0.94260**	**0.91514**	**0.88849**	**0.86261**	**0.83748**	**0.81309**	**0.78941**	
3,126,600	**$ 3,035,534**	**$ 2,947,120**	**$ 2,861,282**	**$ 2,777,943**	**$ 2,697,033**	**$ 2,618,478**	**$ 2,542,212**	**$ 2,468,167**	**$**
139,780	**$ 140,167**	**$ 140,565**	**$ 140,973**	**$ 141,392**	**$ 141,821**	**$ 142,262**	**$ 142,715**	**$ 143,179**	**$**
797,850	**$ 1,594,690**	**$ 1,567,807**	**$ 1,595,588**	**$ 1,621,841**	**$ 1,673,796**	**$ 1,728,868**	**$ 1,646,715**	**$ 1,743,413**	**$**
(2,468,530)	**$ (1,581,011)**	**$ (1,519,878)**	**$ (1,406,667)**	**$ (1,297,494)**	**$ (1,165,058)**	**$ (1,031,873)**	**$ (1,038,212)**	**$ (867,933)**	**$**
3,126,600	**$ 6,162,134**	**$ 9,109,254**	**$ 11,970,536**	**$ 14,748,479**	**$ 17,445,512**	**$ 20,063,990**	**$ 22,606,202**	**$ 25,074,368**	**$**
139,780	**$ 279,947**	**$ 420,512**	**$ 561,486**	**$ 702,877**	**$ 844,699**	**$ 986,961**	**$ 1,129,676**	**$ 1,272,855**	**$**
797,850	**$ 2,392,540**	**$ 3,960,347**	**$ 5,555,935**	**$ 7,177,776**	**$ 8,851,572**	**$ 10,580,440**	**$ 12,227,155**	**$ 13,970,568**	**$**
(2,468,530)	**$ (4,049,541)**	**$ (5,569,419)**	**$ (6,976,086)**	**$ (8,273,580)**	**$ (9,438,638)**	**$ (10,470,511)**	**$ (11,508,723)**	**$ (12,376,656)**	**$**
56,077,264									
7,921,128									
87,017,392									
23,019,000									

ed in Flows

ont Project Cost		
ital Costs/Power	$	41,400,000
ital Costs/Water	$	27,700,000
and BETC Grants	$	23,020,000
Grant	$	4,140,000
isted Capital Costs	$	41,940,000

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2023	2024	2025	2026	2027	2028	2029	2030	2031	
3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$ 3,126,600	$
173,029	$ 178,220	$ 183,567	$ 189,074	$ 194,746	$ 200,588	$ 206,606	$ 212,804	$ 219,188	$
200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	
0.1360	0.1437	0.1519	0.1606	0.1697	0.1794	0.1896	0.2004	0.2119	
27,196	$ 28,746	$ 30,384	$ 32,116	$ 33,947	$ 35,882	$ 37,927	$ 40,089	$ 42,374	$
3,326,825	**$ 3,333,566**	**$ 3,340,551**	**$ 3,347,790**	**$ 3,355,293**	**$ 3,363,070**	**$ 3,371,133**	**$ 3,379,493**	**$ 3,388,162**	**$**
0.081	0.081	0.085	0.090	0.095	0.101	0.106	0.112	0.119	
0.040	0.043	0.045	0.048	0.051	0.053	0.056	0.060	0.063	
-	-	-	-	-	-	-	-	-	
12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	
973,620	$ 968,812	$ 1,024,034	$ 1,082,404	$ 1,144,101	$ 1,209,315	$ 1,278,246	$ 1,351,106	$ 1,428,119	$
486,577	$ 514,312	$ 543,628	$ 574,615	$ 607,368	$ 641,988	$ 678,581	$ 717,261	$ 758,144	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
1,460,197	**$ 1,483,124**	**$ 1,567,662**	**$ 1,657,019**	**$ 1,751,469**	**$ 1,851,303**	**$ 1,956,827**	**$ 2,068,367**	**$ 2,186,263**	**$**
(1,866,627)	**$ (1,850,441)**	**$ (1,772,888)**	**$ (1,690,771)**	**$ (1,603,823)**	**$ (1,511,767)**	**$ (1,414,305)**	**$ (1,311,126)**	**$ (1,201,899)**	**$**
0.72242	**0.70138**	**0.68095**	**0.66112**	**0.64186**	**0.62317**	**0.60502**	**0.58739**	**0.57029**	
2,258,722	**$ 2,192,934**	**$ 2,129,062**	**$ 2,067,051**	**$ 2,006,845**	**$ 1,948,394**	**$ 1,891,644**	**$ 1,836,548**	**$ 1,783,056**	**$**
144,647	**$ 145,162**	**$ 145,690**	**$ 146,233**	**$ 146,789**	**$ 147,360**	**$ 147,946**	**$ 148,548**	**$ 149,165**	**$**
1,054,878	**$ 1,040,234**	**$ 1,067,502**	**$ 1,095,485**	**$ 1,124,202**	**$ 1,153,671**	**$ 1,183,913**	**$ 1,214,947**	**$ 1,246,795**	**$**
(1,348,491)	**$ (1,297,862)**	**$ (1,207,251)**	**$ (1,117,799)**	**$ (1,029,433)**	**$ (942,083)**	**$ (855,678)**	**$ (770,149)**	**$ (685,426)**	**$**
32,055,853	**$ 34,248,787**	**$ 36,377,850**	**$ 38,444,901**	**$ 40,451,746**	**$ 42,400,140**	**$ 44,291,784**	**$ 46,128,332**	**$ 47,911,388**	**$**
1,705,303	**$ 1,850,464**	**$ 1,996,155**	**$ 2,142,387**	**$ 2,289,176**	**$ 2,436,537**	**$ 2,584,483**	**$ 2,733,031**	**$ 2,882,197**	**$**
17,838,183	**$ 18,878,417**	**$ 19,945,919**	**$ 21,041,404**	**$ 22,165,605**	**$ 23,319,276**	**$ 24,503,189**	**$ 25,718,136**	**$ 26,964,932**	**$**
(15,922,972)	**$ (17,220,835)**	**$ (18,428,085)**	**$ (19,545,884)**	**$ (20,575,317)**	**$ (21,517,400)**	**$ (22,373,078)**	**$ (23,143,227)**	**$ (23,828,653)**	**$**

ed in Flows

ont Project Cost		
ital Costs/Power	$	41,400,000
ital Costs/Water	$	27,700,000
and BETC Grants	$	23,020,000
Grant	$	4,140,000
isted Capital Costs	$	41,940,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2034	2035	2036	2037	2038	2039	2040	2041	2042	
3,126,600	$ 3,126,600	$ 3,126,600	$ -	$ -	$ -	$ -	$ -	$ -	$
239,513	$ 246,698	$ 254,099	$ 261,722	$ 269,574	$ 277,661	$ 285,991	$ 294,571	$ 303,408	$
200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	
0.2502	0.2645	0.2795	0.2955	0.3123	0.3301	0.3489	0.3688	0.3898	
50,041	$ 52,893	$ 55,908	$ 59,095	$ 62,463	$ 66,024	$ 69,787	$ 73,765	$ 77,969	$
3,416,154	**$ 3,426,191**	**$ 3,436,607**	**$ 320,817**	**$ 332,037**	**$ 343,685**	**$ 355,778**	**$ 368,335**	**$ 381,377**	**$**
0.140	0.148	0.157	0.166	0.175	0.185	0.196	0.207	0.219	
0.074	0.079	0.083	0.088	0.093	0.098	0.104	0.110	0.116	
-	-	-	-	-	-	-	-	-	
12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	
1,686,512	$ 1,782,643	$ 1,884,254	$ 1,991,656	$ 2,105,180	$ 2,225,176	$ 2,352,011	$ 2,486,075	$ 2,627,782	$
895,317	$ 946,350	$ 1,000,292	$ 1,057,309	$ 1,117,575	$ 1,181,277	$ 1,248,610	$ 1,319,781	$ 1,395,008	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
2,581,829	**$ 2,728,993**	**$ 2,884,546**	**$ 3,048,965**	**$ 3,222,756**	**$ 3,406,453**	**$ 3,600,621**	**$ 3,805,856**	**$ 4,022,790**	**$**
(834,325)	**$ (697,198)**	**$ (552,061)**	**$ 2,728,148**	**$ 2,890,719**	**$ 3,062,768**	**$ 3,244,843**	**$ 3,437,521**	**$ 3,641,413**	**$**
0.52189	**0.50669**	**0.49193**	**0.47761**	**0.46369**	**0.45019**	**0.43708**	**0.42435**	**0.41199**	
1,631,749	**$ 1,584,222**	**$ 1,538,080**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
151,116	**$ 151,801**	**$ 152,503**	**$ 153,224**	**$ 153,964**	**$ 154,723**	**$ 155,502**	**$ 156,302**	**$ 157,122**	**$**
1,347,437	**$ 1,382,758**	**$ 1,419,005**	**$ 1,456,203**	**$ 1,494,375**	**$ 1,533,548**	**$ 1,573,748**	**$ 1,615,001**	**$ 1,657,336**	**$**
(435,428)	**$ (353,265)**	**$ (271,578)**	**$ 1,302,979**	**$ 1,340,411**	**$ 1,378,825**	**$ 1,418,245**	**$ 1,458,699**	**$ 1,500,214**	**$**
52,954,961	**$ 54,539,184**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$**
3,333,560	**$ 3,485,361**	**$ 3,637,864**	**$ 3,791,088**	**$ 3,945,051**	**$ 4,099,774**	**$ 4,255,277**	**$ 4,411,579**	**$ 4,568,701**	**$**
30,904,866	**$ 32,287,624**	**$ 33,706,629**	**$ 35,162,832**	**$ 36,657,207**	**$ 38,190,755**	**$ 39,764,502**	**$ 41,379,503**	**$ 43,036,840**	**$**
(25,383,655)	**$ (25,736,920)**	**$ (26,008,498)**	**$ (24,705,519)**	**$ (23,365,108)**	**$ (21,986,283)**	**$ (20,568,038)**	**$ (19,109,339)**	**$ (17,609,125)**	**$**

ıed in Flows

ont Project Cost	
ital Costs/Power	$ 41,400,000
ital Costs/Water	$ 27,700,000
and BETC Grants	$ 23,020,000
Grant	$ 4,140,000
ısted Capital Costs	$ 41,940,000

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2045	2046	2047	2048	2049	2050	2051	2052	2053	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
331,542	$ 341,488	$ 351,733	$ 362,285	$ 373,153	$ 384,348	$ 395,878	$ 407,755	$ 419,987	$
200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	
0.4604	0.4866	0.5144	0.5437	0.5747	0.6074	0.6421	0.6786	0.7173	
92,077	$ 97,325	$ 102,872	$ 108,736	$ 114,934	$ 121,485	$ 128,410	$ 135,729	$ 143,466	$
423,618	**$ 438,813**	**$ 454,605**	**$ 471,021**	**$ 488,087**	**$ 505,833**	**$ 524,288**	**$ 543,484**	**$ 563,453**	**$**
0.258	0.273	0.288	0.305	0.322	0.341	0.360	0.381	0.402	
0.137	0.145	0.153	0.162	0.171	0.181	0.191	0.202	0.214	
-	-	-	-	-	-	-	-	-	
12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	
3,103,232	$ 3,280,116	$ 3,467,083	$ 3,664,707	$ 3,873,595	$ 4,094,390	$ 4,327,770	$ 4,574,453	$ 4,835,197	$
1,647,410	$ 1,741,312	$ 1,840,567	$ 1,945,480	$ 2,056,372	$ 2,173,585	$ 2,297,480	$ 2,428,436	$ 2,566,857	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
4,750,642	**$ 5,021,429**	**$ 5,307,650**	**$ 5,610,186**	**$ 5,929,967**	**$ 6,267,975**	**$ 6,625,249**	**$ 7,002,889**	**$ 7,402,053**	**$**
4,327,024	**$ 4,582,616**	**$ 4,853,045**	**$ 5,139,165**	**$ 5,441,879**	**$ 5,762,142**	**$ 6,100,961**	**$ 6,459,405**	**$ 6,838,600**	**$**
0.37703	**0.36604**	**0.35538**	**0.34503**	**0.33498**	**0.32523**	**0.31575**	**0.30656**	**0.29763**	
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
159,715	**$ 160,625**	**$ 161,559**	**$ 162,517**	**$ 163,501**	**$ 164,510**	**$ 165,546**	**$ 166,609**	**$ 167,699**	**$**
1,791,117	**$ 1,838,068**	**$ 1,886,251**	**$ 1,935,696**	**$ 1,986,438**	**$ 2,038,509**	**$ 2,091,946**	**$ 2,146,783**	**$ 2,203,058**	**$**
1,631,401	**$ 1,677,443**	**$ 1,724,692**	**$ 1,773,179**	**$ 1,822,937**	**$ 1,873,999**	**$ 1,926,400**	**$ 1,980,175**	**$ 2,035,359**	**$**
56,077,264	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$**
5,045,209	**$ 5,205,834**	**$ 5,367,394**	**$ 5,529,911**	**$ 5,693,412**	**$ 5,857,922**	**$ 6,023,468**	**$ 6,190,077**	**$ 6,357,776**	**$**
48,274,102	**$ 50,112,170**	**$ 51,998,421**	**$ 53,934,117**	**$ 55,920,555**	**$ 57,959,064**	**$ 60,051,010**	**$ 62,197,794**	**$ 64,400,852**	**$**
(12,848,371)	**$ (11,170,928)**	**$ (9,446,236)**	**$ (7,673,057)**	**$ (5,850,121)**	**$ (3,976,122)**	**$ (2,049,721)**	**$ (69,547)**	**$ 1,965,812**	**$**

ed in Flows

ont Project Cost

ital Costs/Power	$ 41,400,000
ital Costs/Water	$ 27,700,000
and BETC Grants	$ 23,020,000
Grant	$ 4,140,000
sted Capital Costs	$ 41,940,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2056	2057	2058	2059	2060	2061	2062
-	$ -	$ -	$ -	$ -	$ -	$ -
458,932	$ 472,699	$ 486,880	$ 501,487	$ 516,531	$ 532,027	$ 547,988
200,000	200,000	200,000	200,000	200,000	200,000	200,000
0.8471	0.8954	0.9464	1.0004	1.0574	1.1177	1.1814
169,424	$ 179,081	$ 189,288	$ 200,078	$ 211,482	$ 223,537	$ 236,278
628,355	**$ 651,780**	**$ 676,169**	**$ 701,565**	**$ 728,014**	**$ 755,564**	**$ 784,267**
0.475	0.502	0.531	0.561	0.593	0.627	0.662
0.252	0.267	0.282	0.298	0.315	0.333	0.352
-	-	-	-	-	-	-
12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000	12,020,000
5,710,039	$ 6,035,512	$ 6,379,536	$ 6,743,169	$ 7,127,530	$ 7,533,799	$ 7,963,226
3,031,284	$ 3,204,067	$ 3,386,699	$ 3,579,741	$ 3,783,786	$ 3,999,462	$ 4,227,431
-	$ -	$ -	$ -	$ -	$ -	$ -
8,741,323	**$ 9,239,579**	**$ 9,766,235**	**$ 10,322,910**	**$ 10,911,316**	**$ 11,533,261**	**$ 12,190,657**
8,112,968	**$ 8,587,798**	**$ 9,090,066**	**$ 9,621,345**	**$ 10,183,302**	**$ 10,777,697**	**$ 11,406,390**
0.27237	**0.26444**	**0.25674**	**0.24926**	**0.24200**	**0.23495**	**0.22811**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
171,146	**$ 172,356**	**$ 173,597**	**$ 174,871**	**$ 176,178**	**$ 177,520**	**$ 178,897**
2,380,890	**$ 2,443,301**	**$ 2,507,349**	**$ 2,573,076**	**$ 2,640,525**	**$ 2,709,743**	**$ 2,780,775**
2,209,744	**$ 2,270,946**	**$ 2,333,752**	**$ 2,398,205**	**$ 2,464,347**	**$ 2,532,223**	**$ 2,601,878**
56,077,264	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**	**$ 56,077,264**
6,867,709	**$ 7,040,065**	**$ 7,213,662**	**$ 7,388,533**	**$ 7,564,711**	**$ 7,742,232**	**$ 7,921,128**
71,362,622	**$ 73,805,924**	**$ 76,313,273**	**$ 78,886,349**	**$ 81,526,874**	**$ 84,236,617**	**$ 87,017,392**
8,417,650	**$ 10,688,596**	**$ 13,022,348**	**$ 15,420,552**	**$ 17,884,899**	**$ 20,417,122**	**$ 23,019,000**

ɔfront Project Cost	
ıpital Costs/Power	$ -
ıpital Costs/Water	$ 30,259,178
ΞTC	$ -
ΤO Grant	$ -
ljusted Capital Costs	$ 30,259,178

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2012	2013	2014	2015	2016	2017	2018	2019	2020
2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802
125,000	$ 128,750	$ 132,613	$ 136,591	$ 140,689	$ 144,909	$ 149,257	$ 153,734	$ 158,346
3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525
0.0739	0.0781	0.0826	0.0873	0.0922	0.0975	0.1031	0.1089	0.1151
225,360	$ 238,205	$ 251,783	$ 266,135	$ 281,304	$ 297,339	$ 314,287	$ 332,201	$ 351,137
2,606,162	**$ 2,622,758**	**$ 2,640,198**	**$ 2,658,528**	**$ 2,677,795**	**$ 2,698,050**	**$ 2,719,346**	**$ 2,741,738**	**$ 2,765,285**
0.069	0.069	0.071	0.074	0.077	0.078	0.080	0.071	0.081
0.010	0.011	0.011	0.012	0.012	0.013	0.014	0.015	0.016
0.020	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(2,606,162)	**$ (2,622,758)**	**$ (2,640,198)**	**$ (2,658,528)**	**$ (2,677,795)**	**$ (2,698,050)**	**$ (2,719,346)**	**$ (2,741,738)**	**$ (2,765,285)**
1	**0.97087**	**0.94260**	**0.91514**	**0.88849**	**0.86261**	**0.83748**	**0.81309**	**0.78941**
2,255,802	**$ 2,190,099**	**$ 2,126,310**	**$ 2,064,378**	**$ 2,004,251**	**$ 1,945,875**	**$ 1,889,199**	**$ 1,834,174**	**$ 1,780,751**
350,360	**$ 356,267**	**$ 362,330**	**$ 368,551**	**$ 374,935**	**$ 381,487**	**$ 388,211**	**$ 395,110**	**$ 402,191**
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(2,606,162)	**$ (2,546,367)**	**$ (2,488,640)**	**$ (2,432,929)**	**$ (2,379,186)**	**$ (2,327,362)**	**$ (2,277,409)**	**$ (2,229,284)**	**$ (2,182,942)**
2,255,802	**$ 4,445,901**	**$ 6,572,211**	**$ 8,636,590**	**$ 10,640,840**	**$ 12,586,715**	**$ 14,475,914**	**$ 16,310,087**	**$ 18,090,839**
350,360	**$ 706,627**	**$ 1,068,957**	**$ 1,437,508**	**$ 1,812,443**	**$ 2,193,930**	**$ 2,582,141**	**$ 2,977,251**	**$ 3,379,442**
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(2,606,162)	**$ (5,152,529)**	**$ (7,641,168)**	**$ (10,074,098)**	**$ (12,453,284)**	**$ (14,780,646)**	**$ (17,058,055)**	**$ (19,287,339)**	**$ (21,470,280)**
40,459,034								
29,949,784								
-								
(70,408,818)								

ıfront Project Cost	
ıpital Costs/Power	$ -
ıpital Costs/Water	$ 30,259,178
ΞTC	$ -
'O Grant	$ -
ljusted Capital Costs	$ 30,259,178

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2023	2024	2025	2026	2027	2028	2029	2030	2031
2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802	$ 2,255,802
173,029	$ 178,220	$ 183,567	$ 189,074	$ 194,746	$ 200,588	$ 206,606	$ 212,804	$ 219,188
3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525
0.1360	0.1437	0.1519	0.1606	0.1697	0.1794	0.1896	0.2004	0.2119
414,669	$ 438,305	$ 463,288	$ 489,696	$ 517,609	$ 547,112	$ 578,298	$ 611,261	$ 646,102
2,843,500	**$ 2,872,327**	**$ 2,902,657**	**$ 2,934,572**	**$ 2,968,157**	**$ 3,003,503**	**$ 3,040,706**	**$ 3,079,867**	**$ 3,121,093**
0.081	0.081	0.085	0.090	0.095	0.101	0.106	0.112	0.119
0.018	0.019	0.021	0.022	0.023	0.024	0.026	0.027	0.029
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(2,843,500)	$ (2,872,327)	$ (2,902,657)	$ (2,934,572)	$ (2,968,157)	$ (3,003,503)	$ (3,040,706)	$ (3,079,867)	$ (3,121,093)
0.72242	0.70138	0.68095	0.66112	0.64186	0.62317	0.60502	0.58739	0.57029
1,629,639	$ 1,582,174	$ 1,536,091	$ 1,491,351	$ 1,447,914	$ 1,405,741	$ 1,364,797	$ 1,325,046	$ 1,286,452
424,566	$ 432,418	$ 440,477	$ 448,747	$ 457,233	$ 465,942	$ 474,880	$ 484,051	$ 493,463
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(2,054,205)	$ (2,014,593)	$ (1,976,568)	$ (1,940,098)	$ (1,905,147)	$ (1,871,684)	$ (1,839,677)	$ (1,809,097)	$ (1,779,916)
23,127,891	$ 24,710,065	$ 26,246,157	$ 27,737,508	$ 29,185,421	$ 30,591,162	$ 31,955,960	$ 33,281,006	$ 34,567,458
4,630,378	$ 5,062,796	$ 5,503,273	$ 5,952,020	$ 6,409,253	$ 6,875,195	$ 7,350,075	$ 7,834,126	$ 8,327,589
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(27,758,269)	$ (29,772,862)	$ (31,749,430)	$ (33,689,528)	$ (35,594,674)	$ (37,466,358)	$ (39,306,035)	$ (41,115,132)	$ (42,895,048)

ɔfront Project Cost	
ɪpital Costs/Power	$ -
ɪpital Costs/Water	$ 30,259,178
ΞTC	$ -
'O Grant	$ -
ljusted Capital Costs	$ 30,259,178

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2034	2035	2036	2037	2038	2039	2040	2041	2042
2,255,802	$ 2,255,802	$ 2,255,802	$ -	$ -	$ -	$ -	$ -	$ -
239,513	$ 246,698	$ 254,099	$ 261,722	$ 269,574	$ 277,661	$ 285,991	$ 294,571	$ 303,408
3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525
0.2502	0.2645	0.2795	0.2955	0.3123	0.3301	0.3489	0.3688	0.3898
763,003	$ 806,494	$ 852,465	$ 901,055	$ 952,415	$ 1,006,703	$ 1,064,085	$ 1,124,738	$ 1,188,848
3,258,318	**$ 3,308,995**	**$ 3,362,366**	**$ 1,162,777**	**$ 1,221,989**	**$ 1,284,364**	**$ 1,350,076**	**$ 1,419,308**	**$ 1,492,256**
0.140	0.148	0.157	0.166	0.175	0.185	0.196	0.207	0.219
0.034	0.036	0.038	0.040	0.042	0.045	0.047	0.050	0.053
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(3,258,318)	**$ (3,308,995)**	**$ (3,362,366)**	**$ (1,162,777)**	**$ (1,221,989)**	**$ (1,284,364)**	**$ (1,350,076)**	**$ (1,419,308)**	**$ (1,492,256)**
0.52189	**0.50669**	**0.49193**	**0.47761**	**0.46369**	**0.45019**	**0.43708**	**0.42435**	**0.41199**
1,177,286	**$ 1,142,996**	**$ 1,109,705**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
523,206	**$ 533,644**	**$ 544,356**	**$ 555,349**	**$ 566,630**	**$ 578,207**	**$ 590,087**	**$ 602,278**	**$ 614,790**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(1,700,492)	**$ (1,676,640)**	**$ (1,654,061)**	**$ (555,349)**	**$ (566,630)**	**$ (578,207)**	**$ (590,087)**	**$ (602,278)**	**$ (614,790)**
38,206,332	**$ 39,349,328**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**
9,866,951	**$ 10,400,595**	**$ 10,944,951**	**$ 11,500,300**	**$ 12,066,930**	**$ 12,645,136**	**$ 13,235,223**	**$ 13,837,502**	**$ 14,452,291**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(48,073,283)	**$ (49,749,923)**	**$ (51,403,985)**	**$ (51,959,334)**	**$ (52,525,963)**	**$ (53,104,170)**	**$ (53,694,257)**	**$ (54,296,535)**	**$ (54,911,325)**

ɔfront Project Cost	
ıpital Costs/Power	$ -
ıpital Costs/Water	$ 30,259,178
ΞTC	$ -
ˈO Grant	$ -
ljusted Capital Costs	$ 30,259,178

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2045	2046	2047	2048	2049	2050	2051	2052	2053
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
331,542	$ 341,488	$ 351,733	$ 362,285	$ 373,153	$ 384,348	$ 395,878	$ 407,755	$ 419,987
3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525
0.4604	0.4866	0.5144	0.5437	0.5747	0.6074	0.6421	0.6786	0.7173
1,403,949	$ 1,483,974	$ 1,568,560	$ 1,657,968	$ 1,752,472	$ 1,852,363	$ 1,957,948	$ 2,069,551	$ 2,187,515
1,735,491	**$ 1,825,462**	**$ 1,920,293**	**$ 2,020,253**	**$ 2,125,626**	**$ 2,236,711**	**$ 2,353,826**	**$ 2,477,306**	**$ 2,607,503**
0.258	0.273	0.288	0.305	0.322	0.341	0.360	0.381	0.402
0.062	0.066	0.070	0.074	0.078	0.082	0.087	0.092	0.097
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(1,735,491)	**$ (1,825,462)**	**$ (1,920,293)**	**$ (2,020,253)**	**$ (2,125,626)**	**$ (2,236,711)**	**$ (2,353,826)**	**$ (2,477,306)**	**$ (2,607,503)**
0.37703	**0.36604**	**0.35538**	**0.34503**	**0.33498**	**0.32523**	**0.31575**	**0.30656**	**0.29763**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
654,325	**$ 668,201**	**$ 682,440**	**$ 697,053**	**$ 712,048**	**$ 727,437**	**$ 743,229**	**$ 759,435**	**$ 776,066**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(654,325)	**$ (668,201)**	**$ (682,440)**	**$ (697,053)**	**$ (712,048)**	**$ (727,437)**	**$ (743,229)**	**$ (759,435)**	**$ (776,066)**
40,459,034	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**
16,375,050	**$ 17,043,251**	**$ 17,725,691**	**$ 18,422,744**	**$ 19,134,792**	**$ 19,862,229**	**$ 20,605,458**	**$ 21,364,893**	**$ 22,140,959**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(56,834,083)	**$ (57,502,284)**	**$ (58,184,725)**	**$ (58,881,777)**	**$ (59,593,826)**	**$ (60,321,263)**	**$ (61,064,492)**	**$ (61,823,927)**	**$ (62,599,992)**

ɔfront Project Cost	
ıpital Costs/Power	$ -
ıpital Costs/Water	$ 30,259,178
ΞTC	$ -
ΓO Grant	$ -
ljusted Capital Costs	$ 30,259,178

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2056	2057	2058	2059	2060	2061	2062
-	$ -	$ -	$ -	$ -	$ -	$ -
458,932	$ 472,699	$ 486,880	$ 501,487	$ 516,531	$ 532,027	$ 547,988
3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525	3,049,525
0.8471	0.8954	0.9464	1.0004	1.0574	1.1177	1.1814
2,583,307	$ 2,730,556	$ 2,886,198	$ 3,050,711	$ 3,224,601	$ 3,408,404	$ 3,602,683
3,042,239	**$ 3,203,255**	**$ 3,373,078**	**$ 3,552,198**	**$ 3,741,133**	**$ 3,940,431**	**$ 4,150,671**
0.475	0.502	0.531	0.561	0.593	0.627	0.662
0.115	0.121	0.128	0.135	0.143	0.151	0.160
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(3,042,239)	**$ (3,203,255)**	**$ (3,373,078)**	**$ (3,552,198)**	**$ (3,741,133)**	**$ (3,940,431)**	**$ (4,150,671)**
0.27237	**0.26444**	**0.25674**	**0.24926**	**0.24200**	**0.23495**	**0.22811**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
828,620	**$ 847,064**	**$ 865,992**	**$ 885,416**	**$ 905,350**	**$ 925,805**	**$ 946,797**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(828,620)	**$ (847,064)**	**$ (865,992)**	**$ (885,416)**	**$ (905,350)**	**$ (925,805)**	**$ (946,797)**
40,459,034	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**	**$ 40,459,034**
24,573,358	**$ 25,420,423**	**$ 26,286,415**	**$ 27,171,831**	**$ 28,077,181**	**$ 29,002,986**	**$ 29,949,784**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(65,032,392)	**$ (65,879,456)**	**$ (66,745,449)**	**$ (67,630,865)**	**$ (68,536,215)**	**$ (69,462,020)**	**$ (70,408,818)**

ɔfront Project Cost	
ɑpital Costs/Power	$ -
ɑpital Costs/Water	$ 40,012,347
ΞTC	$ -
ΓO Grant	$ -
ɗjusted Capital Costs	$ 40,012,347

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2012	2013	2014	2015	2016	2017	2018	2019	2020
2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895
125,000	$ 128,750	$ 132,613	$ 136,591	$ 140,689	$ 144,909	$ 149,257	$ 153,734	$ 158,346
4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818
0.0739	0.0781	0.0826	0.0873	0.0922	0.0975	0.1031	0.1089	0.1151
328,103	$ 346,804	$ 366,572	$ 387,467	$ 409,552	$ 432,897	$ 457,572	$ 483,654	$ 511,222
3,435,997	**$ 3,458,449**	**$ 3,482,079**	**$ 3,506,952**	**$ 3,533,136**	**$ 3,560,701**	**$ 3,589,723**	**$ 3,620,283**	**$ 3,652,463**
0.069	0.069	0.071	0.074	0.077	0.078	0.080	0.071	0.081
0.010	0.011	0.011	0.012	0.012	0.013	0.014	0.015	0.016
0.020	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(3,435,997)	**$ (3,458,449)**	**$ (3,482,079)**	**$ (3,506,952)**	**$ (3,533,136)**	**$ (3,560,701)**	**$ (3,589,723)**	**$ (3,620,283)**	**$ (3,652,463)**
1	**0.97087**	**0.94260**	**0.91514**	**0.88849**	**0.86261**	**0.83748**	**0.81309**	**0.78941**
2,982,895	**$ 2,896,014**	**$ 2,811,664**	**$ 2,729,771**	**$ 2,650,263**	**$ 2,573,071**	**$ 2,498,127**	**$ 2,425,366**	**$ 2,354,725**
453,103	**$ 461,703**	**$ 470,529**	**$ 479,587**	**$ 488,882**	**$ 498,421**	**$ 508,209**	**$ 518,255**	**$ 528,563**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(3,435,997)	**$ (3,357,717)**	**$ (3,282,194)**	**$ (3,209,358)**	**$ (3,139,145)**	**$ (3,071,492)**	**$ (3,006,337)**	**$ (2,943,621)**	**$ (2,883,288)**
2,982,895	**$ 5,878,909**	**$ 8,690,573**	**$ 11,420,344**	**$ 14,070,607**	**$ 16,643,678**	**$ 19,141,806**	**$ 21,567,172**	**$ 23,921,897**
453,103	**$ 914,806**	**$ 1,385,335**	**$ 1,864,922**	**$ 2,353,804**	**$ 2,852,225**	**$ 3,360,435**	**$ 3,878,689**	**$ 4,407,253**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(3,435,997)	**$ (6,793,715)**	**$ (10,075,908)**	**$ (13,285,267)**	**$ (16,424,412)**	**$ (19,495,904)**	**$ (22,502,240)**	**$ (25,445,861)**	**$ (28,329,149)**
53,499,832								
40,697,640								
-								
(94,197,472)								

ɔfront Project Cost	
ɪpital Costs/Power	$ -
ɪpital Costs/Water	$ 40,012,347
ΞTC	$ -
ΊO Grant	$ -
ɟjusted Capital Costs	$ 40,012,347

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2023	2024	2025	2026	2027	2028	2029	2030	2031
2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895	$ 2,982,895
173,029	$ 178,220	$ 183,567	$ 189,074	$ 194,746	$ 200,588	$ 206,606	$ 212,804	$ 219,188
4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818
0.1360	0.1437	0.1519	0.1606	0.1697	0.1794	0.1896	0.2004	0.2119
603,718	$ 638,130	$ 674,504	$ 712,951	$ 753,589	$ 796,543	$ 841,946	$ 889,937	$ 940,664
3,759,642	**$ 3,799,245**	**$ 3,840,965**	**$ 3,884,919**	**$ 3,931,229**	**$ 3,980,026**	**$ 4,031,447**	**$ 4,085,636**	**$ 4,142,747**
0.081	0.081	0.085	0.090	0.095	0.101	0.106	0.112	0.119
0.018	0.019	0.021	0.022	0.023	0.024	0.026	0.027	0.029
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(3,759,642)	**$ (3,799,245)**	**$ (3,840,965)**	**$ (3,884,919)**	**$ (3,931,229)**	**$ (3,980,026)**	**$ (4,031,447)**	**$ (4,085,636)**	**$ (4,142,747)**
0.72242	**0.70138**	**0.68095**	**0.66112**	**0.64186**	**0.62317**	**0.60502**	**0.58739**	**0.57029**
2,154,907	**$ 2,092,142**	**$ 2,031,206**	**$ 1,972,045**	**$ 1,914,607**	**$ 1,858,841**	**$ 1,804,700**	**$ 1,752,136**	**$ 1,701,103**
561,139	**$ 572,572**	**$ 584,304**	**$ 596,344**	**$ 608,700**	**$ 621,379**	**$ 634,391**	**$ 647,744**	**$ 661,447**
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(2,716,046)	**$ (2,664,714)**	**$ (2,615,510)**	**$ (2,568,389)**	**$ (2,523,306)**	**$ (2,480,221)**	**$ (2,439,092)**	**$ (2,399,881)**	**$ (2,362,550)**
30,582,497	**$ 32,674,639**	**$ 34,705,845**	**$ 36,677,890**	**$ 38,592,497**	**$ 40,451,338**	**$ 42,256,038**	**$ 44,008,175**	**$ 45,709,278**
6,057,532	**$ 6,630,104**	**$ 7,214,408**	**$ 7,810,753**	**$ 8,419,453**	**$ 9,040,832**	**$ 9,675,224**	**$ 10,322,968**	**$ 10,984,415**
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(36,640,029)	**$ (39,304,744)**	**$ (41,920,254)**	**$ (44,488,643)**	**$ (47,011,949)**	**$ (49,492,170)**	**$ (51,931,262)**	**$ (54,331,142)**	**$ (56,693,693)**

ɔfront Project Cost	
ıpital Costs/Power	$ -
ıpital Costs/Water	$ 40,012,347
ΞTC	$ -
ΓO Grant	$ -
ɟjusted Capital Costs	$ 40,012,347

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2034	2035	2036	2037	2038	2039	2040	2041	2042
2,982,895	$ 2,982,895	$ 2,982,895	$ -	$ -	$ -	$ -	$ -	$ -
239,513	$ 246,698	$ 254,099	$ 261,722	$ 269,574	$ 277,661	$ 285,991	$ 294,571	$ 303,408
4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818
0.2502	0.2645	0.2795	0.2955	0.3123	0.3301	0.3489	0.3688	0.3898
1,110,860	$ 1,174,179	$ 1,241,107	$ 1,311,850	$ 1,386,626	$ 1,465,663	$ 1,549,206	$ 1,637,511	$ 1,730,849
4,333,268	**$ 4,403,772**	**$ 4,478,101**	**$ 1,573,573**	**$ 1,656,200**	**$ 1,743,325**	**$ 1,835,197**	**$ 1,932,082**	**$ 2,034,257**
0.140	0.148	0.157	0.166	0.175	0.185	0.196	0.207	0.219
0.034	0.036	0.038	0.040	0.042	0.045	0.047	0.050	0.053
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(4,333,268)	$ (4,403,772)	$ (4,478,101)	$ (1,573,573)	$ (1,656,200)	$ (1,743,325)	$ (1,835,197)	$ (1,932,082)	$ (2,034,257)
0.52189	**0.50669**	**0.49193**	**0.47761**	**0.46369**	**0.45019**	**0.43708**	**0.42435**	**0.41199**
1,556,750	**$ 1,511,408**	**$ 1,467,386**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
704,750	**$ 719,947**	**$ 735,543**	**$ 751,547**	**$ 767,971**	**$ 784,826**	**$ 802,122**	**$ 819,872**	**$ 838,087**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(2,261,500)	**$ (2,231,355)**	**$ (2,202,929)**	**$ (751,547)**	**$ (767,971)**	**$ (784,826)**	**$ (802,122)**	**$ (819,872)**	**$ (838,087)**
50,521,037	**$ 52,032,445**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**
13,054,615	**$ 13,774,561**	**$ 14,510,104**	**$ 15,261,651**	**$ 16,029,622**	**$ 16,814,448**	**$ 17,616,570**	**$ 18,436,442**	**$ 19,274,529**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(63,575,652)	**$ (65,807,007)**	**$ (68,009,936)**	**$ (68,761,483)**	**$ (69,529,454)**	**$ (70,314,279)**	**$ (71,116,402)**	**$ (71,936,273)**	**$ (72,774,360)**

ɔfront Project Cost	
ıpital Costs/Power	$ -
ıpital Costs/Water	$ 40,012,347
ΞTC	$ -
ΓO Grant	$ -
ıjusted Capital Costs	$ 40,012,347

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2045	2046	2047	2048	2049	2050	2051	2052	2053
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
331,542	$ 341,488	$ 351,733	$ 362,285	$ 373,153	$ 384,348	$ 395,878	$ 407,755	$ 419,987
4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818
0.4604	0.4866	0.5144	0.5437	0.5747	0.6074	0.6421	0.6786	0.7173
2,044,016	$ 2,160,524	$ 2,283,674	$ 2,413,844	$ 2,551,433	$ 2,696,864	$ 2,850,586	$ 3,013,069	$ 3,184,814
2,375,557	**$ 2,502,013**	**$ 2,635,407**	**$ 2,776,129**	**$ 2,924,586**	**$ 3,081,212**	**$ 3,246,464**	**$ 3,420,824**	**$ 3,604,801**
0.258	0.273	0.288	0.305	0.322	0.341	0.360	0.381	0.402
0.062	0.066	0.070	0.074	0.078	0.082	0.087	0.092	0.097
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(2,375,557)	$ (2,502,013)	$ (2,635,407)	$ (2,776,129)	$ (2,924,586)	$ (3,081,212)	$ (3,246,464)	$ (3,420,824)	$ (3,604,801)
0.37703	0.36604	0.35538	0.34503	0.33498	0.32523	0.31575	0.30656	0.29763
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
895,647	$ 915,849	$ 936,580	$ 957,854	$ 979,686	$ 1,002,091	$ 1,025,083	$ 1,048,677	$ 1,072,890
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(895,647)	$ (915,849)	$ (936,580)	$ (957,854)	$ (979,686)	$ (1,002,091)	$ (1,025,083)	$ (1,048,677)	$ (1,072,890)
53,499,832	$ 53,499,832	$ 53,499,832	$ 53,499,832	$ 53,499,832	$ 53,499,832	$ 53,499,832	$ 53,499,832	$ 53,499,832
21,902,918	$ 22,818,767	$ 23,755,347	$ 24,713,201	$ 25,692,887	$ 26,694,978	$ 27,720,061	$ 28,768,738	$ 29,841,628
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
(75,402,749)	$ (76,318,598)	$ (77,255,178)	$ (78,213,033)	$ (79,192,719)	$ (80,194,810)	$ (81,219,893)	$ (82,268,569)	$ (83,341,459)

ɔfront Project Cost	
ıpital Costs/Power	$ -
ıpital Costs/Water	$ 40,012,347
ĒTC	$ -
ΓO Grant	$ -
ɟjusted Capital Costs	$ 40,012,347

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2056	2057	2058	2059	2060	2061	2062
-	$ -	$ -	$ -	$ -	$ -	$ -
458,932	$ 472,699	$ 486,880	$ 501,487	$ 516,531	$ 532,027	$ 547,988
4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818	4,439,818
0.8471	0.8954	0.9464	1.0004	1.0574	1.1177	1.1814
3,761,049	$ 3,975,429	$ 4,202,029	$ 4,441,544	$ 4,694,712	$ 4,962,311	$ 5,245,163
4,219,981	**$ 4,448,129**	**$ 4,688,909**	**$ 4,943,031**	**$ 5,211,244**	**$ 5,494,338**	**$ 5,793,151**
0.475	0.502	0.531	0.561	0.593	0.627	0.662
0.115	0.121	0.128	0.135	0.143	0.151	0.160
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(4,219,981)	**$ (4,448,129)**	**$ (4,688,909)**	**$ (4,943,031)**	**$ (5,211,244)**	**$ (5,494,338)**	**$ (5,793,151)**
0.27237	**0.26444**	**0.25674**	**0.24926**	**0.24200**	**0.23495**	**0.22811**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
1,149,404	**$ 1,176,257**	**$ 1,203,814**	**$ 1,232,094**	**$ 1,261,115**	**$ 1,290,896**	**$ 1,321,459**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(1,149,404)	**$ (1,176,257)**	**$ (1,203,814)**	**$ (1,232,094)**	**$ (1,261,115)**	**$ (1,290,896)**	**$ (1,321,459)**
53,499,832	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**	**$ 53,499,832**
33,212,005	**$ 34,388,262**	**$ 35,592,076**	**$ 36,824,170**	**$ 38,085,285**	**$ 39,376,182**	**$ 40,697,640**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(86,711,837)	**$ (87,888,094)**	**$ (89,091,908)**	**$ (90,324,002)**	**$ (91,585,117)**	**$ (92,876,013)**	**$ (94,197,472)**

ıt Project Cost	
l Costs/Power	$ -
l Costs/Water	$ 21,225,000
	$ -
irant	$ -
ted Capital Costs	$ 21,225,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2012	2013	2014	2015	2016	2017	2018	2019	2020	
1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$
112,000	$ 115,360	$ 118,821	$ 122,385	$ 126,057	$ 129,839	$ 133,734	$ 137,746	$ 141,878	$
980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6
.0739	0.0781	0.0826	0.0873	0.0922	0.0975	0.1031	0.1089	0.1151	
515,870	$ 545,275	$ 576,356	$ 609,208	$ 643,933	$ 680,637	$ 719,433	$ 760,441	$ 803,786	$
2,210,180	**$ 2,242,945**	**$ 2,277,487**	**$ 2,313,903**	**$ 2,352,300**	**$ 2,392,786**	**$ 2,435,477**	**$ 2,480,497**	**$ 2,527,974**	**$**
0.069	0.069	0.071	0.074	0.077	0.078	0.080	0.071	0.081	
0.010	0.011	0.011	0.012	0.012	0.013	0.014	0.015	0.016	
0.020	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(2,210,180)	**$ (2,242,945)**	**$ (2,277,487)**	**$ (2,313,903)**	**$ (2,352,300)**	**$ (2,392,786)**	**$ (2,435,477)**	**$ (2,480,497)**	**$ (2,527,974)**	**$**
1	**0.97087**	**0.94260**	**0.91514**	**0.88849**	**0.86261**	**0.83748**	**0.81309**	**0.78941**	
1,582,310	**$ 1,536,223**	**$ 1,491,479**	**$ 1,448,038**	**$ 1,405,862**	**$ 1,364,915**	**$ 1,325,160**	**$ 1,286,563**	**$ 1,249,090**	**$**
627,870	**$ 641,393**	**$ 655,271**	**$ 669,512**	**$ 684,126**	**$ 699,123**	**$ 714,514**	**$ 730,308**	**$ 746,516**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(2,210,180)	**$ (2,177,617)**	**$ (2,146,749)**	**$ (2,117,549)**	**$ (2,089,988)**	**$ (2,064,038)**	**$ (2,039,674)**	**$ (2,016,871)**	**$ (1,995,606)**	**$**
1,582,310	**$ 3,118,533**	**$ 4,610,012**	**$ 6,058,050**	**$ 7,463,912**	**$ 8,828,827**	**$ 10,153,986**	**$ 11,440,549**	**$ 12,689,639**	**$**
627,870	**$ 1,269,264**	**$ 1,924,534**	**$ 2,594,046**	**$ 3,278,172**	**$ 3,977,295**	**$ 4,691,809**	**$ 5,422,118**	**$ 6,168,634**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(2,210,180)	**$ (4,387,797)**	**$ (6,534,547)**	**$ (8,652,096)**	**$ (10,742,084)**	**$ (12,806,122)**	**$ (14,845,796)**	**$ (16,862,667)**	**$ (18,858,273)**	**$**
28,379,588									
59,676,943									
-									
88,056,531)									

nt Project Cost	
l Costs/Power	$ -
l Costs/Water	$ 21,225,000
	$ -
irant	$ -
ted Capital Costs	$ 21,225,000

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2023	2024	2025	2026	2027	2028	2029	2030	2031	
1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$ 1,582,310	$
155,034	$ 159,685	$ 164,476	$ 169,410	$ 174,492	$ 179,727	$ 185,119	$ 190,673	$ 196,393	$
980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6
.1360	0.1437	0.1519	0.1606	0.1697	0.1794	0.1896	0.2004	0.2119	
949,217	$ 1,003,322	$ 1,060,512	$ 1,120,961	$ 1,184,856	$ 1,252,392	$ 1,323,779	$ 1,399,234	$ 1,478,991	$
2,686,561	**$ 2,745,318**	**$ 2,807,298**	**$ 2,872,681**	**$ 2,941,658**	**$ 3,014,430**	**$ 3,091,208**	**$ 3,172,217**	**$ 3,257,693**	**$**
0.081	0.081	0.085	0.090	0.095	0.101	0.106	0.112	0.119	
0.018	0.019	0.021	0.022	0.023	0.024	0.026	0.027	0.029	
-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(2,686,561)	**$ (2,745,318)**	**$ (2,807,298)**	**$ (2,872,681)**	**$ (2,941,658)**	**$ (3,014,430)**	**$ (3,091,208)**	**$ (3,172,217)**	**$ (3,257,693)**	**$**
.72242	**0.70138**	**0.68095**	**0.66112**	**0.64186**	**0.62317**	**0.60502**	**0.58739**	**0.57029**	
1,143,094	**$ 1,109,800**	**$ 1,077,476**	**$ 1,046,093**	**$ 1,015,625**	**$ 986,043**	**$ 957,324**	**$ 929,440**	**$ 902,369**	**$**
797,735	**$ 815,710**	**$ 834,157**	**$ 853,087**	**$ 872,514**	**$ 892,450**	**$ 912,908**	**$ 933,903**	**$ 955,448**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(1,940,829)	**$ (1,925,511)**	**$ (1,911,633)**	**$ (1,899,181)**	**$ (1,888,138)**	**$ (1,878,493)**	**$ (1,870,232)**	**$ (1,863,343)**	**$ (1,857,817)**	**$**
16,222,830	**$ 17,332,630**	**$ 18,410,106**	**$ 19,456,200**	**$ 20,471,824**	**$ 21,457,868**	**$ 22,415,191**	**$ 23,344,632**	**$ 24,247,001**	**$**
8,509,736	**$ 9,325,446**	**$ 10,159,603**	**$ 11,012,690**	**$ 11,885,204**	**$ 12,777,653**	**$ 13,690,561**	**$ 14,624,464**	**$ 15,579,911**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
24,732,566)	**$ (26,658,076)**	**$ (28,569,709)**	**$ (30,468,890)**	**$ (32,357,028)**	**$ (34,235,521)**	**$ (36,105,752)**	**$ (37,969,095)**	**$ (39,826,912)**	**$**

ıt Project Cost	
ıl Costs/Power	$ -
ıl Costs/Water	$ 21,225,000
	$ -
;rant	$ -
ted Capital Costs	$ 21,225,000

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2034	2035	2036	2037	2038	2039	2040	2041	2042	
1,582,310	$ 1,582,310	$ 1,582,310	$ -	$ -	$ -	$ -	$ -	$ -	$
214,604	$ 221,042	$ 227,673	$ 234,503	$ 241,538	$ 248,784	$ 256,248	$ 263,935	$ 271,853	$
980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6
).2502	0.2645	0.2795	0.2955	0.3123	0.3301	0.3489	0.3688	0.3898	
1,746,588	$ 1,846,143	$ 1,951,373	$ 2,062,601	$ 2,180,170	$ 2,304,439	$ 2,435,792	$ 2,574,633	$ 2,721,387	$
3,543,501	**$ 3,649,495**	**$ 3,761,356**	**$ 2,297,105**	**$ 2,421,708**	**$ 2,553,224**	**$ 2,692,040**	**$ 2,838,568**	**$ 2,993,240**	**$**
0.140	0.148	0.157	0.166	0.175	0.185	0.196	0.207	0.219	
0.034	0.036	0.038	0.040	0.042	0.045	0.047	0.050	0.053	
-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(3,543,501)	**$ (3,649,495)**	**$ (3,761,356)**	**$ (2,297,105)**	**$ (2,421,708)**	**$ (2,553,224)**	**$ (2,692,040)**	**$ (2,838,568)**	**$ (2,993,240)**	**$**
.52189	**0.50669**	**0.49193**	**0.47761**	**0.46369**	**0.45019**	**0.43708**	**0.42435**	**0.41199**	
825,796	**$ 801,743**	**$ 778,392**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
1,023,531	**$ 1,047,425**	**$ 1,071,946**	**$ 1,097,110**	**$ 1,122,933**	**$ 1,149,433**	**$ 1,176,628**	**$ 1,204,536**	**$ 1,233,175**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(1,849,327)	**$ (1,849,169)**	**$ (1,850,338)**	**$ (1,097,110)**	**$ (1,122,933)**	**$ (1,149,433)**	**$ (1,176,628)**	**$ (1,204,536)**	**$ (1,233,175)**	**$**
26,799,453	**$ 27,601,196**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$**
18,581,247	**$ 19,628,672**	**$ 20,700,618**	**$ 21,797,728**	**$ 22,920,661**	**$ 24,070,095**	**$ 25,246,723**	**$ 26,451,259**	**$ 27,684,434**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
45,380,699)	**$ (47,229,868)**	**$ (49,080,206)**	**$ (50,177,316)**	**$ (51,300,249)**	**$ (52,449,683)**	**$ (53,626,311)**	**$ (54,830,847)**	**$ (56,064,022)**	**$**

nt Project Cost	
l Costs/Power	$ -
l Costs/Water	$ 21,225,000
	$ -
irant	$ -
ted Capital Costs	$ 21,225,000

Financial Parameters

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2045	2046	2047	2048	2049	2050	2051	2052	2053	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
297,062	$ 305,973	$ 315,153	$ 324,607	$ 334,345	$ 344,376	$ 354,707	$ 365,348	$ 376,309	$
980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6
.4604	0.4866	0.5144	0.5437	0.5747	0.6074	0.6421	0.6786	0.7173	
3,213,773	$ 3,396,958	$ 3,590,585	$ 3,795,248	$ 4,011,577	$ 4,240,237	$ 4,481,931	$ 4,737,401	$ 5,007,433	$
3,510,835	**$ 3,702,932**	**$ 3,905,737**	**$ 4,119,855**	**$ 4,345,923**	**$ 4,584,613**	**$ 4,836,638**	**$ 5,102,749**	**$ 5,383,741**	**$**
0.258	0.273	0.288	0.305	0.322	0.341	0.360	0.381	0.402	
0.062	0.066	0.070	0.074	0.078	0.082	0.087	0.092	0.097	
-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(3,510,835)	**$ (3,702,932)**	**$ (3,905,737)**	**$ (4,119,855)**	**$ (4,345,923)**	**$ (4,584,613)**	**$ (4,836,638)**	**$ (5,102,749)**	**$ (5,383,741)**	**$**
.37703	**0.36604**	**0.35538**	**0.34503**	**0.33498**	**0.32523**	**0.31575**	**0.30656**	**0.29763**	
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
1,323,677	**$ 1,355,439**	**$ 1,388,034**	**$ 1,421,484**	**$ 1,455,810**	**$ 1,491,036**	**$ 1,527,186**	**$ 1,564,283**	**$ 1,602,352**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(1,323,677)	**$ (1,355,439)**	**$ (1,388,034)**	**$ (1,421,484)**	**$ (1,455,810)**	**$ (1,491,036)**	**$ (1,527,186)**	**$ (1,564,283)**	**$ (1,602,352)**	**$**
28,379,588	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$**
31,563,402	**$ 32,918,842**	**$ 34,306,876**	**$ 35,728,359**	**$ 37,184,169**	**$ 38,675,205**	**$ 40,202,391**	**$ 41,766,674**	**$ 43,369,026**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
59,942,990)	**$ (61,298,429)**	**$ (62,686,464)**	**$ (64,107,947)**	**$ (65,563,757)**	**$ (67,054,793)**	**$ (68,581,979)**	**$ (70,146,262)**	**$ (71,748,614)**	**$**

ıt Project Cost

ıl Costs/Power	$ -
ıl Costs/Water	$ 21,225,000
	$ -
ırant	$ -
ıted Capital Costs	$ 21,225,000

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of Power Beyond 2024	5.70%

2056	2057	2058	2059	2060	2061	2062
-	$ -	$ -	$ -	$ -	$ -	$ -
411,203	$ 423,539	$ 436,245	$ 449,332	$ 462,812	$ 476,697	$ 490,997
ı80,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655	6,980,655
ı.8471	0.8954	0.9464	1.0004	1.0574	1.1177	1.1814
5,913,438	$ 6,250,504	$ 6,606,783	$ 6,983,370	$ 7,381,422	$ 7,802,163	$ 8,246,886
6,324,641	**$ 6,674,043**	**$ 7,043,028**	**$ 7,432,702**	**$ 7,844,234**	**$ 8,278,859**	**$ 8,737,884**
0.475	0.502	0.531	0.561	0.593	0.627	0.662
0.115	0.121	0.128	0.135	0.143	0.151	0.160
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(6,324,641)	**$ (6,674,043)**	**$ (7,043,028)**	**$ (7,432,702)**	**$ (7,844,234)**	**$ (8,278,859)**	**$ (8,737,884)**
.27237	**0.26444**	**0.25674**	**0.24926**	**0.24200**	**0.23495**	**0.22811**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
1,722,654	**$ 1,764,875**	**$ 1,808,203**	**$ 1,852,666**	**$ 1,898,295**	**$ 1,945,120**	**$ 1,993,173**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(1,722,654)	**$ (1,764,875)**	**$ (1,808,203)**	**$ (1,852,666)**	**$ (1,898,295)**	**$ (1,945,120)**	**$ (1,993,173)**
28,379,588	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**	**$ 28,379,588**
48,414,610	**$ 50,179,485**	**$ 51,987,688**	**$ 53,840,354**	**$ 55,738,649**	**$ 57,683,770**	**$ 59,676,943**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
76,794,198)	**$ (78,559,073)**	**$ (80,367,276)**	**$ (82,219,942)**	**$ (84,118,237)**	**$ (86,063,358)**	**$ (88,056,531)**

ɔnt Project Cost	
tal Costs/Power	$ -
tal Costs/Water	$ 44,267,169
;	$ -
Grant	$ -
sted Capital Costs	$ 44,267,169

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2012	2013	2014	2015	2016	2017	2018	2019	2020	
3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$
125,000	$ 128,750	$ 132,613	$ 136,591	$ 140,689	$ 144,909	$ 149,257	$ 153,734	$ 158,346	$
,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	
0.0739	0.0781	0.0826	0.0873	0.0922	0.0975	0.1031	0.1089	0.1151	
373,531	$ 394,822	$ 417,327	$ 441,115	$ 466,258	$ 492,835	$ 520,927	$ 550,620	$ 582,005	$
3,798,620	**$ 3,823,661**	**$ 3,850,029**	**$ 3,877,795**	**$ 3,907,036**	**$ 3,937,833**	**$ 3,970,272**	**$ 4,004,443**	**$ 4,040,440**	**$**
0.069	0.069	0.071	0.074	0.077	0.078	0.080	0.071	0.081	
0.010	0.011	0.011	0.012	0.012	0.013	0.014	0.015	0.016	
0.020	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(3,798,620)	**$ (3,823,661)**	**$ (3,850,029)**	**$ (3,877,795)**	**$ (3,907,036)**	**$ (3,937,833)**	**$ (3,970,272)**	**$ (4,004,443)**	**$ (4,040,440)**	**$**
1	**0.97087**	**0.94260**	**0.91514**	**0.88849**	**0.86261**	**0.83748**	**0.81309**	**0.78941**	
3,300,089	**$ 3,203,970**	**$ 3,110,650**	**$ 3,020,049**	**$ 2,932,086**	**$ 2,846,686**	**$ 2,763,772**	**$ 2,683,274**	**$ 2,605,121**	**$**
498,531	**$ 508,323**	**$ 518,371**	**$ 528,683**	**$ 539,265**	**$ 550,124**	**$ 561,268**	**$ 572,704**	**$ 584,440**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(3,798,620)	**$ (3,712,292)**	**$ (3,629,021)**	**$ (3,548,731)**	**$ (3,471,351)**	**$ (3,396,810)**	**$ (3,325,040)**	**$ (3,255,978)**	**$ (3,189,561)**	**$**
3,300,089	**$ 6,504,059**	**$ 9,614,709**	**$ 12,634,758**	**$ 15,566,844**	**$ 18,413,529**	**$ 21,177,302**	**$ 23,860,576**	**$ 26,465,697**	**$**
498,531	**$ 1,006,854**	**$ 1,525,225**	**$ 2,053,907**	**$ 2,593,172**	**$ 3,143,296**	**$ 3,704,564**	**$ 4,277,268**	**$ 4,861,708**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(3,798,620)	**$ (7,510,912)**	**$ (11,139,934)**	**$ (14,688,665)**	**$ (18,160,016)**	**$ (21,556,825)**	**$ (24,881,866)**	**$ (28,137,844)**	**$ (31,327,405)**	**$**
59,188,882									
45,449,897									
-									
(104,638,780)									

ont Project Cost	
tal Costs/Power	$ -
tal Costs/Water	$ 44,267,169
:	$ -
Grant	$ -
sted Capital Costs	$ 44,267,169

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2023	2024	2025	2026	2027	2028	2029	2030	2031	
3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$ 3,300,089	$
173,029	$ 178,220	$ 183,567	$ 189,074	$ 194,746	$ 200,588	$ 206,606	$ 212,804	$ 219,188	$
,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	
0.1360	0.1437	0.1519	0.1606	0.1697	0.1794	0.1896	0.2004	0.2119	
687,308	$ 726,485	$ 767,895	$ 811,665	$ 857,929	$ 906,831	$ 958,521	$ 1,013,157	$ 1,070,906	$
4,160,426	**$ 4,204,794**	**$ 4,251,550**	**$ 4,300,827**	**$ 4,352,764**	**$ 4,407,509**	**$ 4,465,216**	**$ 4,526,049**	**$ 4,590,184**	**$**
0.081	0.081	0.085	0.090	0.095	0.101	0.106	0.112	0.119	
0.018	0.019	0.021	0.022	0.023	0.024	0.026	0.027	0.029	
-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(4,160,426)	**$ (4,204,794)**	**$ (4,251,550)**	**$ (4,300,827)**	**$ (4,352,764)**	**$ (4,407,509)**	**$ (4,465,216)**	**$ (4,526,049)**	**$ (4,590,184)**	**$**
0.72242	**0.70138**	**0.68095**	**0.66112**	**0.64186**	**0.62317**	**0.60502**	**0.58739**	**0.57029**	
2,384,054	**$ 2,314,616**	**$ 2,247,200**	**$ 2,181,747**	**$ 2,118,201**	**$ 2,056,506**	**$ 1,996,608**	**$ 1,938,454**	**$ 1,881,995**	**$**
621,526	**$ 634,542**	**$ 647,899**	**$ 661,606**	**$ 675,672**	**$ 690,107**	**$ 704,921**	**$ 720,123**	**$ 735,723**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(3,005,581)	**$ (2,949,158)**	**$ (2,895,099)**	**$ (2,843,353)**	**$ (2,793,874)**	**$ (2,746,614)**	**$ (2,701,529)**	**$ (2,658,577)**	**$ (2,617,718)**	**$**
33,834,570	**$ 36,149,186**	**$ 38,396,386**	**$ 40,578,134**	**$ 42,696,335**	**$ 44,752,841**	**$ 46,749,449**	**$ 48,687,904**	**$ 50,569,898**	**$**
6,688,561	**$ 7,323,103**	**$ 7,971,002**	**$ 8,632,607**	**$ 9,308,280**	**$ 9,998,387**	**$ 10,703,308**	**$ 11,423,431**	**$ 12,159,154**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(40,523,131)	**$ (43,472,289)**	**$ (46,367,388)**	**$ (49,210,741)**	**$ (52,004,615)**	**$ (54,751,228)**	**$ (57,452,757)**	**$ (60,111,334)**	**$ (62,729,052)**	**$**

ont Project Cost	
tal Costs/Power	$ -
tal Costs/Water	$ 44,267,169
C	$ -
Grant	$ -
sted Capital Costs	$ 44,267,169

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2034	2035	2036	2037	2038	2039	2040	2041	2042	
3,300,089	$ 3,300,089	$ 3,300,089	$ -	$ -	$ -	$ -	$ -	$ -	$
239,513	$ 246,698	$ 254,099	$ 261,722	$ 269,574	$ 277,661	$ 285,991	$ 294,571	$ 303,408	$
,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	
0.2502	0.2645	0.2795	0.2955	0.3123	0.3301	0.3489	0.3688	0.3898	
1,264,668	$ 1,336,754	$ 1,412,949	$ 1,493,487	$ 1,578,616	$ 1,668,597	$ 1,763,707	$ 1,864,238	$ 1,970,500	$
4,804,270	**$ 4,883,541**	**$ 4,967,137**	**$ 1,755,209**	**$ 1,848,190**	**$ 1,946,258**	**$ 2,049,698**	**$ 2,158,809**	**$ 2,273,908**	**$**
0.140	0.148	0.157	0.166	0.175	0.185	0.196	0.207	0.219	
0.034	0.036	0.038	0.040	0.042	0.045	0.047	0.050	0.053	
-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(4,804,270)	**$ (4,883,541)**	**$ (4,967,137)**	**$ (1,755,209)**	**$ (1,848,190)**	**$ (1,946,258)**	**$ (2,049,698)**	**$ (2,158,809)**	**$ (2,273,908)**	**$**
0.52189	**0.50669**	**0.49193**	**0.47761**	**0.46369**	**0.45019**	**0.43708**	**0.42435**	**0.41199**	
1,722,292	**$ 1,672,128**	**$ 1,623,425**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
785,021	**$ 802,322**	**$ 820,077**	**$ 838,298**	**$ 856,996**	**$ 876,184**	**$ 895,875**	**$ 916,083**	**$ 936,820**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(2,507,312)	**$ (2,474,450)**	**$ (2,443,502)**	**$ (838,298)**	**$ (856,996)**	**$ (876,184)**	**$ (895,875)**	**$ (916,083)**	**$ (936,820)**	**$**
55,893,329	**$ 57,565,457**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$**
14,464,068	**$ 15,266,390**	**$ 16,086,467**	**$ 16,924,765**	**$ 17,781,761**	**$ 18,657,945**	**$ 19,553,820**	**$ 20,469,903**	**$ 21,406,722**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(70,357,397)	**$ (72,831,847)**	**$ (75,275,349)**	**$ (76,113,647)**	**$ (76,970,643)**	**$ (77,846,827)**	**$ (78,742,702)**	**$ (79,658,785)**	**$ (80,595,605)**	**$**

ɔnt Project Cost	
ıal Costs/Power	$ -
ıal Costs/Water	$ 44,267,169
;	$ -
Grant	$ -
sted Capital Costs	$ 44,267,169

Financial Parameters

Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2045	2046	2047	2048	2049	2050	2051	2052	2053	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
331,542	$ 341,488	$ 351,733	$ 362,285	$ 373,153	$ 384,348	$ 395,878	$ 407,755	$ 419,987	$
;,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	
0.4604	0.4866	0.5144	0.5437	0.5747	0.6074	0.6421	0.6786	0.7173	
2,327,027	$ 2,459,667	$ 2,599,868	$ 2,748,061	$ 2,904,700	$ 3,070,268	$ 3,245,273	$ 3,430,254	$ 3,625,778	$
2,658,568	**$ 2,801,155**	**$ 2,951,601**	**$ 3,110,345**	**$ 3,277,853**	**$ 3,454,616**	**$ 3,641,152**	**$ 3,838,009**	**$ 4,045,766**	**$**
0.258	0.273	0.288	0.305	0.322	0.341	0.360	0.381	0.402	
0.062	0.066	0.070	0.074	0.078	0.082	0.087	0.092	0.097	
-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(2,658,568)	**$ (2,801,155)**	**$ (2,951,601)**	**$ (3,110,345)**	**$ (3,277,853)**	**$ (3,454,616)**	**$ (3,641,152)**	**$ (3,838,009)**	**$ (4,045,766)**	**$**
0.37703	**0.36604**	**0.35538**	**0.34503**	**0.33498**	**0.32523**	**0.31575**	**0.30656**	**0.29763**	
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
1,002,350	**$ 1,025,349**	**$ 1,048,950**	**$ 1,073,170**	**$ 1,098,025**	**$ 1,123,531**	**$ 1,149,707**	**$ 1,176,568**	**$ 1,204,133**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(1,002,350)	**$ (1,025,349)**	**$ (1,048,950)**	**$ (1,073,170)**	**$ (1,098,025)**	**$ (1,123,531)**	**$ (1,149,707)**	**$ (1,176,568)**	**$ (1,204,133)**	**$**
59,188,882	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$**
24,347,112	**$ 25,372,461**	**$ 26,421,411**	**$ 27,494,581**	**$ 28,592,606**	**$ 29,716,137**	**$ 30,865,844**	**$ 32,042,411**	**$ 33,246,544**	**$**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$**
(83,535,994)	**$ (84,561,343)**	**$ (85,610,293)**	**$ (86,683,463)**	**$ (87,781,488)**	**$ (88,905,019)**	**$ (90,054,726)**	**$ (91,231,293)**	**$ (92,435,427)**	**$**

›nt Project Cost	
ɫal Costs/Power	$ -
ɫal Costs/Water	$ 44,267,169
;	$ -
Grant	$ -
ꞩted Capital Costs	$ 44,267,169

Financial Parameters	
Life of Bonds	25
Life of Project	50
Interest	5.50%
Inflation	3.00%
Green Tag, Cost and Value of	5.70%

2056	2057	2058	2059	2060	2061	2062
-	$ -	$ -	$ -	$ -	$ -	$ -
458,932	$ 472,699	$ 486,880	$ 501,487	$ 516,531	$ 532,027	$ 547,988
;,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548	5,054,548
0.8471	0.8954	0.9464	1.0004	1.0574	1.1177	1.1814
4,281,798	$ 4,525,861	$ 4,783,835	$ 5,056,513	$ 5,344,735	$ 5,649,385	$ 5,971,400
4,740,730	**$ 4,998,560**	**$ 5,270,715**	**$ 5,558,000**	**$ 5,861,266**	**$ 6,181,412**	**$ 6,519,388**
0.475	0.502	0.531	0.561	0.593	0.627	0.662
0.115	0.121	0.128	0.135	0.143	0.151	0.160
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	$ -	$ -	$ -	$ -	$ -	$ -
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(4,740,730)	**$ (4,998,560)**	**$ (5,270,715)**	**$ (5,558,000)**	**$ (5,861,266)**	**$ (6,181,412)**	**$ (6,519,388)**
0.27237	**0.26444**	**0.25674**	**0.24926**	**0.24200**	**0.23495**	**0.22811**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
1,291,241	**$ 1,321,812**	**$ 1,353,185**	**$ 1,385,380**	**$ 1,418,419**	**$ 1,452,325**	**$ 1,487,119**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(1,291,241)	**$ (1,321,812)**	**$ (1,353,185)**	**$ (1,385,380)**	**$ (1,418,419)**	**$ (1,452,325)**	**$ (1,487,119)**
59,188,882	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**	**$ 59,188,882**
37,031,657	**$ 38,353,470**	**$ 39,706,655**	**$ 41,092,035**	**$ 42,510,454**	**$ 43,962,779**	**$ 45,449,897**
-	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
(96,220,539)	**$ (97,542,352)**	**$ (98,895,537)**	**$ (100,280,917)**	**$ (101,699,337)**	**$ (103,151,661)**	**$ (104,638,780)**

CHAPTER 9
FINANCIAL ANALYSIS

Prepared for
City of Bend, Oregon
October 23, 2009
Revised November 11, 2009

Prepared by

Deb Galardi, Galardi Consulting, LLC.

BROWN AND CALDWELL

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CHAPTER 9

ALTERNATIVE OPTION SELECTION

9.0 Summary

This chapter summarizes the financial analysis that was conducted in conjunction with the City of Bend (City) Water Supply Alternative project. The scope of the financial analysis was to perform the following tasks:

1. Update the previous financial plan model developed by Galardi Consulting in 2008 to reflect current operating and capital budget data, as well as updated assumptions related to future cost and revenue projections (e.g., customer growth and consumption trends and cost escalation) as provided by City finance staff.
2. Evaluate potential financing options for capital improvements in conjunction with Brown and Caldwell (which provided information related to renewable energy construction incentive programs) and the City's finance staff and financial advisor (who provided information on current bond market conditions and existing bond covenants).
3. Determine rate impacts of different capital project alternatives using the updated financial plan model and the relevant package of construction and financing assumptions.
4. Develop documentation and presentation material, including a memorandum and matrix of construction/financing alternatives and corresponding rate impacts.

Over the course of the study, 22 primary scenarios were developed representing different options related to hydropower, treatment technology, timeline (2012 deadline versus 2014 treatment deadline), and penstock construction. Additional scenarios were developed to analyze the impact of alternative debt assumptions (e.g., subordination of debt) and modified operation and maintenance (O&M) and hydropower revenue assumptions. This chapter presents information on the baseline financial plan assumptions, as well as the specific assumptions and findings related to the four primary Bridge Creek alternatives presented to the City Council in August and September 2009.

9.1 Baseline financial Plan

The financial plan provides annual O&M and capital cost forecasts and projects revenue under existing rates and required annual system-wide revenue increases to meet established financial policies through the City's 5-year capital improvement plan (CIP) period (fiscal year [FY] 2009–10 through FY2013–14). The financial plan model—originally developed for the City in 2008—was updated with the following data:

- FY2009–10 and FY2010–11 adopted budget (O&M line item expenditures, revenues, and transfers)
- FY2009–10 through FY2013–14 CIP
- FY2009–10 through FY2013–14 system development charge (SDC) forecast

The forecast model was also extended through FY2019–20; however, because the City does not have annual projections of capital improvement needs beyond FY2013–14, the rate impact analysis focused on a 5-year window.

9.1.1 Forecast Assumptions

The financial plan relies on a number of assumptions related to future cost and revenue escalation and customer growth and consumption trends. The key assumptions used in the study include the following:

- Rate revenue:
  - FY2010 water consumption adjustment (-15 percent summer; -9 percent annual)
  - Future years' consumption per account: flat
  - FY2010 and FY2011 account growth: 0 percent
  - Post FY2011 annual account growth: 1.5 percent
- Cost escalation (post FY2010 and FY2011 budget):
  - Salaries and wages: 3 to 4 percent per year (based on Financial Consulting Solutions Group [FCSG] report)
  - Benefits: 4.2 percent (per FCSG report)
  - Materials and services: 5 percent
  - Transfers: 5 percent
  - Capital: 0 percent (projects already inflated)
- Interest earnings: 3.0 to 4.5 percent (per FCSG report)
- Other:
  - Contingency: 60 days of O&M
  - Budget spent: 100 percent

9.1.2 CIP

Table 9-1 lists the components of the City's 5-year CIP, excluding the source water project. Total project costs are about $20.4 million and include improvements to wells, reservoirs, transmission, and distribution, as well as equipment and costs for studies and planning. Construction costs for the project alternatives are presented in Section 9-3.

9.1.3 Capital Financing

The City will use a combination of current revenues (primarily rates and SDCs) and long-term financing to fund the CIP and project costs. Long-term financing options considered include conventional revenue bonds (paid by revenues of the water system; no voter approval required), as well as state and federal loan programs.

The CIP is assumed to be funded from the following sources:

- SDCs (based on projected development activity)
- $5.6 million in stimulus funding which assumes 50 percent grant and 50 percent loan (repaid at 3 percent interest and a 20-year term)
- Revenue bonds

Table 9-1. Water System CIP						
Project	**FY 2009–10, dollars**	**FY 2010–11, dollars**	**FY 2011–12, dollars**	**FY 2012–13, dollars**	**FY 2013–14, dollars**	**Total, dollars**
CIP: consultants	250,000	200,000	0	0	0	450,000
Water rights acquisition	595,000	250,000	500,000	500,000	500,000	2,345,000
New reservoir, Rock Bluff 2	0	0	1,109,000	725,000	0	1,834,000
Airport well 3 design/drilling	100,000	0	0	0	0	100,000
Automatic meter reading	1,850,000	0	0	0	0	1,850,000
Avion 12-inch	70,000	0	0	0	0	70,000
Water Division Shiloh well	650,000	0	0	0	0	650,000
TBR Road/Murphy 16-inch water	1,253,000	0	0	0	0	1,253,000
Well 4 Pilot Butte control facility	1,610,000	0	0	0	0	1,610,000
WA0808 water modeling	100,000	100,000	100,000	100,000	100,000	500,000
WA09FA optimization	400,000	0	0	0	0	400,000
New projects						
Juniper Ridge reservoir	0	0	150,000	2,704,000	0	2,854,000
Outback 3 reservoir	100,000	0	0	0	0	100,000
Pilot Butte wells (5, 6, 7, 8)	0	0	1,250,000	2,450,000	1,250,000	4,950,000
Tillicum Village projects	515,000	0	0	0	0	515,000
Water management and conservation plan update	50,000	50,000	100,000	0	0	200,000
Water reuse feasibility	0	75,000	0	0	0	75,000
Repair and maintenance						
Communication equipment	0	0	200,000	200,000	200,000	600,000
Total CIP	**7,543,000**	**675,000**	**3,409,000**	**6,679,000**	**2,050,000**	**20,356,000**

In estimating debt service costs for revenue bonds, the following assumptions were used:

- Interest rate: 5.5 percent
- Term: 30 years
- Issuance cost: 1.5 percent (funded with proceeds)
- Required reserve: 8 percent (funded with proceeds)
- Minimum debt service coverage target: 1.5 (with SDCs); 1.0 (without SDCs)
- Timing: just-in-time financing (i.e., separate issues were assumed for each year's funding needs, as opposed to a larger issue earlier in the plan to fund multiple years of construction)
- First year payment: 50 percent for most issues; 2 years' deferral of principal on the largest bond (FY2012)

9.1.4 Operating Costs

Baseline budgeted operating costs are listed in Table 9-2, based on the adopted budget for FY2009–10 and FY2010–11. As listed in Table 9-2, total O&M costs for the 2-year budget period average $11.4 million. Costs do not include projected additional O&M costs and electrical cost savings associated with the project.

Table 9-2. Operating Budget

	FY2009–10, dollars	FY2010–11, dollars
Watershed/surface water	129,600	130,552
Wells	801,586	825,961
Disinfection	218,881	224,773
Water resources	482,860	496,570
Reservoirs	171,611	153,679
Distribution mains	1,752,303	1,837,685
Water services	2,905,773	2,930,902
Pumping	342,509	351,985
Administration and support (e.g., legal)	2,417,225	2,567,647
Billed services (e.g, garage, fuel)	441,900	459,900
Transfers (e.g., finance, information and technology)	1,547,777	1,523,300
Capital expansion	83,425	87,553
Total	**11,295,450**	**11,590,507**

Based on the escalation factors discussed previously, total baseline O&M costs may increase to $13.2 million in FY2013–14.

9.2 Bridge Creek Alternatives

Table 9-3 summarizes the results of the financial analysis associated with the Bridge Creek alternatives presented to the City Council in August and September 2009. Financial plans were developed for each alternative, based on the baseline data and analysis described in Section 9-2. In addition, project-specific assumptions were developed for each scenario related to the following issues:

- Total construction costs and financing
- Annual O&M costs and savings
- Hydroelectric power production revenue (if applicable)
- Annual system-wide water rate increase

Table 9-3. Summary of Bridge Creek Alternatives

Alternative	Total construction costs, dollars in millions	Annual O&M cost[1], dollars	Annual hydro revenue, dollars in millions[1]	Annual rate increase, percent
Membrane and penstock only	58.2	502,000	0.0	10.8
Ultraviolet and penstock only	44.9	190,000	0.0	8.2
Membrane, penstock, and hydroelectric	71.2	502,000	1.3	7.6
UV, penstock, and hydroelectric	57.9	190,000	1.3	4.7

[1] First full year of project operation (FY2013–14)

9.2.1 Capital Costs and Financing

As listed in Table 9-3, construction costs for the Bridge Creek alternatives range from \$44.9 million (UV treatment and penstock only) to \$71.2 million (membrane treatment, penstock, and hydroelectric). Funding for the treatment costs are assumed to be a combination of SDCs, rates, and revenue bond funding, as described in Section 9-2 for the 5-year CIP projects.

In addition, the hydroelectric project may be eligible for state and federal loan, grant, and tax credit programs targeted specifically for renewable energy projects. The following funding was assumed for the hydroelectric and penstock (pipeline) project costs (\$41.4 million):

- City will obtain partner funding up-front to utilize state and federal energy tax credits (worth about \$7.8 million discounted) to reduce the amount that needs to be financed to \$33.6 million.
- \$12.4 million will be in the form of federal government grants (Federal Business Energy Investment Tax Credit).
- \$6 million will be in the form of state loans (Oregon Department of Energy) that assume 3 percent interest, no reserves, 20-year term, and subordinated obligations.

More detailed information about the project financing assumptions for the hydroelectric scenarios is provided in Appendix 9-A.

The City's current water system debt service is limited to about \$0.3 million annually for the series 2000 revenue bonds. Annual debt service costs are projected to increase significantly under all of the Bridge Creek alternatives—in part to fund a portion of costs associated with the 5-year CIP—ranging from about \$4.2 million for the UV scenarios to about \$5.1 million for the membrane scenarios.

9.2.2 Operating Costs

Operating costs vary for the alternatives, based on the assumed treatment technology. Annual operating costs for membrane treatment are estimated to be \$502,000 in FY2013–14 (the first full year of operation). The annual costs for UV treatment are \$190,000. Some reductions in baseline operating costs are projected for the membrane treatment alternatives, due to reduced energy costs (about \$55,000) associated with reduced reliance on the wells.

9.2.3 Revenue

Revenue under existing rates is projected to be about \$11.4 million in FY2009–10. As debt service costs increase significantly to fund the project, as well as the other CIP costs, revenue requirements from rates are projected to increase to between \$14.0 million (for the UV, penstock and hydroelectric scenario) and \$18.0 million (for the membrane and penstock only scenario).

The revenue requirements from rates reflect projected revenues from other sources of funds, including hydroelectric revenues, which are available to fund a portion of the debt service and operating costs of the water system. Hydroelectric revenues are assumed to be about \$1.3 million in FY2013–14, and help mitigate water rate increases for the hydroelectric alternatives. As listed in Table 9-3, the annual rate increase needed for the Bridge Creek options through FY2013–14 range from 4.7 percent (for the UV, penstock, and hydroelectric scenario), to 10.8 percent (for the membrane and penstock only scenario). Additional rate increases will likely be needed in subsequent years to fund additional capital improvements and normal increases in operating costs.

9.2.4 2014 Scenarios

The City is currently operating under the assumption that the project construction will need to be completed in 2012. However, some other communities are pursuing delayed construction schedules through 2014. Additional scenarios were developed to examine the impact of delaying the treatment plant construction for 2 years. Table 9-4 lists the revised rate increases based on the delayed schedule.

Table 9-4. Summary of Bridge Creek Alternatives: 2014 Treatment Plant Construction

Alternative	Annual rate increase, percent
Membrane and penstock only	8.8
UV and penstock only	7.2
Membrane, penstock, and hydroelectric	5.85
UV, penstock, and hydroelectric	4.1

9.3 Conclusion

The City has a longstanding practice of adjusting water rates annually based on a long-term financial plan to avoid large single-year rate adjustments. The City last adopted a water system financial plan in 2008, and projected the need for an annual rate increase of 8.25 percent through FY2012–13; the City implemented the first two rate increases from that plan in FY2008–09 and FY2009–10. The updated financial plan projects rate increases of 4.7 percent to 10.8 percent for FY2010–11 through FY2013–14, to fund the City's current adopted 5-year, projected baseline O&M costs, as well as projected construction and O&M costs associated with a Bridge Creek water supply and treatment alternative. The hydroelectric options significantly mitigate projected rate increases, due to the additional revenue projected from the sale of hydroelectric power, as well as significant construction cost incentives. All of the Bridge Creek alternatives will greatly increase the City's debt service costs, and therefore will require a long-term commitment from the City to maintain sufficient rates and charges to meet bond covenants.

The rate increases projected herein are based on available information on costs and revenues as of May 2009, and include a number of assumptions related to future financing eligibility and market conditions. Changes in these assumptions may warrant modifications to the rate increases. Furthermore, continued economic challenges will require close monitoring of revenues and expenses, and possible future revisions to rate increases if customer growth and consumption drop below projected levels.

APPENDIX 9-A

Source Project Financing Assumptions

Source Project Financing Assumptions
Scenario
Membrane Treatment with Powerhouse and Penstock

	Total	Discounted Value	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14
Construction Costs							
WTP	$29,750,000		$925,000	$4,550,000	$22,300,000	$1,975,000	
Powerhouse & Penstock	$41,400,000		$725,000	$14,275,000	$13,750,000	$12,650,000	$0
Total	**$71,150,000**		**$1,650,000**	**$18,825,000**	**$36,050,000**	**$14,625,000**	**$0**
Construction Funding Sources							
	Total	**Discounted Value**					
		6%					
Construction Incentives -- Grants/Partner Financing							
WTP	$0		$0	$0	$0	$0	$0
Powerhouse & Penstock							
Federal Business Energy Inv Tax Credit (ITC)	$12,420,000	$12,420,000	$0	$0	$6,398,559	$6,021,441	$0
0% Unused	$0	$0	$0	$0	$0	$0	$0
Federal Renewable Energy Grants	$400,000	$335,848	$0	$117,867	$113,532	$104,449	$0
Oregon Energy Business Tax Credits (OBETC)	$10,000,000	$7,497,978	$0	$2,631,435	$2,534,657	$2,331,885	$0
0% Energy Trust of Oregon Open Solicitation Program	$0	$0	$0	$0	$0	$0	$0
ETO non Open Soliciation Program	$0	$0	$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Grants	$0	$0	$0	$0	$0	$0	$0
Subtotal	$22,820,000	$20,253,825	$0	$2,749,302	$9,046,748	$8,457,775	$0
Net Construction Financing							
WTP	$29,750,000	$29,750,000	$925,000	$4,550,000	$22,300,000	$1,975,000	$0
Powerhouse & Penstock	$18,580,000	$21,146,175	$725,000	$11,525,698	$4,703,252	$4,192,225	$0
Total	**$48,330,000**	**$50,896,175**	**$1,650,000**	**$16,075,698**	**$27,003,252**	**$6,167,225**	**$0**
Construction Incentives -- Loans							
WTP							
Powerhouse & Penstock							
Clean Renewable Energy Bonds (CREBs)	$0		$0	$0	$0	$0	$0
Qualified Energy Conservation Bonds (QECBs)	$0		$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Loan	$0		$0	$0	$0	$0	
Oregon Small Scale Loan Program	$0		$0	$0	$0	$0	$0
Subtotal	$0	$0	$0	$0	$0	$0	$0
O&M							
WTP			$0	$0	**$0**	**$362,000**	**$502,000**
Powerhouse & Penstock			$0	$0	$0	$25,500	$53,000
Reduction in Electricity Costs						-$55,000	-$57,750
Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$332,500**	**$497,250**

Source Project Financing Assumptions
Scenario
Membrane Treatment with Powerhouse and Penstock

	Total	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14
O&M and Debt Funding Sources -- Hydro						
mWh produced hydro					4,475	9,260
mWh produced Total					4,475	9,260
Rate -- PP&L					$0.071	$0.074
Rate -- Green Tags					$0.022	$0.023
Rate -- Hydro Production Incentive					$0.022	$0.023
Power Production Payment - PP&L rate schedule					$317,725	$684,314
Green Tags					$98,450	$215,332
Hydro Production Incentive					$98,450	$211,869
Renewable Energy Production Tax Credits					$98,450	$203,720
Total			**$0**	**$0**	**$613,075**	**$1,315,235**

11/11/2009

Source Project Financing Assumptions
Scenario
UV Treatment w/Penstock and Powerhouse

	Total	Discounted Value	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14
Construction Costs							
WTP	$16,500,000		$500,000	$2,475,000	$12,375,000	$1,150,000	
Powerhouse & Penstock	$41,400,000		$725,000	$14,275,000	$13,750,000	$12,650,000	$0
Total	**$57,900,000**		**$1,225,000**	**$16,750,000**	**$26,125,000**	**$13,800,000**	**$0**
Construction Funding Sources							
	Total	**Discounted Value**					
		6%					
Construction Incentives -- Grants/Partner Financing							
WTP	$0		$0	$0	$0	$0	$0
Powerhouse & Penstock							
Federal Business Energy Inv Tax Credit (ITC)	$12,420,000	$12,420,000	$0	$0	$6,398,559	$6,021,441	$0
0% Unused	$0	$0	$0	$0	$0	$0	$0
Federal Renewable Energy Grants	$400,000	$335,848	$0	$117,867	$113,532	$104,449	$0
Oregon Energy Business Tax Credits (OBETC)	$10,000,000	$7,497,978	$0	$2,631,435	$2,534,657	$2,331,885	$0
0% Energy Trust of Oregon Open Solicitation Program	$0	$0	$0	$0	$0	$0	$0
ETO non Open Soliciation Program	$0	$0	$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Grants	$0	$0	$0	$0	$0	$0	$0
Subtotal	$22,820,000	$20,253,825	$0	$2,749,302	$9,046,748	$8,457,775	$0
		$20,253,825					
Net Construction Financing							
WTP	$16,500,000	$16,500,000	$500,000	$2,475,000	$12,375,000	$1,150,000	$0
Powerhouse & Penstock	$18,580,000	$21,146,175	$725,000	$11,525,698	$4,703,252	$4,192,225	$0
Total	**$35,080,000**	**$37,646,175**	**$1,225,000**	**$14,000,698**	**$17,078,252**	**$5,342,225**	**$0**
Construction Incentives -- Loans							
WTP							
Powerhouse & Penstock							
Clean Renewable Energy Bonds (CREBs)	$0		$0	$0	$0	$0	$0
Qualified Energy Conservation Bonds (QECBs)	$0		$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Loan	$0		$0	$0	$0	$0	
Oregon Small Scale Loan Program	$0		$0	$0	$0	$0	$0
Subtotal	$0	$0	$0	$0	$0	$0	$0
O&M							
WTP			$0	$0	**$0**	**$95,000**	**$190,000**
Powerhouse & Penstock			$0	$0	$0	$25,500	$53,000
Reduction in Electricity Costs							

11/11/2009

Source Project Financing Assumptions
Scenario
UV Treatment w/Penstock and Powerhouse

	Total		FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14
Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$120,500**	**$243,000**
O&M and Debt Funding Sources -- Hydro							
mWh produced hydro						4,475	9,260
mWh produced Total						4,475	9,260
Rate -- PP&L						$0.071	$0.074
Rate -- Green Tags						$0.022	$0.023
Rate -- Hydro Production Incentive						$0.022	$0.023
Power Production Payment - PP&L rate schedule						$317,725	$684,314
Green Tags						$98,450	$215,332
Hydro Production Incentive						$98,450	$211,869
Renewable Energy Production Tax Credits						$98,450	$203,720
Total				**$0**	**$0**	**$613,075**	**$1,315,235**

Source Project Financing Assumptions
Scenario
Membrane Treatment with Powerhouse and Penstock (2014)

	Total	Discounted Value	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14	FY 2014-15
Construction Costs								
WTP	$29,750,000				$925,000	$4,550,000	$22,300,000	$1,975,000
Powerhouse & Penstock	$41,400,000		$725,000	$14,275,000	$13,750,000	$12,650,000	$0	
Total	**$71,150,000**		**$725,000**	**$14,275,000**	**$14,675,000**	**$17,200,000**	**$22,300,000**	**$1,975,000**
Construction Funding Sources								
	Total	**Discounted Value**						
		6%						
Construction Incentives -- Grants/Partner Financing								
WTP	$0		$0	$0	$0	$0	$0	$0
Powerhouse & Penstock								
Federal Business Energy Inv Tax Credit (ITC)	$12,420,000	$12,420,000	$0	$0	$6,398,559	$6,021,441	$0	$0
0% Unused	$0	$0	$0	$0	$0	$0	$0	$0
Federal Renewable Energy Grants	$400,000	$335,848	$0	$117,867	$113,532	$104,449	$0	$0
Oregon Energy Business Tax Credits (OBETC)	$10,000,000	$7,497,978	$0	$2,631,435	$2,534,657	$2,331,885	$0	$0
0% Energy Trust of Oregon Open Solicitation Program	$0	$0	$0	$0	$0	$0	$0	$0
ETO non Open Soliciation Program	$0	$0	$0	$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Grants	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal	$22,820,000	$20,253,825	$0	$2,749,302	$9,046,748	$8,457,775	$0	$0
Net Construction Financing								
WTP	$29,750,000	$29,750,000	$0	$0	$925,000	$4,550,000	$22,300,000	$1,975,000
Powerhouse & Penstock	$18,580,000	$21,146,175	$725,000	$11,525,698	$4,703,252	$4,192,225	$0	$0
Total	**$48,330,000**	**$50,896,175**	**$725,000**	**$11,525,698**	**$5,628,252**	**$8,742,225**	**$22,300,000**	**$1,975,000**
Construction Incentives -- Loans								
WTP								
Powerhouse & Penstock								
Clean Renewable Energy Bonds (CREBs)	$0		$0	$0	$0	$0	$0	$0
Qualified Energy Conservation Bonds (QECBs)	$0		$0	$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Loan	$0		$0	$0	$0	$0		
Oregon Small Scale Loan Program	$0		$0	$0	$0	$0	$0	$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0
O&M								
WTP			$0	$0	**$0**	$0	**$0**	**$362,000**
Powerhouse & Penstock			$0	$0	$0	$25,500	$53,000	$55,253
Reduction in Electricity Costs						-$55,000	-$57,750	-$60,060
Total	**$0**	**$0**	**$0**	**$0**	**$0**	**-$29,500**	**-$4,750**	**$357,193**
O&M and Debt Funding Sources -- Hydro								
mWh produced hydro						4,475	9,260	9,450
mWh produced Total						4,475	9,260	9,450

Source Project Financing Assumptions
Scenario
Membrane Treatment with Powerhouse and Penstock (2014)

	Total	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14	FY 2014-15
Rate -- PP&L					$0.071	$0.074	$0.076
Rate – Green Tags					$0.022	$0.023	$0.025
Rate – Hydro Production Incentive					$0.022	$0.023	$0.024
Power Production Payment - PP&L rate schedule					$317,725	$684,314	$718,200
Green Tags					$98,450	$215,332	$232,276
Hydro Production Incentive					$98,450	$211,869	$224,865
Renewable Energy Production Tax Credits					$98,450	$203,720	$207,900
Total			**$0**	**$0**	**$613,075**	**$1,315,235**	**$1,383,241**

Source Project Financing Assumptions
Scenario
UV Treatment with Powerhouse and Penstock (2014)

	Total	Discounted Value	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14	FY 2014-15
Construction Costs								
WTP	$16,500,000				$500,000	$2,475,000	$12,375,000	$1,150,000
Powerhouse & Penstock	$41,400,000		$725,000	$14,275,000	$13,750,000	$12,650,000	$0	
Total	**$57,900,000**		**$725,000**	**$14,275,000**	**$14,250,000**	**$15,125,000**	**$12,375,000**	**$1,150,000**
Construction Funding Sources								
	Total	**Discounted Value**						
		6%						
Construction Incentives -- Grants/Partner Financing								
WTP	$0		$0	$0	$0	$0	$0	$0
Powerhouse & Penstock								
Federal Business Energy Inv Tax Credit (ITC)	$12,420,000	$12,420,000	$0	$0	$6,398,559	$6,021,441	$0	$0
0% Unused	$0	$0	$0	$0	$0	$0	$0	$0
Federal Renewable Energy Grants	$400,000	$335,848	$0	$117,867	$113,532	$104,449	$0	$0
Oregon Energy Business Tax Credits (OBETC)	$10,000,000	$7,497,978	$0	$2,631,435	$2,534,657	$2,331,885	$0	$0
0% Energy Trust of Oregon Open Solicitation Program	$0	$0	$0	$0	$0	$0	$0	$0
ETO non Open Soliciation Program	$0	$0	$0	$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Grants	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal	$22,820,000	$20,253,825	$0	$2,749,302	$9,046,748	$8,457,775	$0	$0
Net Construction Financing								
WTP	$16,500,000	$16,500,000	$0	$0	$500,000	$2,475,000	$12,375,000	$1,150,000
Powerhouse & Penstock	$18,580,000	$21,146,175	$725,000	$11,525,698	$4,703,252	$4,192,225	$0	$0
Total	**$35,080,000**	**$37,646,175**	**$725,000**	**$11,525,698**	**$5,203,252**	**$6,667,225**	**$12,375,000**	**$1,150,000**
Construction Incentives -- Loans								
WTP								
Powerhouse & Penstock								
Clean Renewable Energy Bonds (CREBs)	$0		$0	$0	$0	$0	$0	$0
Qualified Energy Conservation Bonds (QECBs)	$0		$0	$0	$0	$0	$0	$0
0% USDA Rural Energy for America Program (REAP) Loan	$0		$0	$0	$0	$0		
Oregon Small Scale Loan Program	$0		$0	$0	$0	$0	$0	$0
Subtotal	$0	$0	$0	$0	$0	$0	$0	$0
O&M								
WTP			$0	$0	**$0**	$0	**$0**	**$95,000**
Powerhouse & Penstock			$0	$0	$0	$25,500	$53,000	$55,253
Reduction in Electricity Costs								
Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$25,500**	**$53,000**	**$150,253**
O&M and Debt Funding Sources -- Hydro								
mWh produced hydro						4,475	9,260	9,450
mWh produced Total						4,475	9,260	9,450

11/11/2009

Source Project Financing Assumptions
Scenario
UV Treatment with Powerhouse and Penstock (2014)

	Total	FY 2009-10	FY 2010-11	FY 2011-12	FY 2012-13	FY 2013-14	FY 2014-15
Rate -- PP&L					$0.071	$0.074	$0.076
Rate -- Green Tags					$0.022	$0.023	$0.025
Rate -- Hydro Production Incentive					$0.022	$0.023	$0.024
Power Production Payment - PP&L rate schedule					$317,725	$684,314	$718,200
Green Tags					$98,450	$215,332	$232,276
Hydro Production Incentive					$98,450	$211,869	$224,865
Renewable Energy Production Tax Credits					$98,450	$203,720	$207,900
Total			**$0**	**$0**	**$613,075**	**$1,315,235**	**$1,383,241**

CHAPTER 11
WATER RIGHTS CONSIDERATIONS

Prepared for
City of Bend, Oregon
October 23, 2009

Prepared by

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WATER RIGHTS CONSIDERATIONS

11.0 Introduction

As part of its Water Supply Alternatives Project, the City of Bend (City) wishes to integrate water rights information into its preliminary alternatives development for future use of its existing surface water and groundwater rights. The City requested that GSI Water Solutions, Inc. (GSI) develop this chapter to provide foundational information about the its water rights, and in particular, the opportunities, impediments, regulatory requirements, and basin-wide context of the City's current water rights.

This chapter describes the water rights held by the City and, more specifically, explores the amount of surface water available to the City under its existing surface water rights. It also describes the City's historic use of surface water and groundwater, and surface water variability. Finally, it considers how the amount of surface water use could vary under different scenarios, based on the likely availability of water under a particular water right due to its relative priority date within the system. We have developed this analysis of the City's water rights, without regard to infrastructure considerations.

11.1 City Groundwater Rights

The City has groundwater rights that authorize the use of up to 68.24 cubic feet per second (cfs). The City holds seven water right certificates that authorize use of up to 31.43 cfs of groundwater. The City holds five permits that authorize use of up to 36.81 cfs of groundwater. The City's most junior permits (G-16177 and G-16178) authorize the use of up to 24.0 cfs in total. Both permits are conditioned to require the City to provide mitigation for the use of groundwater under these permits, under the Oregon Water Resources Department's (OWRD) Deschutes Groundwater Mitigation Program. Mitigation for the maximum use under both rights combined would require 3,223 mitigation credits. Assuming a cost of $2,500 per credit, this would total $8,057,500.

If the City applied for a new groundwater right, a new permit would include a similar mitigation requirement. *It is unlikely that a new permit would be issued at this time, however, because of a limitation built into OWRD's mitigation program rules.* The program rules allow only an additional 200 cfs of new groundwater use authorized under the mitigation program. As of the development of this chapter, the groundwater use requested under applications, now pending with OWRD, and authorized under the final order and permits issued under the mitigation program, exceed the 200 cfs cap. As a result, without changes to OWRD's administrative rules or new legislation, groundwater may not be an option for long-term water supply.

11.2 City Surface Water Rights

Table 11-1 describes the City's surface water rights as of the date this chapter was developed. The City holds five surface water rights from Bridge Creek and Tumalo Creek. As summarized in Table 11-1, the City holds three certificates (31411, 31665 and 85526) for the use of water from Tumalo Creek. The City also has a transfer (B-112) for use of Tumalo Creek. These rights authorize a total combined maximum use of up to 21.113 cfs for municipal purposes. In addition to the rights for water from Tumalo Creek, the City also holds a permit for the use of up to 15.00 cfs from Bridge Creek and Tumalo Creek for municipal purposes. As listed in Table 11-1, the combined maximum rate of diversion for all of the City's Tumalo Creek and Bridge Creek water rights is 36.113 cfs or 23.33 million gallons per day (mgd).

Table 11-1. City Surface Water Rights

Source	Transfer, permit, or certificate number	Priority date	Authorized rate, cfs/mgd	Season of use	Status	Stated annual volume limits, acre-feet
Bridge Creek	Permit S-49823	12/12/1983	15.00/9.69	year-round	Permit	N/A
Tumalo Creek	Certificate 85526	N/A	6.00/3.88	year-round	-	N/A
	Certificate 31411	9/30/1900	4.50/2.91	April 15 to October 15	Certificated	821.7
		8/5/1900	2.00/1.29			
		6/1/1907	0.02/0.01			
	Certificate 31665	9/30/1900	1.314/0.85		Certificated	328.14
		4/28/1905	0.186/0.12			
		6/1/1907	1.103/0.71			
	Transfer B-112	10/29/1913	2.43–5.99/ 1.57–3.87[1]	April 1 to November 1	Inchoate (to be completed by 2019)	1,923.5
	Total authorized rate		36.113 cfs (23.33 mgd)			

[1] Maximum authorized rate of diversion varies based on the season. Maximum rate of 5.99 cfs is allowed May 15 to September 15. It appears, however, that there may be an error in the transfer order and the maximum rate may be 7.99 cfs.

Although the City's surface water rights have a total authorized rate of 36.113 cfs, this amount of water is not necessarily available to the City year-round. First, the use of water under Certificates 31411 and 31665 and Transfer B-112 is limited by a season of use. All three of these water rights were irrigation rights originally and as a result, have a season of use consistent with the irrigation season: April 15 to October 15 for the certificates and April 1 to November 1 for Transfer B-112. For ease of analysis herein, the season of use for Transfer B-112 also will be considered to be April 15 to October 15. Tables 11-2 and 11-3 summarize the seasonal limitations on the City's surface water rights.

Table 11-2. City Surface Water Rights During the Irrigation Season (April 15 to October 15)

Source	Transfer, permit, or certificate number	Maximum authorized rate, cfs/mgd	
Bridge Creek	Permit S-49823	15.00/9.69	15.00/9.69
Tumalo Creek	Certificate 85526	6.00/3.88	21.113/13.6
	Certificate 31411	4.50/2.91	
		2.00/1.29	
		0.02/0.01	
	Certificate 31665	1.314/0.85	
		0.186/0.12	
		1.103/0.71	
	Transfer B-112	2.43–5.99/ 1.57–3.87[1]	
Total authorized rate			36.113 cfs/23.33 mgd

[1] Maximum authorized rate of diversion varies based on the season. Maximum rate of 5.99 cfs is allowed May 15 to September 15. It appears, however, that there may be an error in the transfer order and the maximum rate may be 7.99 cfs.

Table 11-3. City Surface Water Rights Outside the Irrigation Season (October 16 to April 14)

Source	Transfer, permit, or certificate	Maximum authorized rate, cfs/mgd
Bridge Creek	Permit S-49823	15.0/9.69
Tumalo Creek	Certificate 85526	6.0/3.88
Total authorized rate		21.0 cfs/13.57 mgd

In addition, the City's use of water is subject to annual volume limits. Certificates 31411 and 31665 and Transfer B-112 contain annual volume limits associated with the originating irrigation rights. (See Table 11-1.) The maximum annual volume authorized by Certificate 31411 is 821.7 acre-feet and the maximum volume authorized by Certificate 3165 is 328.14 acre-feet. The maximum annual volume for Transfer B-112 is 1923.5 acre-feet. Certificate 85526 and Permit S-49823 do not include a stated annual volume limitation, but allow use of the maximum authorized rate year-around.

Finally, the use of these surface water rights, except Certificate 85526, is subject to regulation by the State of Oregon watermaster according to its priority within the system and an established distribution schedule created by the watermaster to distribute the waters of Tumalo Creek between the City and the Tumalo Irrigation District (TID). As described above, several of the water rights held by the City were part of irrigation water rights, which are now held by TID. As a result, the City and TID hold several water rights with the same priority dates. In addition, several instream water rights on Tumalo Creek have the same priority dates, because they were also created from the original irrigation rights. To distribute water equitably among the City's, TID's and the instream water rights with identical priority dates when streamflow is not sufficient to meet the water users' needs, the watermaster uses a distribution schedule (based on streamflow and the proportionate share of water rights) to allocate water among these water uses. As streamflows decrease during the irrigation season, less water is available for use under these water rights, based on their priority dates. Regulation is typically complaint-driven. That is, the watermaster does not generally regulate water rights unless a water right holder requests regulation. However, the watermaster does need to monitor streamflow proactively for distribution associated with the instream water rights.

In the following sections, we explore the volumes of surface water that may be available to the City under its current water rights during the period of April 15 to October 15 (the irrigation season) after considering all of the above-described limitations. The following scenarios were developed to demonstrate the amount of water potentially available to the City during this time period, and to show where opportunities and limitations exist to use surface water differently.

11.3 The City's Historic Use of Surface Water and Groundwater

Historically, the City has used surface water primarily during the late fall, winter, and early spring months. This has been supplemented during the summer months by the use of groundwater. According to information provided by the City, the annual volume of surface water used has been relatively constant over the past 9 years, as shown in Figure 11-1. The City's use of groundwater has increased generally during that time period. The City produced roughly the same volume of surface water and groundwater in 2004 and 2005, but from 2006 through 2008, groundwater was the predominant water source for meeting its municipal water needs.

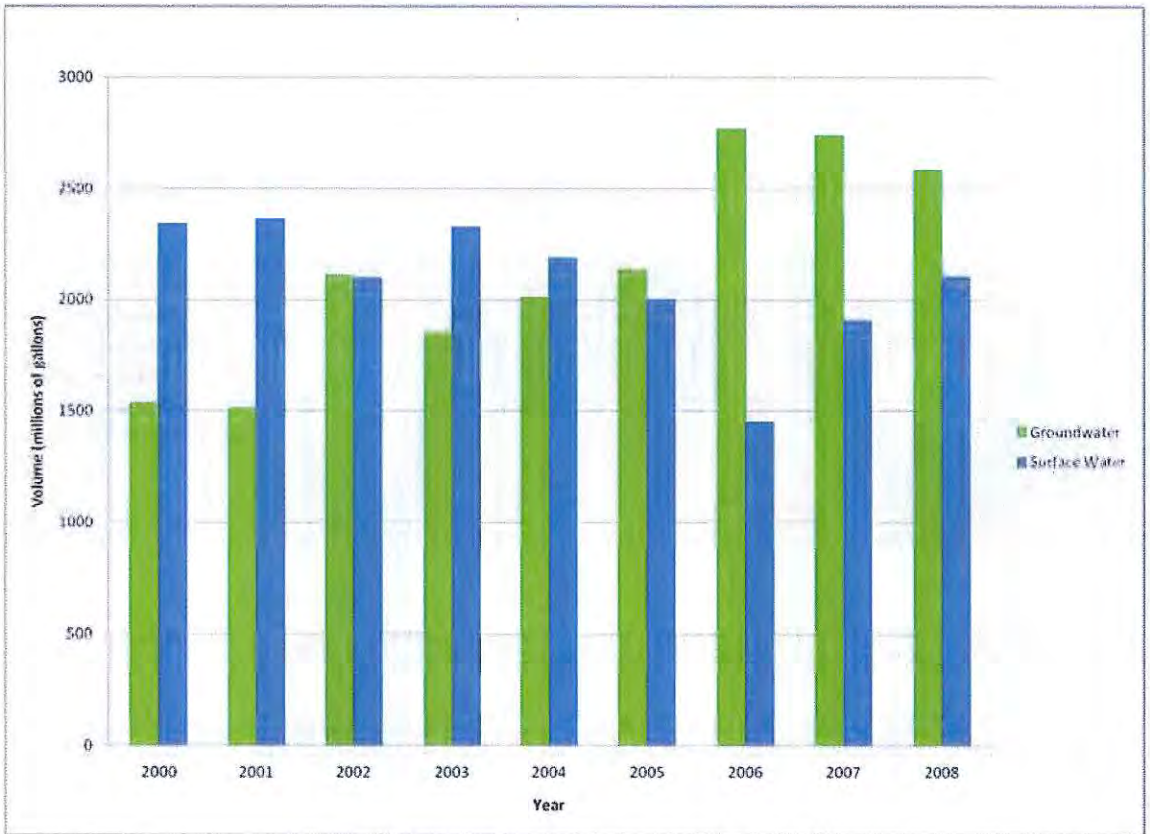


Figure 11-1. City of Bend Yearly Production Volume by Source

As shown in Figure 11-2, the City's seasonal production of surface water has been variable over the last 5 years. The numerous rapid daily declines in surface water use are reported to be associated with high turbidity events which cause cessation of use of this source under current regulatory requirements and treatment regimes. Surface water use would likely stabilize if higher-level treatment were available for this source. However, there is a discernable general trend that, not surprisingly, shows higher surface water production in late summer and early autumn, and lower surface water production during the winter months. From this information, we have developed an average surface water production trend line, which we have used later in this chapter to represent the general pattern of City's surface water production.

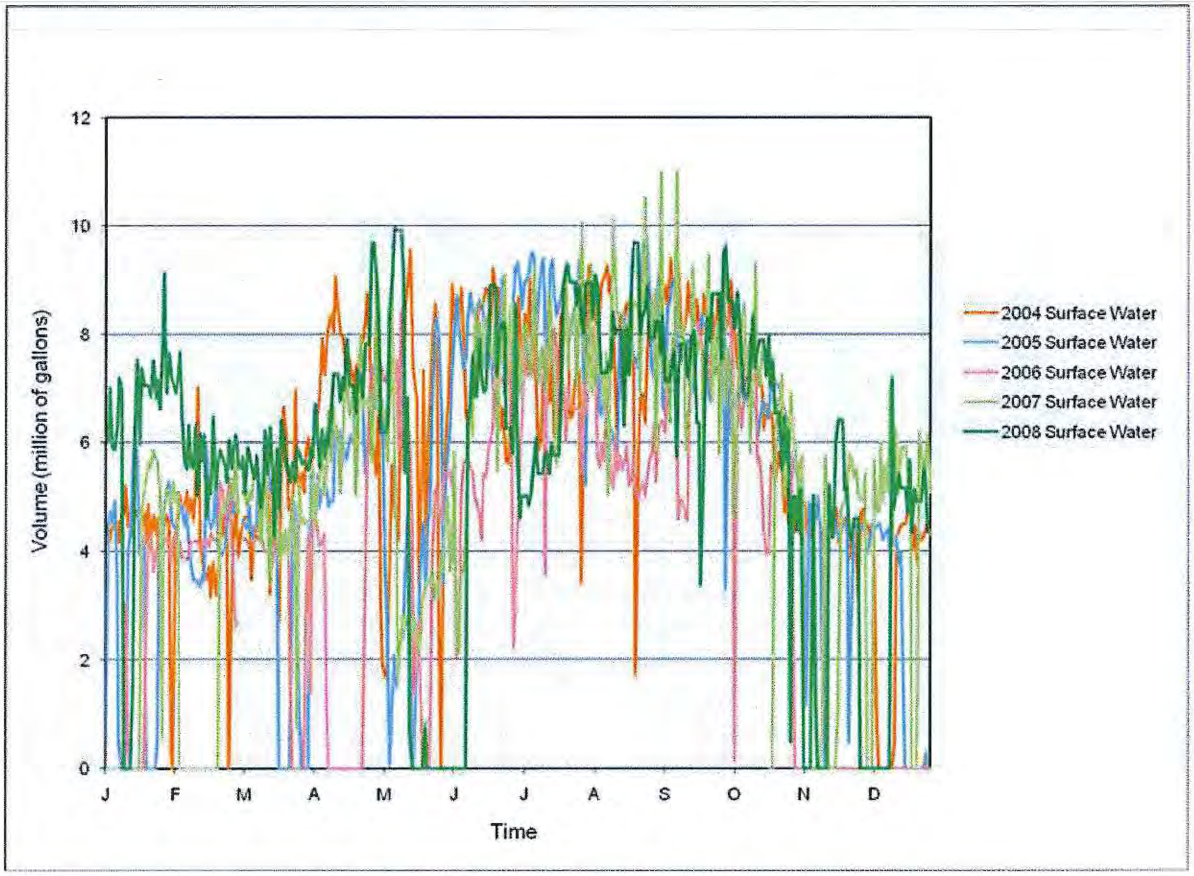


Figure 11-2. Annual Surface Water Production by Year

11.4 Alternative Scenarios

As a starting point, we compared the City's surface water rights with the surface water flows in Tumalo Creek. In particular, we determined whether the mean daily flows in Tumalo Creek ever dropped below the combined maximum rates of diversion authorized by the City's surface water rights. The mean daily flow of Tumalo Creek based on 63 years of mean daily values (1923 to 1987) is shown in blue in Figure 11-3. The combined maximum authorized rate of diversion for the City's water rights is shown in red. The maximum authorized rate increases at the start of the irrigation season (April 15) when use of Certificates 31411 and 31665 and Transfer B-112 can begin. The maximum rate fluctuates during the irrigation season based on the varying maximum authorized rate in Transfer B-112. (As noted in Table 11-1, the maximum authorized rate of diversion under Transfer B-112 varies from 2.43 to 5.99 cfs, based on the season. The maximum rate of 5.99 cfs is allowed from May 15 to September 15.) At the end of the irrigation season (October 15), the maximum authorized rate returns to 21.0 cfs, where it remains until the beginning of the next irrigation season. In addition, we have worked with the watermaster in OWRD's Bend office to obtain information about the combined maximum authorized rate of diversion for the TID's Tumalo Creek water rights. One of TID's water rights (Certificate 74147) has a maximum rate of diversion that varies during the irrigation season; however, for purposes of general reference and in the interest of efficiency, we have used the largest rate authorized, which is authorized between May 15 and September 15. TID's combined maximum authorized rate of 211 cfs is shown in green in Figure 11-3.

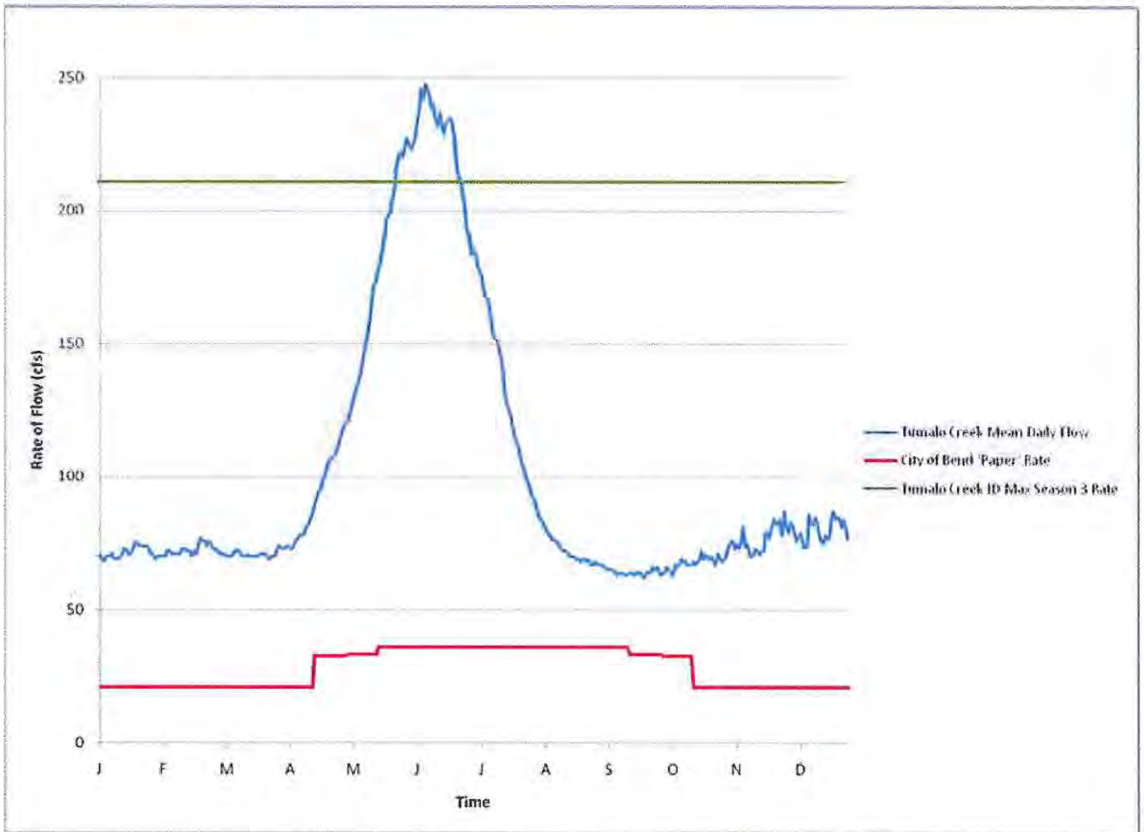


Figure 11-3. Tumalo Creek Flow and City of Bend and TID Water Rights

As shown in Figure 11-3, the mean daily flows always significantly exceed the combined maximum authorized rates for the City's water rights throughout the year. Consequently, surface water flows are not, per se, a limiting factor for the City's use of its surface water rights.

However, the City's use of water under its surface water rights is limited by their seasons of use, volume limitations, and potential regulation by the watermaster according to the distribution schedule for the City and TID. The following discussion provides four scenarios describing various assumptions about how the above variables might come together and implications for the City's use of surface water. Since the maximum authorized rate of the City's surface water rights do not vary outside of the irrigation season, this analysis focuses on the period from April 15 to October 15. The scenarios provided are solely to demonstrate opportunities and limitations and should not be construed as recommendations for surface water use.

11.4.1 Scenario 1

Scenario 1 is included for demonstration purposes only to show how all the above-described limitations work together. This scenario assumes that the City has access to all of its surface water rights and that the watermaster regulates the City according to the above-described City/TID distribution schedule throughout the irrigation season (April 15 through October 15). Since the watermaster typically does not regulate Tumalo Creek until July or August, this is a very conservative assumption. Under this scenario, we have assumed that the City would begin using all of its surface water rights at their maximum authorized rates on April 15 and would continue to use each right at its maximum rate until either it reached its maximum annual volume limitation, it was regulated off, or the irrigation season ended.

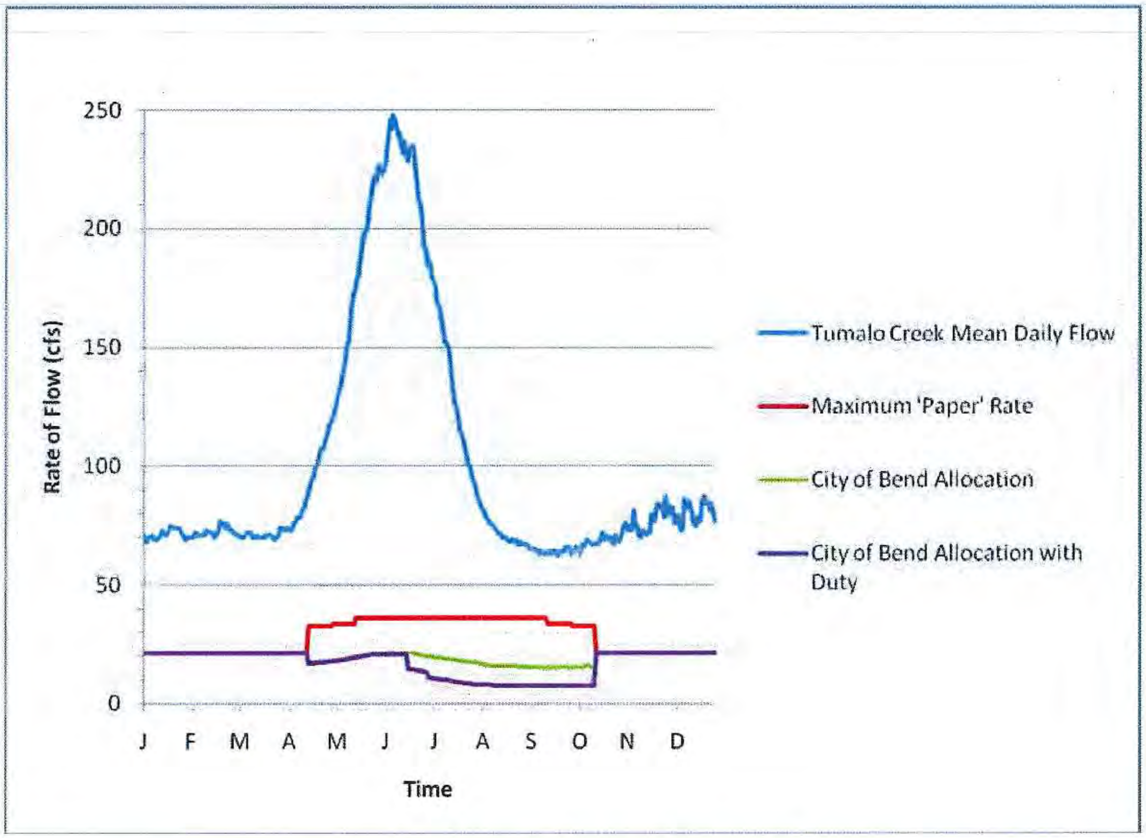


Figure 11-4. Rate Comparison – Scenario 1

The red line in Figure 11-4 shows the combined maximum rates of the City's surface water rights, without regard to the volume limitations contained in some of these rights. The green line shows the watermaster's allocation of water to the City if the flow in Tumalo Creek was that identified by the blue line (the mean daily flow). The use of the City's surface water rights is also limited by the annual volume limitations in Certificates 31411 and 31665 and in Transfer B-112, as described above. These limitations are shown by the purple line. Figure 11-5 describes in more detail how this water would be accounted for under the City's existing water rights and describes the daily volume of water that could be produced under this scenario.

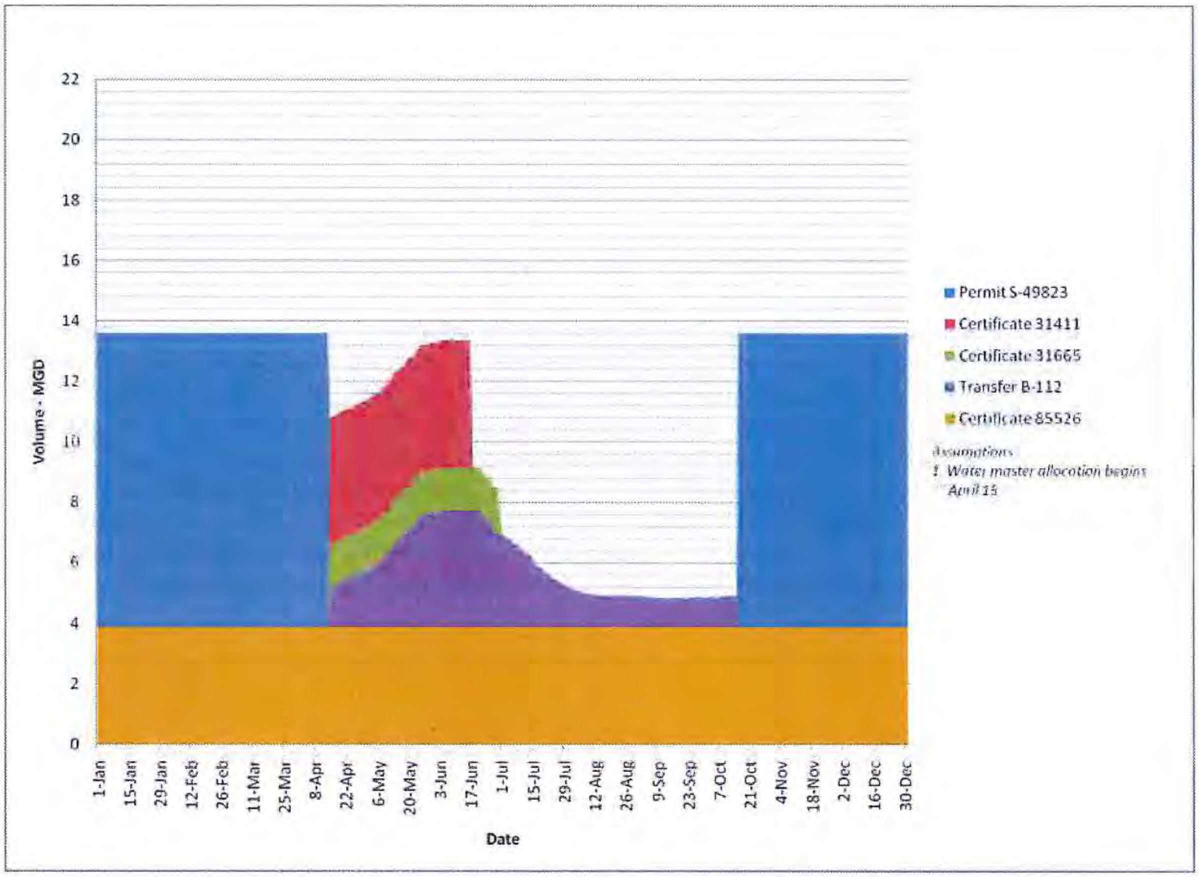


Figure 11-5. Daily Volume Produced During Year – Scenario 1

Under Scenario 1, the City would be able to use the full 6.0 cfs under Certificate 85526 (shown in orange) throughout the year because it is senior to all other water rights on Tumalo Creek. Also, the City could fully utilize Permit S-49823 (in blue) outside of the irrigation season but, under this scenario, once the irrigation season began the permit would be regulated off by the watermaster due to its early priority date and would not contribute to the surface water available to the City during that portion of the year. As described above, the City's other water rights can be used only during the irrigation season. The use of water under Transfer B-112 (shown in purple) would increase and then decrease, according to its maximum authorized rates during the irrigation season and due to regulation by the watermaster according to the distribution schedule. Under this scenario, Certificates 31411 and 31665 would be available at their maximum authorized rates until the City reached its annual volume limitations in mid-June and late-June, respectively. .

While Scenario 1 is not a realistic method for utilizing the City's surface water rights, it is a useful demonstration of the limitations of the individual water rights. The following scenarios present potentially more realistic circumstances for the availability of surface water under the City's water rights.

11.4.2 Scenario 2

In Scenario 2, we have again assumed that the watermaster will begin regulating the City's surface water rights according to the distribution schedule for the entire irrigation season (April 15 through October 15), which is, as previously described, a very conservative assumption. In this case, however, we have staggered the use of the City's surface water rights in an effort to match the City's average surface water production curve, which is shown as an orange line in Figure 11-6. Since the City's use of Certificate 85526 and Permit S-49823 outside of the irrigation season would not be affected by the assumptions used in the following scenarios, we have only represented the use of the City's water rights during the irrigation season.

In this scenario, as in all scenarios, the City could use the full 6.0 cfs under Certificate 85526 throughout the irrigation season due to its seniority. The City would also use water at the full authorized rate under Certificate 31411 at the beginning of the irrigation season until it reached its annual volume limit. When that limit was reached in mid-June, the City would then begin using Transfer B-112 and Certificate 31665 for the remainder of the irrigation season. Initially, water could be used at the maximum authorized rate under Certificate 31665, but as stream flows decreased later in the summer, the rate of diversion would be reduced under the distribution schedule. Under this scenario, the City could not use the full authorized rate under Transfer B-112 due to its junior relative priority, and the allowed rate of diversion would be reduced further as stream flows decreased. As in Scenario 1, Permit S-49823 would contribute little water during the irrigation season due to its junior priority date. Under this scenario, the City would not be able to meet the average surface water production in the later part of the summer (after mid-July), as shown in Figure 11-6. While this scenario is not realistic today, it shows the potential implications of significant modifications to the implementation of the current distribution schedule. It should be noted that Figure 11-6 shows a scenario that has never occurred to date. As a result, it does *not* demonstrate that the City has used surface water in excess of its water rights. It only illustrates what could happen *if* regulation occurred throughout the irrigation season.

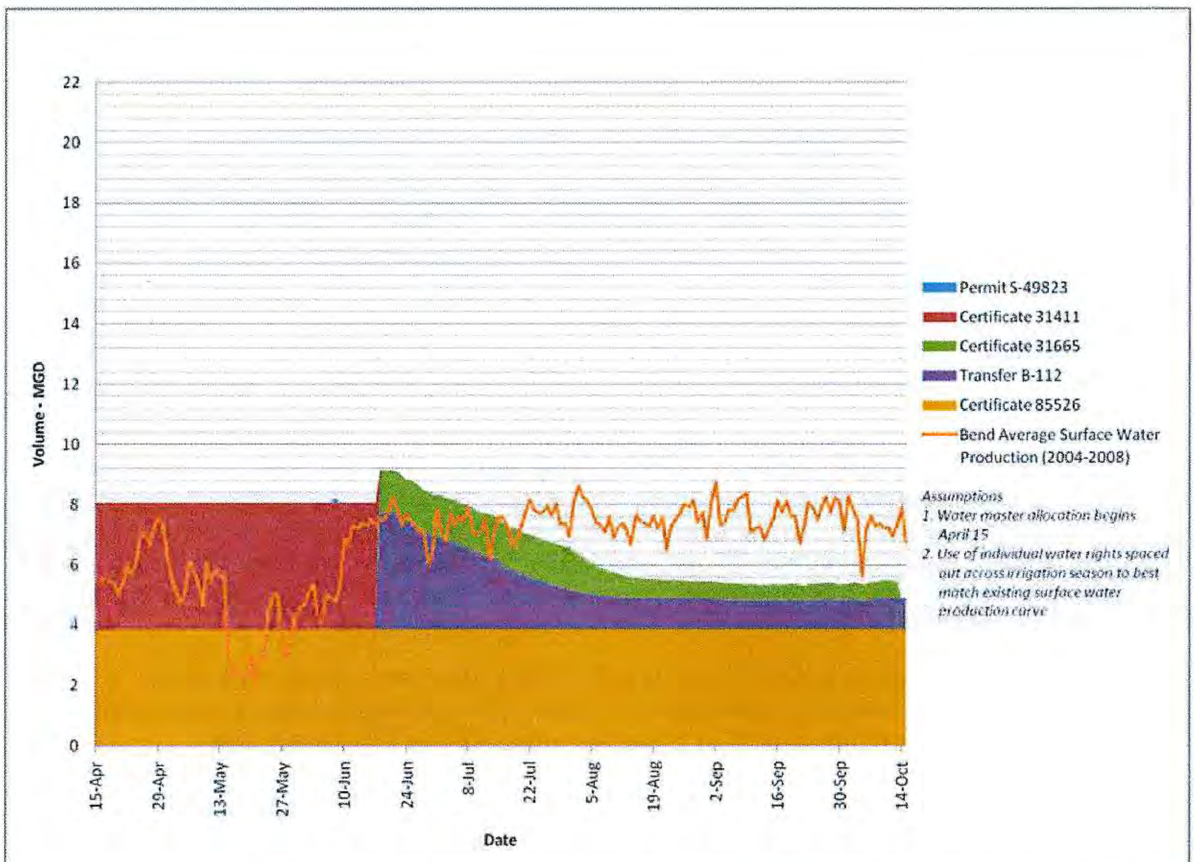


Figure 11-6. Daily Volume Produced During Irrigation Season – Scenario 2

(Not representative of actual use of water by the City of Bend)

11.4.3 Scenario 3

In Scenario 3, we assume that the watermaster will not begin regulating the City's water rights according to the distribution schedule until June 1 and will stop regulating after September 22. Based on historic regulation patterns (streamflow versus TID's need for water), this is a relatively conservative assumption. According to City staff, historically distribution has occurred in late July or early August. Similar to Scenario 2, we have arranged the City's use of its surface water rights during the irrigation season to match somewhat the City's average surface water production curve during the regulated portion of the irrigation season (June 1 to September 22).

As shown in Figure 11-7, assuming later initiation of regulation according to the distribution schedule increases the City's ability to use its Permit S-49823. It also increases the City's opportunity to use more water under its relatively junior water right, Transfer B-112, which has a 1913 priority date, during the unregulated portions of the irrigation season. In this scenario, the City is able to use its certificates to match closely its average surface water production curve during the regulated portions of the irrigation season and to exceed the historic production curve outside of the regulated portion of the irrigation season. The City could use the full authorized rate under Certificate 31665. Water could be used initially at the full rate authorized by Certificate 31411, but decreased streamflows would quickly result in a reduced rate of appropriation under the distribution schedule.

If the City wanted to improve its opportunity to increase use of surface water during the regulated portion of the irrigation season, it will need to obtain access to additional water rights or otherwise adjust its proportional share of Tumalo Creek water rights with TID. For example, the City could provide water from an irrigation district with Deschutes River water rights to TID in exchange for use of Tumalo Creek water. The water rights held by districts within the area authorize the use of water at rates that range from 1 cfs for every 32 acres of irrigation to 1 cfs for every 80 acres irrigation.

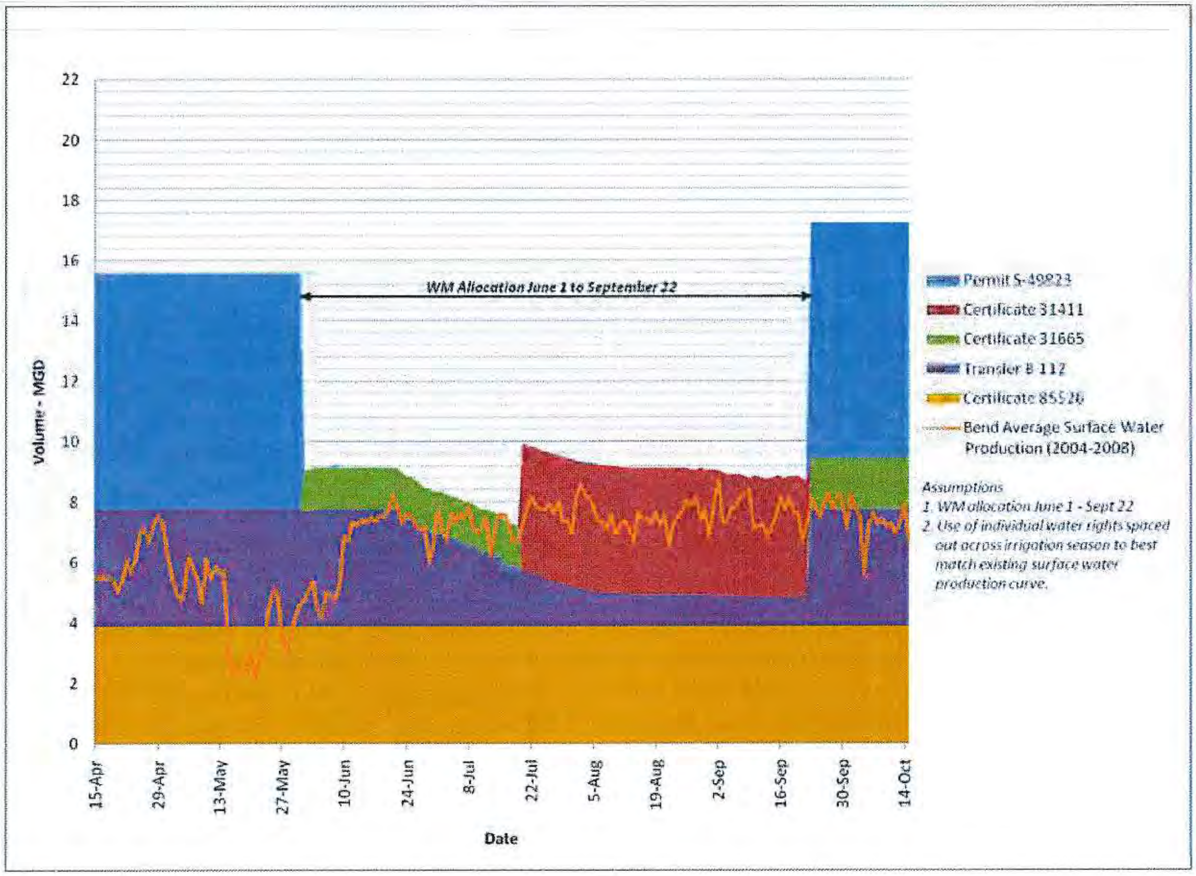


Figure 11-7. Daily Volume Produced During Irrigation Season – Scenario 3

Hypothetical use of the City's surface water rights under Scenario 3.

(Not representative of actual use of water by the City of Bend)

11.4.4 Scenario 4

In Scenario 4, we assume that the watermaster will not begin regulating the City's surface water rights according to the distribution schedule until August 1. Under current conditions, this may be a relatively realistic scenario, since based on the City's records, the watermaster often does not regulate Tumalo Creek until late July or early August. We have retained the other assumptions from Scenario 3.

Similar to Scenario 3, later initiation of regulation provides the opportunity for the City to more fully utilize its junior water rights (Permit S-49823 and Transfer B-112) during the irrigation season before stream flows drop and regulation by the watermaster begins, as shown in Figure 11-8. In addition, since the time period during which Tumalo Creek is currently regulated is short, the City appears to have opportunities to meet current and future demands through the use of surface water, if it chooses to do so. As described for Scenario 3, if the City wanted to improve its opportunity to increase use of surface water during the regulated portion of the year, it could obtain access to additional water rights or otherwise adjust its proportional share of Tumalo Creek water rights.

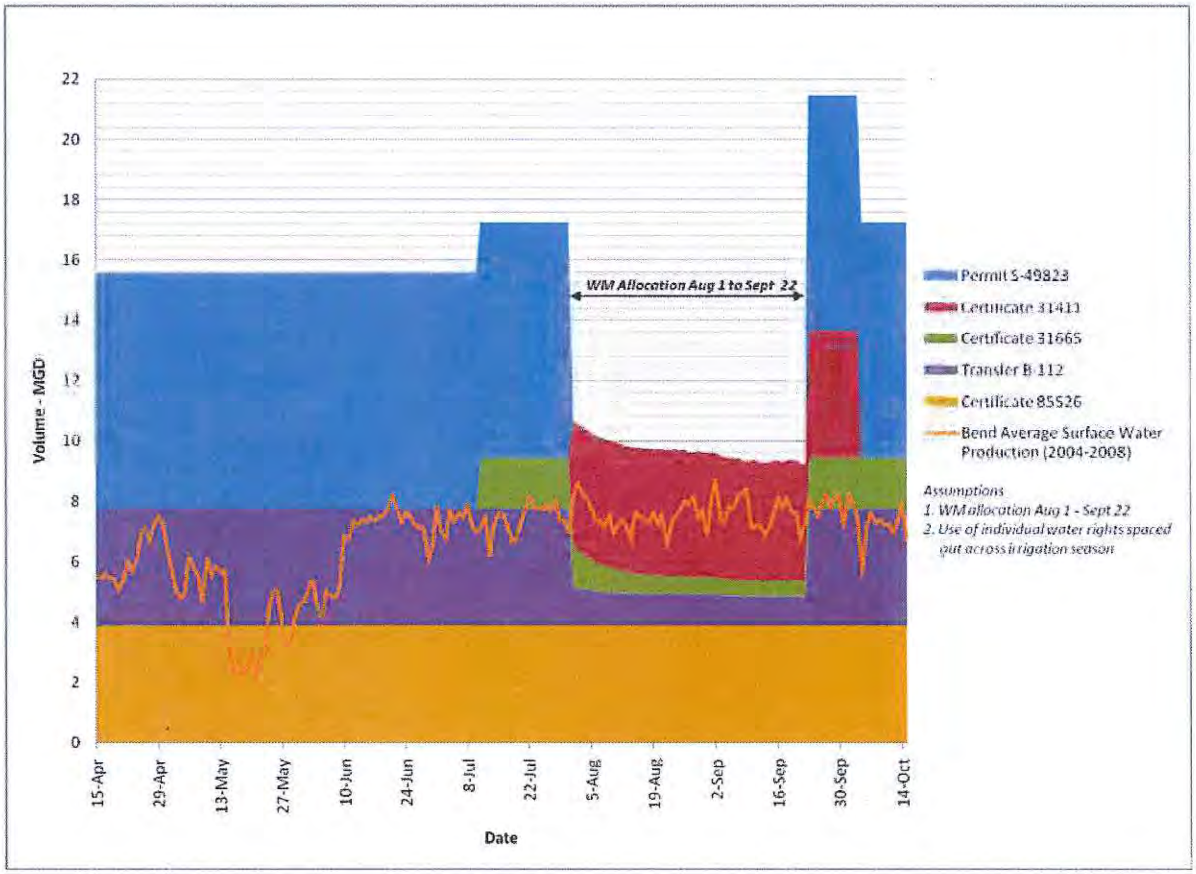


Figure 11-8. Daily Volume Produced During Irrigation Season – Scenario 4

Hypothetical use of the City's surface water rights under Scenario 4.

(Not representative of actual use of water by the City of Bend)

11.5 Summary

The City holds surface water and groundwater rights that it uses to meet municipal water demands. As the City considers how to best utilize these water rights to meet future water needs, in addition to engineering considerations, it will need to consider the limitations on the use of these water rights. Many of the City's surface water rights have season of use and annual water use limitations because they originated from irrigation rights. In addition, many of the surface water rights will be subject to regulation at some time during the irrigation season under the watermaster's distribution schedule. As a result, when considering potential changes to its use of surface water, the City should be mindful of these considerations and the basin-wide context of changing how it uses surface water currently.

To: Heidi Lansdowne, PE, City of Bend

From: Bryan Black, PE

Project: Surface Water Improvement Project

Date: October 27, 2010

RE: Surface Water / Groundwater Cost Comparison, FINAL

1 Executive Summary

The City of Bend currently relies on both surface water from Bridge Creek and groundwater from the Deschutes Regional Aquifer to serve its residents, and each source provides about one-half of the City's annual water supply. Surface water flows from higher elevations to customers through a gravity system; whereas groundwater is pumped from 300- to 750-feet below ground.

To continue using the surface water from Bridge Creek, the City must substantially re-invest in the surface water system to comply with new federal treatment requirements, as well as replace old transmission pipelines that are at risk of catastrophic failure. Facing this expense, the City completed a Water Supply Alternatives Study (WSAS) in 2009 that analyzed three alternatives for water delivery to Bend residents. The alternatives included re-investing in the surface water system, replacing the Bridge Creek supply with groundwater, or supplying water from the Deschutes River. After analyzing multiple variables - including water rights, existing water delivery infrastructure, and long term energy, construction, and operational costs, the consultant identified reinvestment in the Bridge Creek water supply as the most economical long-term water supply option.

The Water Supply Alternatives Study (2009) included consideration of hydroelectric power generation, associated grant funding, and revenue associated with selling the power generated. Some of the revenue sources assumed in the 2009 study are either no longer available or are substantially diminished. Therefore, the City Council directed staff to re-evaluate whether re-investment in the surface water system is still the most viable long-term option for providing water to the citizens of Bend.

1.1 Executive Summary – Purpose

The purpose of this memorandum is to determine which, out of the three options before the City (1-Surface water reinvestment with Hydropower, 2-Surface water reinvestment without Hydropower, and 3- Groundwater only), is the most economical choice for the ratepayers in the City of Bend.

To accurately analyze the costs associated with each option, this memorandum evaluates the initial and ongoing costs of each alternative over a 50-year planning horizon to determine which alternative is in the best long-term interest of the City and its ratepayers. A 50-year planning horizon was used since improvements will be designed to last for that duration, similar to the existing surface water system that has been in operation since 1926.

1.2 Executive Summary – Findings

The cost evaluation contained in this memorandum concludes that re-investing in the surface water source remains the least expensive long-term water supply alternative for the City, either with or without hydropower. This finding is mostly due to the lower cost (primarily power cost) of operating the surface water system as opposed to pumping groundwater. **Table ES-1** compares the primary alternatives to 1) keep surface water with hydropower; 2) keep surface water without hydropower; and 3) abandon surface water (use groundwater only). Abandoning surface water is anticipated to cost the City between $372 to $454 million more than surface-water options over the 50-year analysis period (see **Table ES-1, Figure ES-1**).

Table ES-1. Summary of Cumulative Cash Flow Costs of Water Supply Alternatives

Time Frame	Keep Surface Water with hydropower ($M)	Keep Surface Water no hydropower ($M)	Abandon Surface Water (Use Groundwater only) ($M)
2023 (10-year)	$64	$59	$71
2038 (25-year)	$148	$139	$201
2063 (50 year)	$103	$185	$557

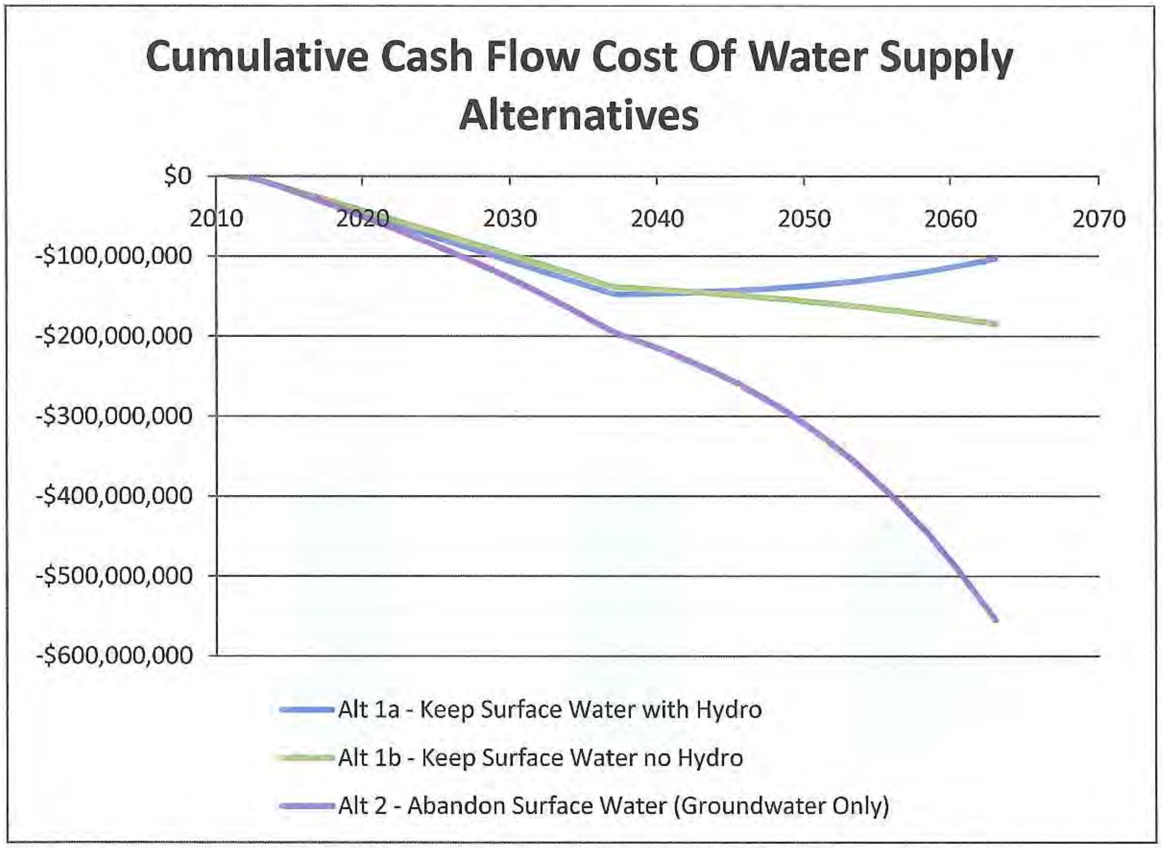


Figure ES-1. Cumulative Cash Flow Cost of Water Supply Alternatives

Figure ES-2 presents the present-worth costs of the water supply alternatives in year 2010 dollars. The alternatives that retain surface water are less expensive than the alternative to abandon surface water. This is primarily due to the power consumption and costs of pumping groundwater to replace surface water. The anticipated O&M cost for the abandon surface water (all groundwater) option is only slightly less than the entire project costs for the surface water alternatives.

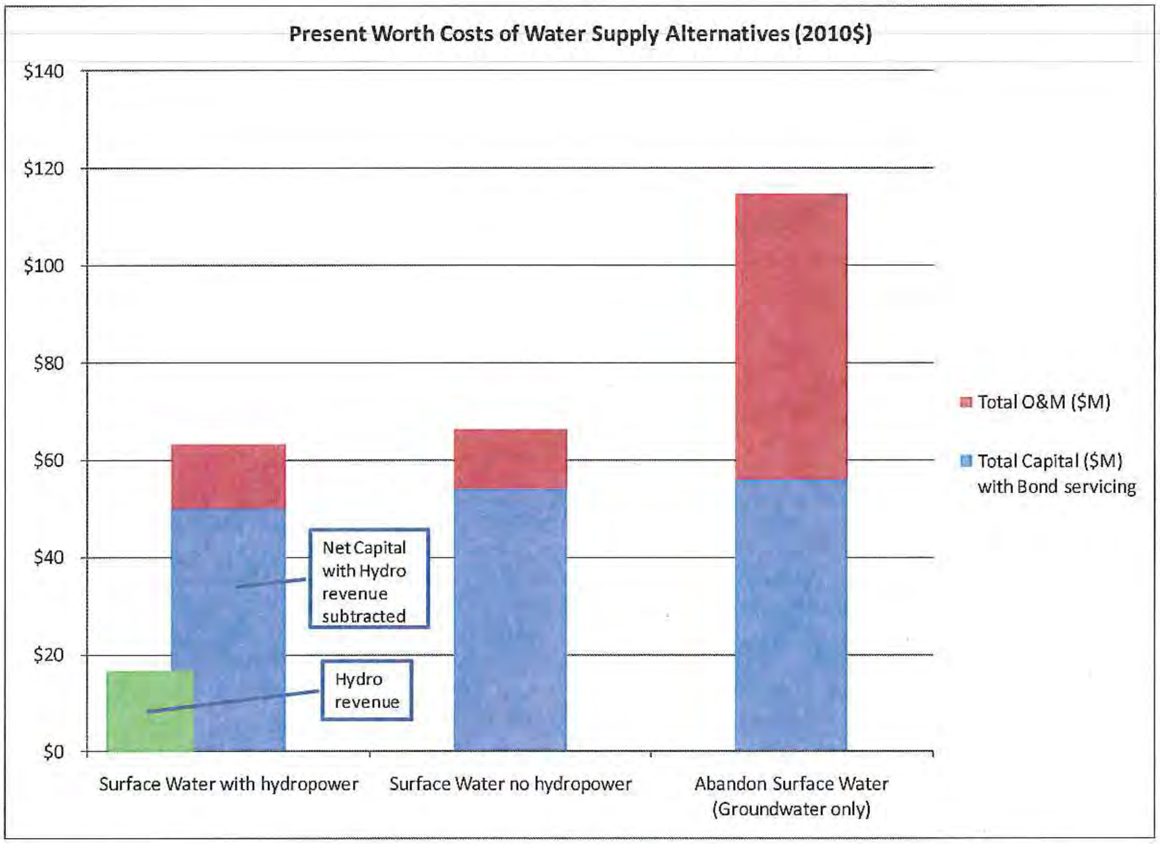


Figure ES-2. Present Worth Costs of Water Supply Alternatives (2010$)

2 Background

The City's drinking water is supplied from both groundwater and surface water sources. Over the last 10 years, each source provided about one-half of the City's annual water supply (**Figure 1**).

Figure 2 illustrates the elevations of the water sources. Surface water flows from higher elevations by gravity without pumping or power consumption. By contrast, groundwater must be pumped up from far below the City.

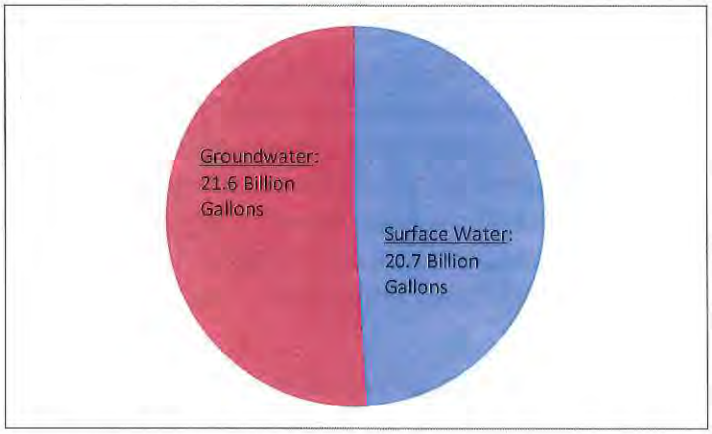


Figure 1. Surface water and groundwater each have provided about one-half of the City's supply over the last 10 years

The power consumption of pumping groundwater from 300- to 750-feet below the City is substantially greater than using surface water that flows by gravity without power consumption from 1,320-feet above the City. This makes surface water the more energy efficient and cost effective source to use.

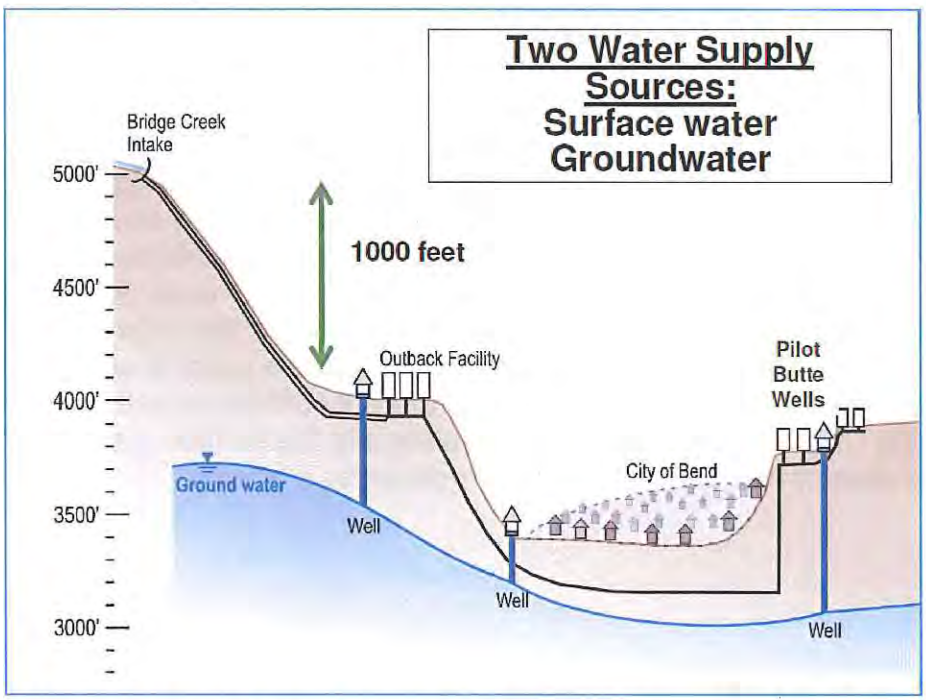


Figure 2. City of Bend's Dual Source Water System: Groundwater pumped from 300- to 750-feet below the City and Surface Water Flowing by Gravity without pumping from 1,320-feet above the City

Although surface water is less expensive to operate than groundwater, surface water supplies of high quality and in sufficient quantity to meet the entire water demand of the City of Bend are generally not available. Therefore, the

City developed a groundwater supply system to supplement surface water during times of peak water demands when the surface water supply is not sufficient.

The City's dual-source water system has served it well. Surface water is used year-round to meet the base water demands of the City, since surface water is the least expensive water source to operate. Groundwater capacity is more available but has higher operating costs – so it is best used to meet the short-term summer peak needs. By strategically developing and using both water sources as identified in **Table 1**, the City maintains the most cost-effective water system for its customers.

Table 1. General costs of City water supplies and best uses

Source	Operating cost	Best Use Principle
Surface Water	Lower	Year-round continuous operation to meet base demands minimizes energy use and operating costs
Groundwater	Higher	Short term operation to meet summer peak needs minimizes capital investment

Figure 3 illustrates the typical use of both surface water and groundwater to meet the overall water demands in the City. Since surface water has the lowest operating cost, City staff prioritizes the use of surface water and only uses groundwater when sufficient quantities of surface water are not available. In winter months – when there is enough surface water available to meet demand - most of the water used by the City is surface water since this is the most cost and energy efficient source to deliver. In the summer, surface water is used to the maximum extent possible, but available flows are not sufficient to meet the water needs of the City. Therefore, the City supplements the surface water supply with groundwater to meet peak summer demands.

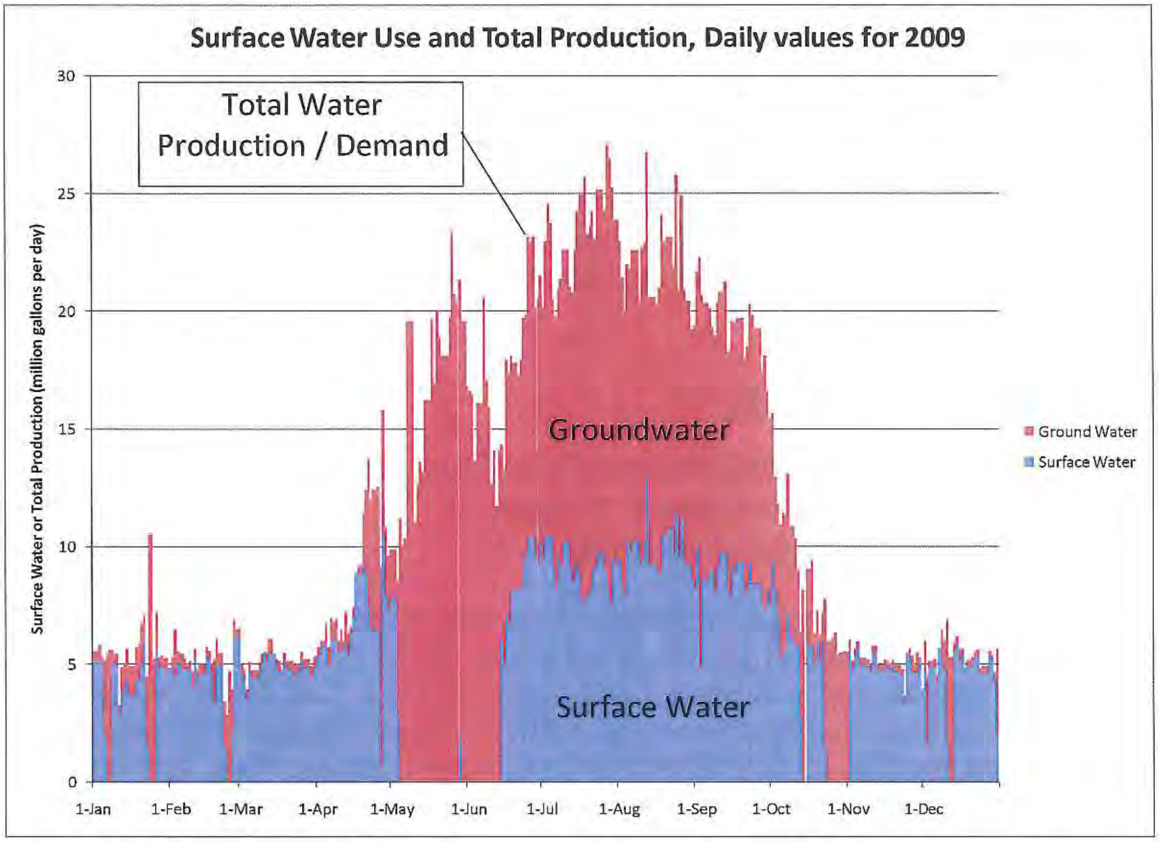


Figure 3. City staff prioritizes the use of surface water throughout the year since it is less expensive to operate and supplements with groundwater when surface water is not sufficient (during summer higher water use and during turbidity events)

Although the City's surface water system has historically been the most economical source of supply to operate, it now requires re-investment due to new treatment requirements and old transmission pipelines that are at risk of failure. A potential alternative to re-investment is to abandon the surface water supply system and replace it with additional groundwater wells. Although additional wells may seem to require less initial capital investment, the long-term costs of operations are greater. Therefore, to accurately analyze the costs associated with each option, this memorandum evaluates the initial and ongoing costs of each alternative over a 50-year planning horizon to determine which alternative is in the best long-term interest of the City and ratepayers.

An evaluation of alternative sources of supply, including re-investment in surface water and development of additional groundwater supply capacity, was completed in 2009 (Water Supply Alternatives Study, WSAS 2009). The WSAS recommended re-investing in the surface water system. The recommendation was based on inclusion of hydropower and associated assumed revenue and funding incentives. The projections for revenue and funding have now decreased, and on August 18, 2010, the City Council requested that the costs and feasibility of developing additional groundwater supply in lieu of re-investment in surface water be re-evaluated.

Abandoning the surface water supply system would require development of additional groundwater supply capacity. This memorandum compares the initial and on-going costs of 1) re-investing in (keeping) the surface water supply system and 2) abandoning the surface water supply and developing additional groundwater to meet demand. To determine which alternative is in the best long-term interest of the City's ratepayers, the analysis was completed over a 50-year planning horizon.

3 Water Demands

Current water demands (2008) for the City of Bend are:

- Average day annual demand: 12.8 mgd
- Maximum day demand: 29.2 mgd

Future water demands were projected for the City of Bend's master planning effort (see Future Demand section of the *Water Model Development Documentation for Water System Optimization* by MSA, Dec 2009). Water Demands are projected to increase by about 60% over the next 10 years and almost triple under build-out conditions in the current Master Plan, as shown in **Figure 4**. A sensitivity analysis was performed to evaluate the impact of water demand projections on the relative cost of alternatives as described in **Section 7**. The sensitivity analysis indicates that no reasonable variation in the water demand forecast would change the cost ranking of the water supply alternatives.

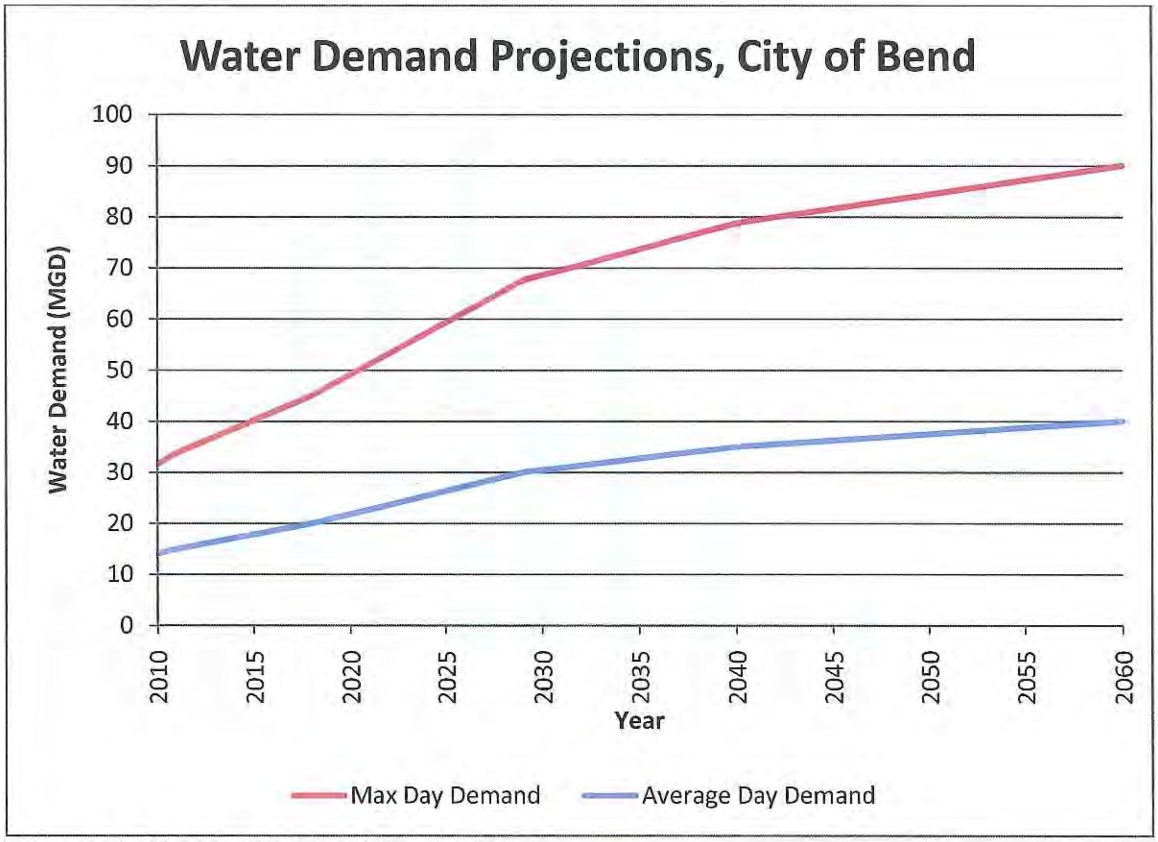


Figure 4. Water Demand Projections

To determine the potential use of surface water in the future, water demands were estimated on a monthly basis through the 50-year planning period. Demands were allocated by month based on the historical patterns of use, shown in **Figure 5**. Projected water demands by month through the 50-year planning period are presented in **Appendix A, Table A-1**.

This analysis did not consider effects of water conservation strategies, such as conservation pricing schemes and outreach programs, on projected demands. Projecting potential changes in use based on such efforts is highly speculative. The City continues to consider conservation pricing and has directed staff to remove the remaining base quantity allowance. At the same time, the City is committed to maintaining affordable water rates to its citizens. The City will continue to implement their Water Management and Conservation Plan and its WaterWise program as budgets allow. However, water conservation alone will not provide adequate supplies for all future water demands.

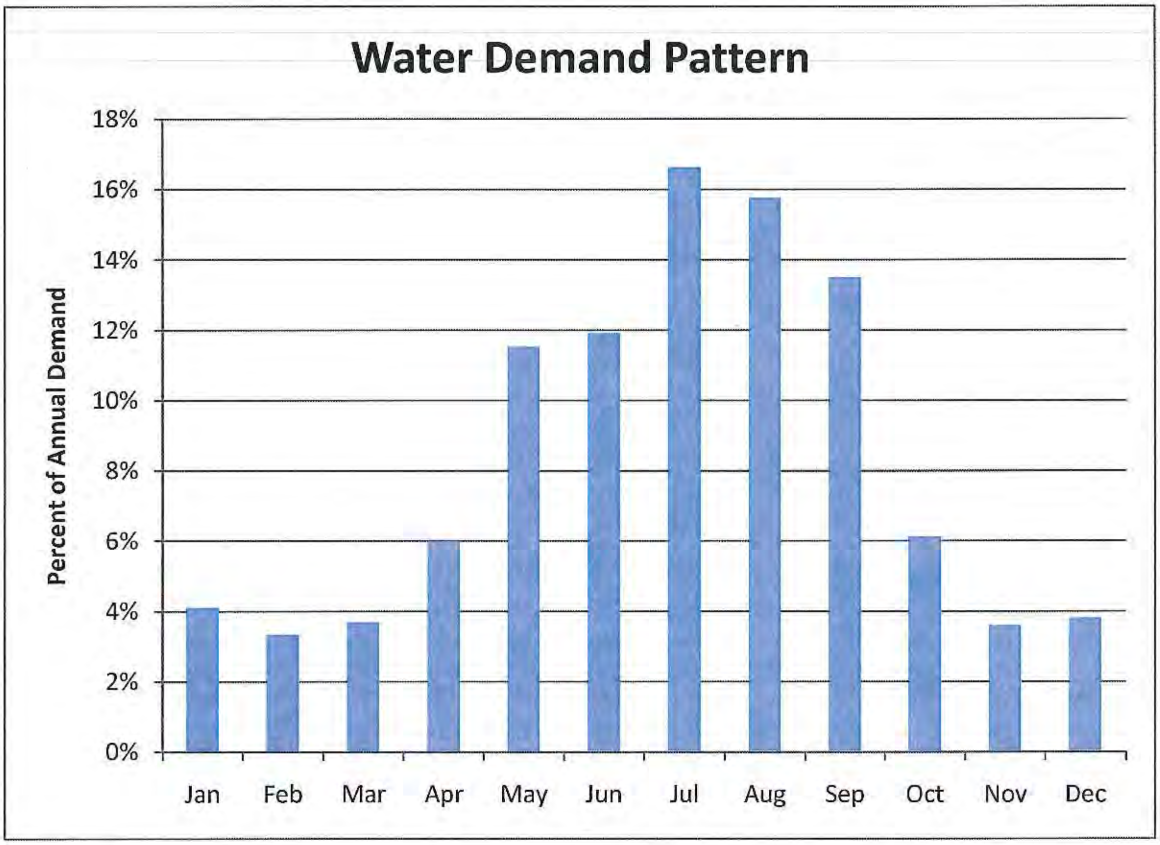


Figure 5. Historical water demand pattern

4 Cost Analysis Assumptions

This section describes some of the assumptions used in the cost analysis.

4.1 Cost Evaluation Period

Deciding whether to re-invest in its surface water supply is an important long-term decision, given that elements of the existing surface water system have lasted over 80-years (since 1926). Although a new surface water project is anticipated to last 80-years or longer, this cost evaluation has been limited to a 50-year time frame. Extending the cost evaluation beyond 50-years will favor the water supply alternative with the lower operating costs.

4.2 Future Cost of Power

A long-term decision on whether to re-invest in the surface water system requires understanding the operational cost differences between a new surface water system and replacing the surface water system with groundwater, so power consumption and costs must be estimated over the evaluation period of 50-years. Data from the Northwest Power and Conservation Council was used to estimate potential power cost increases over the 50-year planning period

In 2010, the NW Power and Conservation Council developed a long-term forecast (through 2030) of Mid-Columbia wholesale power prices as a key input to its 6th Northwest Power Plan (see www.nwcouncil.org).

The Northwest Power and Conservation Council uses the AURORA$^{xmp®}$ Electric Market Model to forecast electricity prices for the Pacific Northwest. The AURORA^{xmp} model projects future wholesale power market prices based on model inputs that determine the underlying supply and demand conditions in the future. Key inputs to the AURORA^{xmp} model include forecasts of future electricity demand, inventories of existing electricity generating plants, forecasts of construction costs for new electricity generating plants, and forecasts of future fuel prices for electricity generating plants. Given the forecast of future electricity demand and the set of drivers of future electricity supply, the model then uses economic logic to project future resource additions and market-clearing wholesale electricity prices. Prices shown reflect spot market transactions for wholesale power supplies delivered at the Mid-Columbia trading hub. The price forecast is expressed nominal dollar values (includes inflation).

The average NW Power and Conservation Council wholesale power cost forecast is presented in **Figure 6**. Wholesale power costs are anticipated to triple over the next 20 years. Power costs are projected to be lowest in May and June, and highest in November and December.

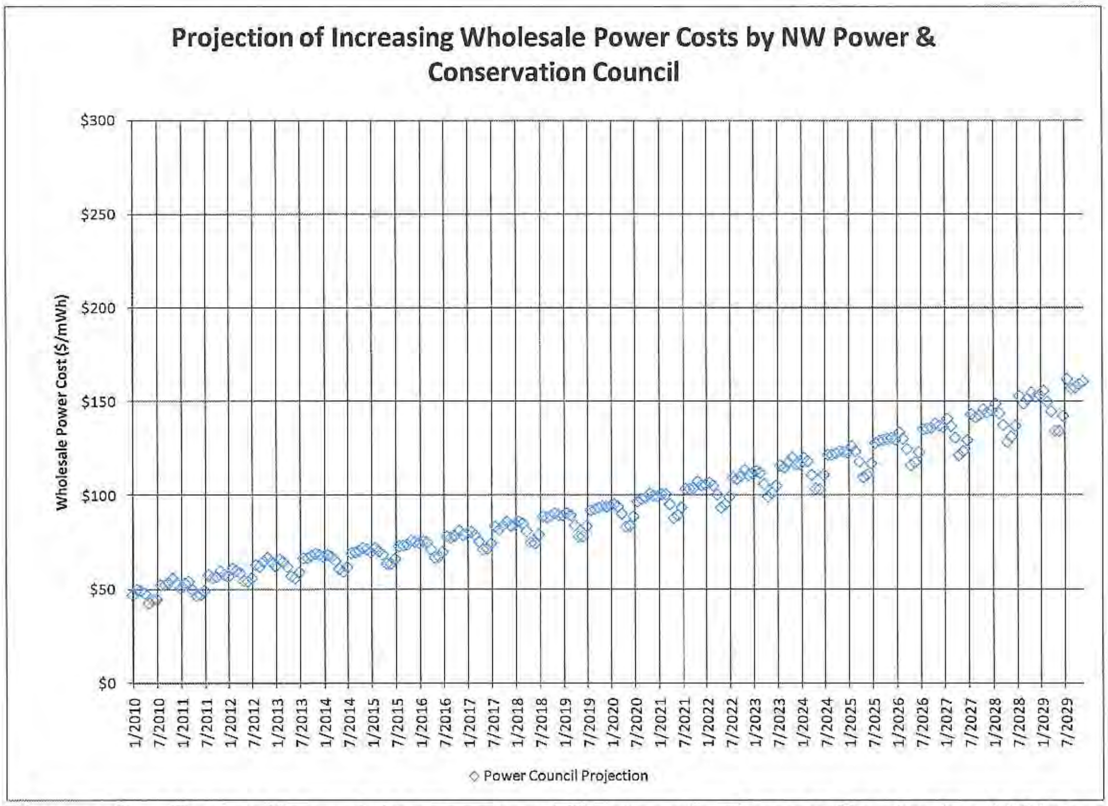


Figure 6. Projection of Increasing Wholesale Power Costs by NW Power and Conservation Council

The NW Power and Conservation Council projections were analyzed to determine the equivalent annual percent increase. The best-fit equivalent annual percent increase was determined by minimizing the squared residuals between Council derived and model predicted costs (least-squares optimization). The best-fit equivalent annual wholesale power percent increase was determined to be 6.22% per year. **Figure 7** compares the Council's projections (data points) against projections using the 6.22% per year increase model (solid line). The 6.22% per year model provides a good approximation of the NW Power Council's forecasted wholesale power cost data.

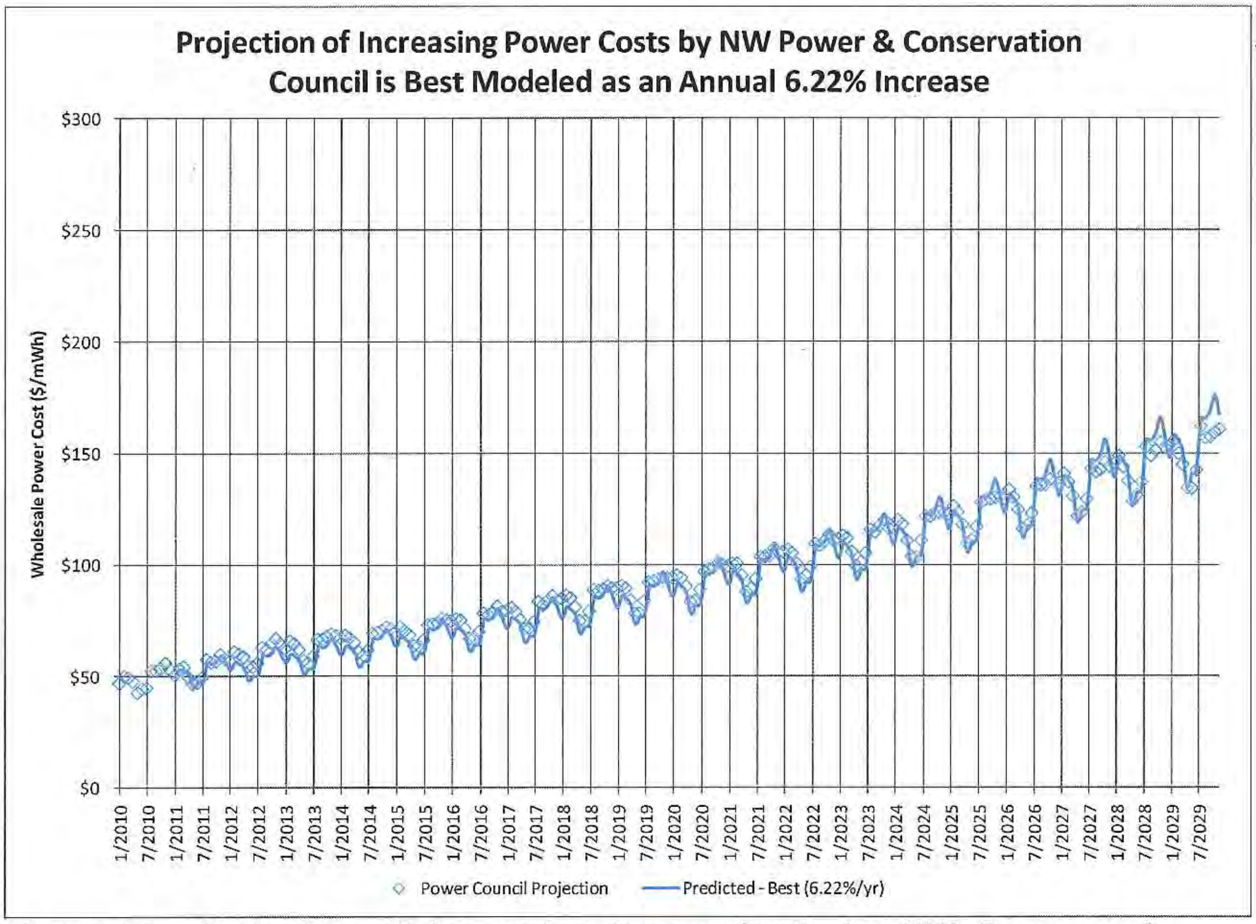


Figure 7. Projection of Increasing Power Costs by NW Power and Conservation Council is Best Modeled as Annual 6.22% Increase

A sensitivity analysis was performed to evaluate the impact of power cost escalation on the relative cost of alternatives as described in **Section 7**. The sensitivity analysis indicates that no reasonable variation in the power cost escalation would change the cost ranking of the water supply alternatives.

4.3 Other Cost Assumptions

The cost analysis was performed using the assumptions listed in **Table 2**.

Table 2. Assumptions used in the Cost Analysis

Cost Analysis Parameter	Value
Discount Rate	6%
Interest rate for tax free bonds	5.5%
Interest rate for taxable bonds	7%
Escalation of O&M Costs (except power), last 10-year average inflation	2.3%
Escalation of Power Purchase Costs (including inflation); Escalation of Power Revenue after schedule expiration in 20 years	6.22%
Loan duration	25 years

5 Water Sources

The City's dual-source water supply system provides flexibility and reliability for the City. The current maximum day water demand (2008) is approximately 29.2 mgd. Existing wells in service can provide about 26.8 mgd. The surface water system, with proposed improvements, could provide 13.6 mgd, bringing the total reliable water supply to about 40.4 mgd. If re-investment in the surface water system is not made, the City will need to invest in additional groundwater wells to replace the 13.6 mgd capacity.

The water sources are briefly described below.

5.1 Surface Water

The City's surface water is obtained from Bridge Creek, a tributary to Tumalo Creek. Water flows from the source to customers' taps by gravity. Historically, surface water has been the least expensive source for the City to use because it does not require pumping.

The City's surface water system now requires re-investment for continued use due to new treatment requirements and the need to replace the old raw water transmission pipelines that are in poor condition. Because of the elevation drop from the source, the City could add hydroelectric turbines to the surface water delivery system to produce power from the water supply flowing to town. Installation of hydropower would require water intake improvements to comply with Oregon fish passage requirements. No intake improvements are anticipated to be required if hydropower is not installed.

5.1.1 Projected future surface water use

The future use of the Bridge Creek surface water supply will be determined by either the City's demand or water availability, whichever is less. Projected water demands by month through the 50-year planning period are presented in **Appendix A, Table A-1**. The City has rights to divert up to 13.6 mgd (21 cfs) of surface water in the winter and up to 23.3 mgd (36 cfs) in the summer.

However, water availability and other senior rights to divert water from Tumalo Creek will likely limit the rate at which the City can divert surface water. Based on an evaluation of creek flows, the expected typical maximum water diversion rate is listed in **Table 3**.

Table 3. Expected typical maximum water diversion rate

Month	Typical Water Right Availability (MGD)	Typical Water Right Availability (cfs)
Jan	13.6	21.0
Feb	13.6	21.0
Mar	13.6	21.0
Apr	11.6	18.0
May	12.9	20.0
Jun	13.6	21.0
Jul	11.6	18.0
Aug	11.0	17.0
Sep	11.0	17.0
Oct	11.0	17.0
Nov	13.6	21.0
Dec	13.6	21.0

Future surface water use is projected by taking the minimum of the projected water demand by the City and the surface water supply available under the water right. The projections assume filtration is installed so that surface water can be used year-round, even during spring snow-melt conditions. **Figure 8** projects total water demand and projected surface water use in year 2015. Use of surface water in the winter would be limited by the water demand in the City. During summer, water demand increases and available water becomes the factor limiting surface water use.

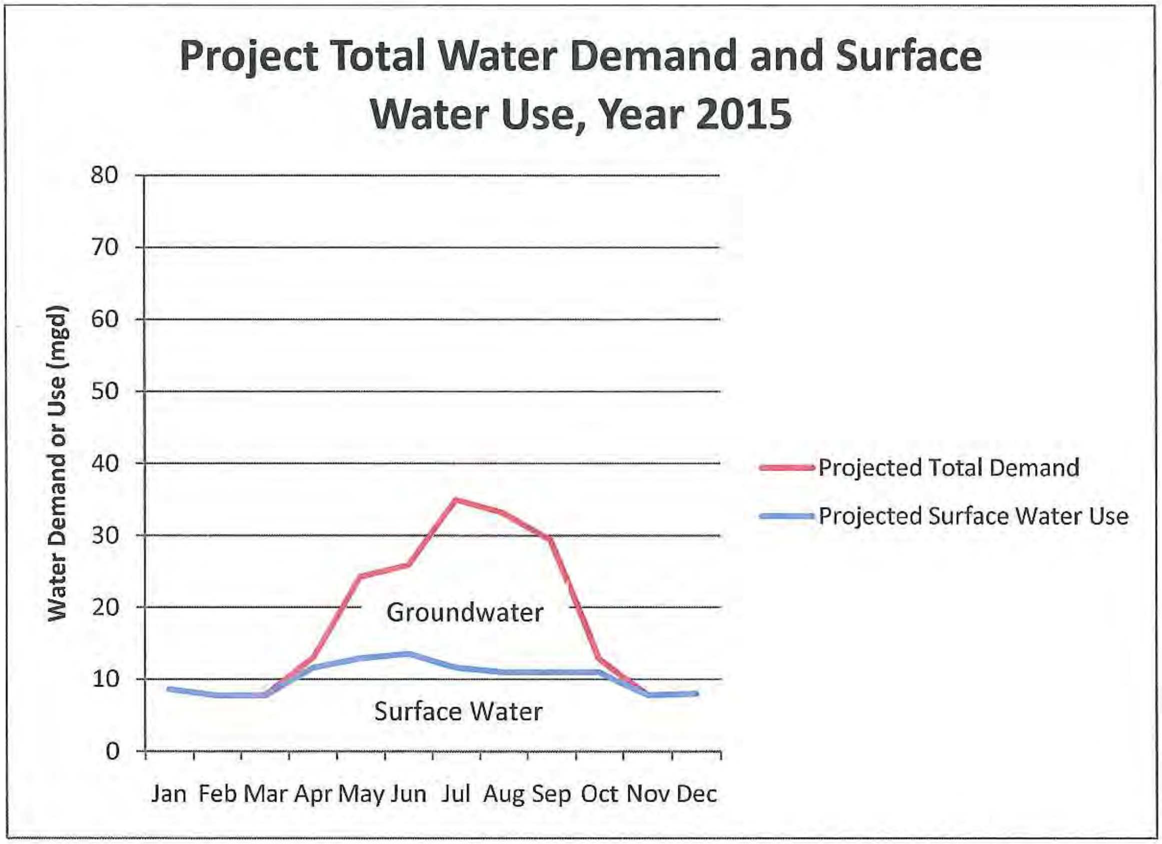


Figure 8. Projected total water demand and surface water use, year 2015.

Figure 9 projects total water demand and surface water use in year 2040. By 2040, winter demands are expected to be greater than the rights / availability of surface water. Therefore, in 2040, surface water use would be limited by rights / availability throughout the year. Surface water use is not currently anticipated to increase beyond the use shown in 2040 due to limited availability and water rights.

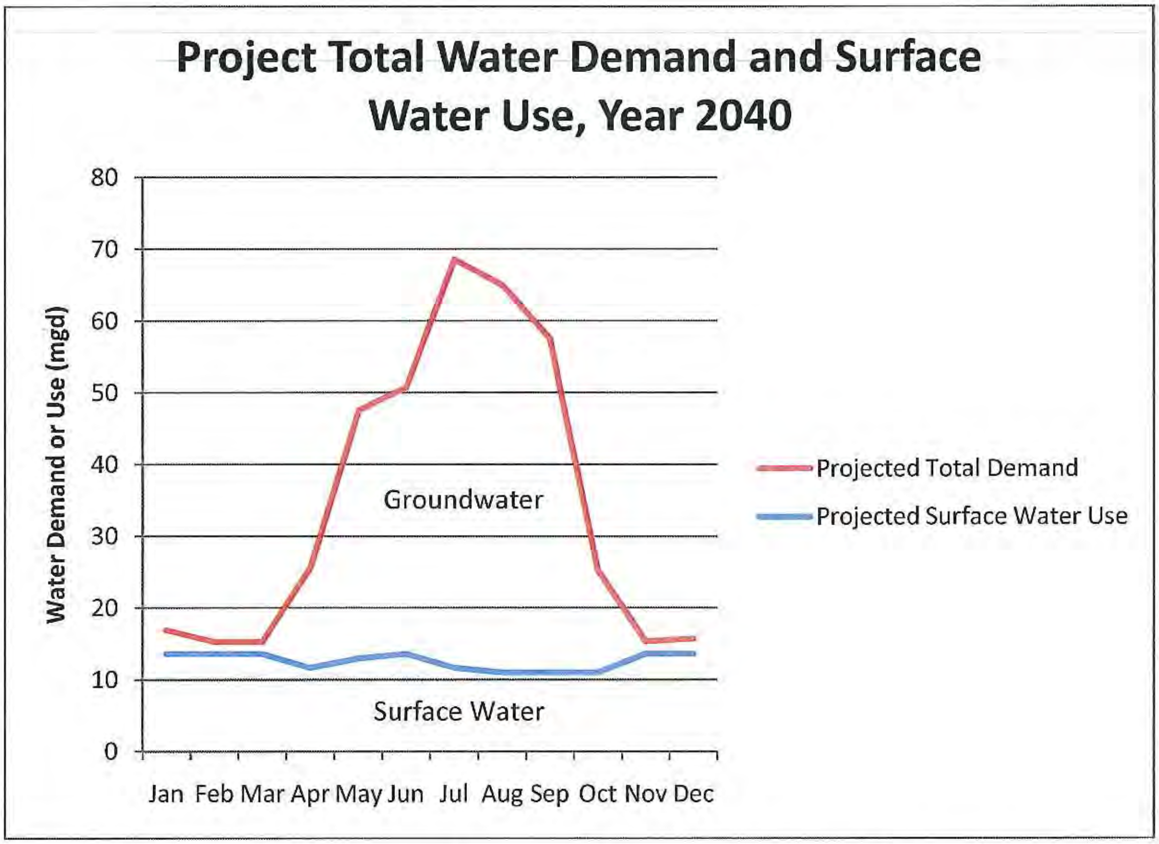


Figure 9. Projected total water demand and surface water use, year 2040

Appendix A, Table A-2 presents the projections of potential surface water use by month over the 50-year planning period.

5.1.2 Capital Costs

Cost estimates for required and optional improvements are listed in **Table 4**. Cost estimates assume a new raw water transmission pipeline (conduit) to the Bridge Creek Intake and a membrane filtration water treatment plant. Optional improvements related to production of hydropower include intake modifications or replacement and a hydroelectric powerhouse.

Table 4. Current capital cost estimates for needed and optional surface water improvements

Required or optional?	Item	Cost $M
Required	Conduit	28.0
	Membrane Filtration WTP	29.75
	Subtotal Required	**57.75**
Optional	Intake	1.87
	Hydropower	13.46
	Total Project	**73.08**

The capacity of the surface water system (with proposed improvements) is assumed to be 13.6 mgd (21 cfs), but the City holds rights to 23.3 mgd (36 cfs) during the summer irrigation season.

5.1.3 O&M Costs

The operation and maintenance (O&M) costs for the re-built surface water system would be higher since filtration is proposed. The expected annual 2010 O&M cost for a membrane filtration plant (including capital refurbishment and filter replacement) is projected to be $502,000 (see **Appendix A, Table A-3**), and for hydropower generation is assumed to be $55,250 (WSAS, 2009). These O&M costs are considered to be conservative given the excellent raw water quality of Bridge Creek. Power costs associated with membrane filtration water treatment are escalated similar to that for groundwater as described in **Section 4.2.**

5.2 Groundwater

Bend currently operates 9 groundwater facilities throughout its service area, consisting of 25 wells that pump Deschutes Aquifer water to the City's system. The total in-service groundwater well capacity is 26.8 mgd (Optimatics, 2010) and the 2008 maximum day water demand was 29.2 mgd. The City must operate its systems to meet peak day demand, and does not currently have excess well capacity. In 2011 the City utilized over 11 mgd of surface water to meet its peak demand. Groundwater is located generally 300- to 750-feet below the ground in Bend and must be pumped up to the various pressure zones throughout the City. The pumping required to supply groundwater makes the groundwater system more costly for the City to operate than the surface water source that does not require pumping.

5.2.1 Capital Costs

To deliver the same amount of water provided by the current dual-source water system, an additional 13.6 mgd in groundwater well capacity would need to be developed. The cost for new wells is estimated at $1.89M per MGD of capacity including contingency, engineering, and administration (MSA 2009, Optimatics 2010). This cost estimate assumes a 16-inch diameter steel casing and a static water depth of 750 ft below ground surface. **Table 5** lists the assumptions associated with estimating the capital costs of additional groundwater wells. A total well capacity of 15.1 mgd is estimated to be needed to achieve the firm capacity of 13.6 mgd (with one well out of service) that would be equivalent to the surface water supply capacity. The new wells would need to be outfitted with standby engine power generators (diesel) to ensure reliability. The total estimated capital cost for installing the groundwater wells is $28.5M, but additional facilities would be needed to transmit the water to new terminal storage reservoirs for water distribution.

The City's water distribution system has been developed to accept and distribute surface water through the Outback Reservoir site. The City has planned to retain surface water and supplement the surface water with wells at the Outback site. If the surface water source is abandoned, then new well fields would need to be installed out in undeveloped areas of the distribution system to supplement the wells already planned for the Outback site. Developing additional groundwater to replace the surface water would require new pipelines in addition to new wells to transmit the water to new terminal storage reservoirs. New terminal storage reservoirs would be required to equalize the flow rate so the water can be distributed to meet the City's variable water demand pattern.

Additional actions and facilities costs associated with integrating the new additional wells to replace surface water are described in the memorandum in **Appendix B.** A summary of facilities and estimated costs are presented in **Table 6**. Groundwater right mitigation costs are unknown and so mitigation costs are included in this analysis. However, these mitigation costs are not considered insignificant. Current mitigation requirements are estimated at $6M.

Table 5. Capital Cost of Additional Wells to Replace Surface Water with Groundwater

Surface Water Supply (MGD)	13.6
Typical Well Capacity (MGD)	1.5
Number of Wells Required	9.0
Extra Well for Firm Capacity (reliability)	1
Total Number of Wells	10.0
Total Well Capacity (MGD)	15.1
Unit Cost of Well Capacity ($M/mgd)	1.89
Total Capital Cost ($M)	28.5
Construction Start Date	2011
Construction End Date	2016
Construction Duration (years)	5
Average Annual Expenditure ($M/yr)	5.7
Well O&M Rate (% of capital cost)	1.00%
Well O&M excluding power ($M/year)	0.204

Table 6. Additional costs required to develop 13.6 mgd additional groundwater supply to replace surface water

Action / Facility	Anticipated Cost, $M
Construction of new well fields (see **Table 5**)	$28.5
Water Master Plan	$0.2
Land Acquisition	$0.25
Well field transmission piping	$22.01
New terminal storage reservoirs	$8.51
Booster pumping capital costs	None anticipated - needs review
Additional storage in the distribution system	None anticipated – needs review
Total	**$59.47**

5.2.2 O&M Costs

Drilling and installation costs for the new wells are included above under Capital Costs. The O&M costs associated with groundwater pumping are related primarily to pumping energy, mechanical repairs, and labor.

5.2.2.1 Pumping energy and costs

The City of Bend tracks power costs for operating its existing wells. Power costs for groundwater wells including power demand charges for 2008 are listed in **Table 7**.

Table 7. City of Bend Observed Annual Power Costs for Wells in 2008

Facilities	2008 Annual Cost Pacific Power
Bear Creek Wells 1 & 2	$80,700
Copperstone Well	$42,800
Hole 10 Wells	$67,100
Outback 6,7,8	$27,700
Outback Wells 1,2	$40,500
Outback Wells 3,4,5	$91,200
Pilot Butte Wells 1,3	$74,900
North River Well	$29,200
South River Well	$74,700
Rock Bluff Well 1,2,3	$50,300
Shilo Wells	$16,300
Westwood Well	$7,600
Total	**$603,000**

Operating costs include energy and demand charges for water facilities in the main system. Does not include costs associated with:

Surface water
Reservoirs
Disinfection
Irrigation
Airport system

Observed well production was obtained to understand the relationship between well water production and power costs. Observed well production and power costs are presented in **Table 8**.

Table 8. 2008 Well Production and Power Cost

Month	Well production (MG/month)	Power Cost ($/month)
Jan-08	60	22,742
Feb-08	25	19,263
Mar-08	20	10,572
Apr-08	42	13,380
May-08	380	35,614
Jun-08	442	88,614
Jul-08	580	103,291
Aug-08	466	96,626
Sep-08	380	95,779
Oct-08	80	68,168
Nov-08	68	21,687
Dec-08	85	27,265
Total	**2628**	**603,000**

The 2008 power cost of $603,000 was associated with operating the wells to produce 2,628 million gallons in 2008, resulting in an observed power cost for groundwater production of $230/Million Gallons (MG). Theoretical engineering calculations were also performed using the 2008 well production data. The engineering calculations generally agree with the values observed presented in **Table 8,** as described in **Appendix C**.

The observed power cost for groundwater production of $230/MG was applied to the projected future use of surface water, assuming that the City would replace the future use of surface water with groundwater. **Appendix A, Table A-4** provides estimates of the estimated power consumption by using wells / groundwater instead of surface water. **Appendix A, Table A-5** lists the assumed unit power costs ($/kW-hr) and **Table A-6** lists the anticipated costs of pumping groundwater to replace the available surface water.

5.2.2.2 Other O&M costs

Other O&M costs related to operating additional wells include labor, mechanical materials / repairs, and upkeep. These other O&M costs are typically estimated as 2.5% of the capital costs of the facilities. However, for purposes of this study since other wells are already operated by the City, the O&M costs were estimated at only 1% of the capital costs. This results in an estimated annual cost for other O&M of approximately $200,000 per year (2010 dollars) for the 10 new wells needed to replace surface water. A significant component of the other O&M costs is anticipated to be pump motor maintenance and replacement. New motors for these wells are anticipated to cost in the range of $30,000.

6 Cost analysis and results

The cost analysis compared the known and assumed costs for building and operating the water sources, either 1a) refurbished surface water system with membrane filtration and hydropower; 1b) refurbished surface water system with membrane filtration no hydropower; and 2) abandoning the surface water system and replacing with additional groundwater supply.

A summary comparison of initial capital and year one O&M costs and revenue is presented in **Table 9**.

Table 9. Summary of initial capital costs and year one O&M costs / revenue

Year 2010 Costs	Surface Water with Hydropower ($M)	Surface Water no Hydropower ($M)	Abandon Surface Water (New Groundwater Only) ($M)
Capital Cost ($M)	73.08	57.75	59.47
O&M Cost ($/yr)	557,253	502,000	985,478
Hydro revenue ($/yr)	700,000	0	0

The cost analysis was completed over a 50-year planning horizon. The current surface water system has lasted since 1926, over 80 years, so a 50- to 80-year analysis time frame is considered appropriate.

The 50-year analysis, including initial construction costs and on-going operating costs, indicates that the dual-source system (surface water and groundwater) is a significantly less costly water supply alternative for the City of Bend than the all-groundwater alternative (see **Table 10 and Figures 10 and 11**). The all-groundwater alternative is anticipated to cost more than double the dual-source alternative over the 50-year period, and this differential gets even larger if viewed on an 80-year time frame. When compared with the dual-source alternative that includes hydropower, the groundwater-only alternative is more than three times as expensive. If the City decides to abandon surface water, it can expect to pay an additional $372 million to $454 million over the course of the 50-year planning period.

Table 10. Costs of Water Supply Alternatives over 50 Years (cumulative cash flows)

	Surface Water with hydropower	Surface Water no hydropower	Abandon Surface Water (Groundwater only)
Total Capital ($M) with Bond servicing	$151	$119	$122
Total O&M ($M)	$71	$66	$434
Total Revenue ($M)	($119)	$0	$0
Total Cumulative Cash Flow ($M)	$103	$185	$557

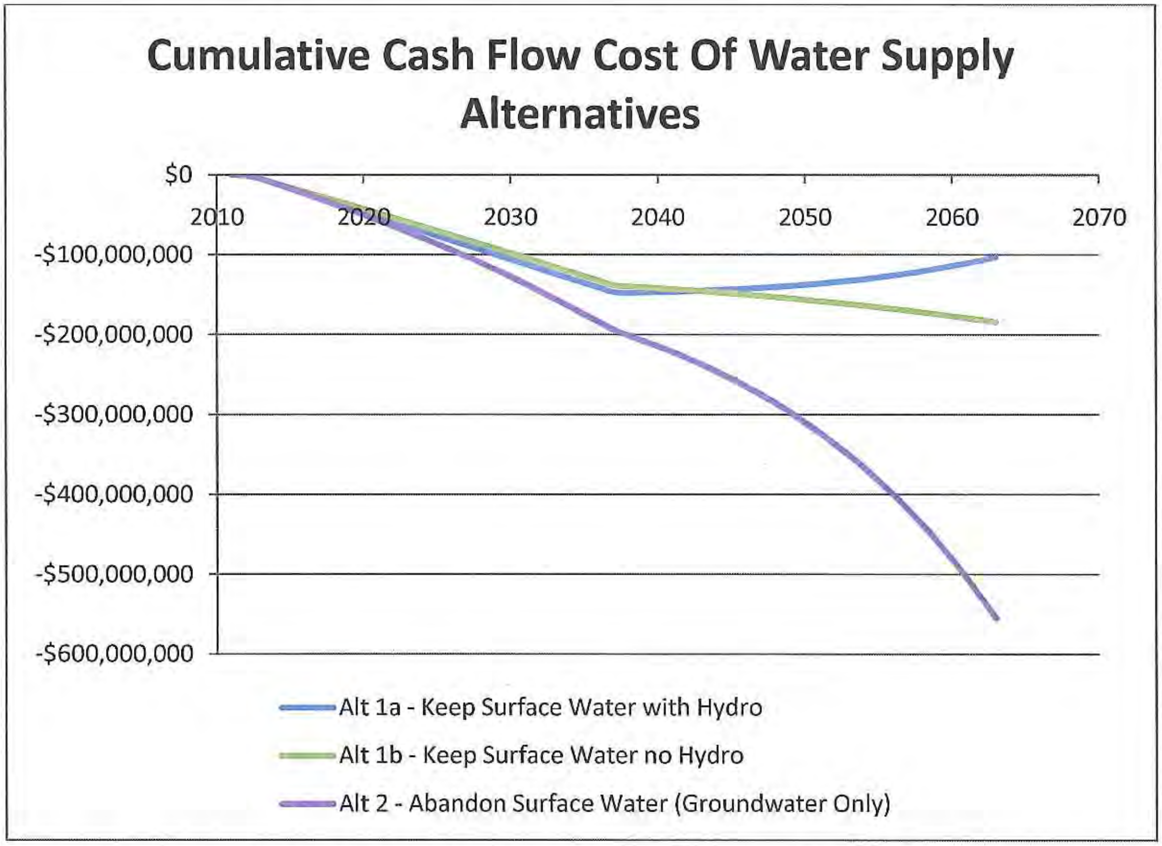


Figure 10. Cumulative Cash Flow Cost of Water Supply Alternatives

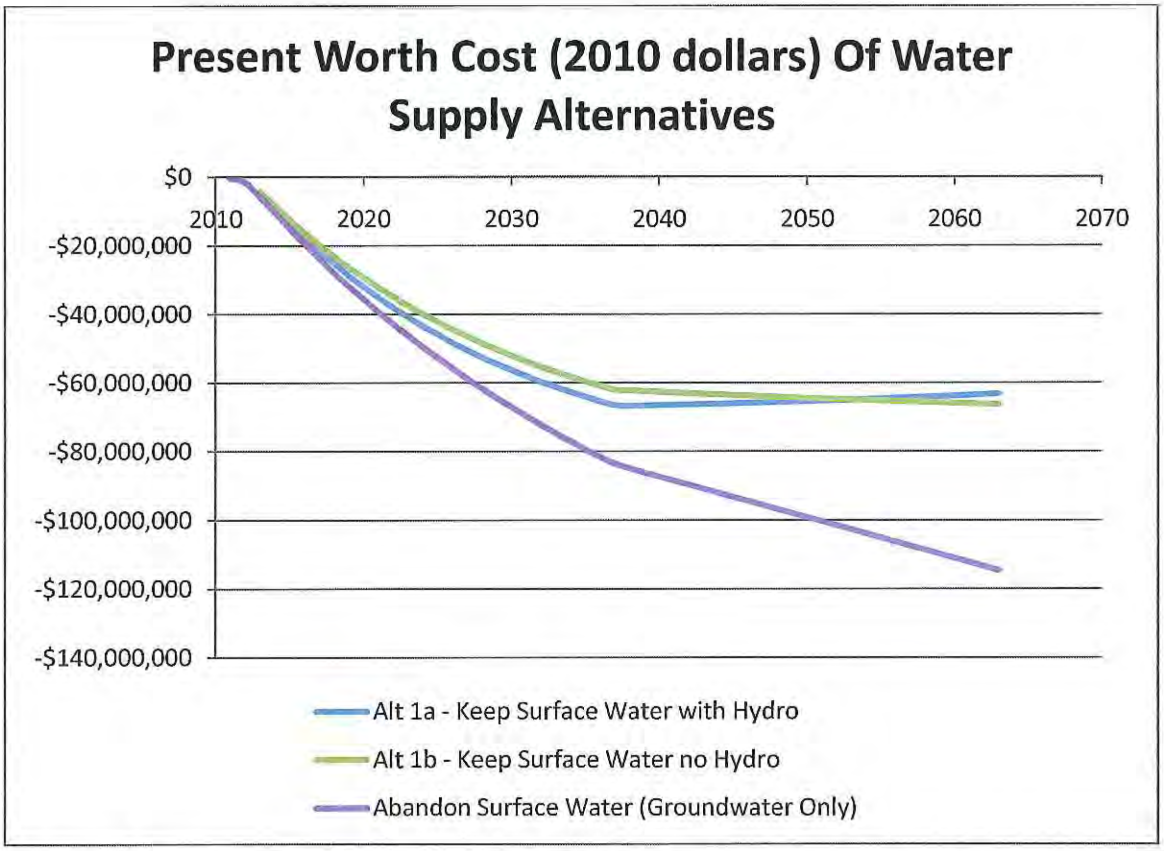


Figure 11. Present Worth Cost (2010 dollars) of Water Supply Alternatives

Abandoning surface water and going all groundwater is an expensive option for the City. The initial costs are comparable to re-building the surface water system, but the operating costs are much greater primarily due to the greater power consumption.

7 Sensitivity Analysis

The relative cost of water supply alternatives may be impacted by key assumptions in the cost analysis, including the escalation in power cost and the projection of water demands. This section provides a sensitivity analysis for these cost parameters.

7.1 Escalation in Power Cost

The cost analysis assumes a 6.22% annual increase in the cost of power, including inflation assumed to be 2.3%. This sensitivity analysis evaluated cost projections under conditions where the cost of power escalated at only 1% over inflation, or 3.3%. Under these conditions, the total 50-year cumulative cost of the abandon surface water (all groundwater) option is estimated to be $287M (see **Table 11**). Under the low power escalation scenario, the abandon surface water (all groundwater) option is $102M to $184M more expensive than the surface water options (see **Table 12**).

Table 11. Results of Sensitivity Analysis for Escalation in Power Costs, Costs of Abandon Surface Water (Groundwater Only) Alternative (50-year (cumulative cash flow)

Scenario:	Base Condition	Low Power Escalation (1% greater than inflation)
Assumed power escalation	6.22% / year	3.3% / year
Inflation included in Assumed Power Escalation	2.3% / year	2.3% / year
Total Capital ($M) with Bond servicing	$122M	$122M
Total O&M ($M)	$434M	$165M
Total Cumulative Cash Flow ($M)	$557M	$287M

Table 12. Costs of Water Supply Alternatives Under Low Power Cost Escalation Scenario, (50-year cumulative cash flow)

	Surface Water with hydropower	Surface Water no hydropower	Abandon Surface Water (Groundwater only) – Low Power Escalation Scenario
Total Cumulative Cash Flow ($M)	$103M	$185M	$287M

7.2 Water Demand Projection

The cost projections are impacted slightly by the water demand projections. Maximum day water demands are projected to increase by almost 60 MGD over the next 50 years. Lower demand forecasts would tend to decrease the additional costs associated with the abandon surface water (all groundwater) alternative since less water would need to be pumped from underground. This sensitivity analysis assumed a low demand increase of 13.6 MGD maximum day demand over the next 50 years. If the low demand increase were to occur, the estimated 50-year cumulative cost of the abandon surface water (all groundwater) option is $488M (see **Table 13**). Under a low demand forecast scenario, the abandon surface water (all groundwater) option is $303M to $385 more expensive than the surface water options (see **Table 14**).

Table 13. Results of Sensitivity Analysis for Water Demand Forecast, Costs of Abandon Surface Water (Groundwater Only) Alternative over 50 Years (cumulative cash flows)

Scenario:	Base Condition	Low Demand Assumption for Sensitivity
Assumed max. day demand increase over 50 years	60 MGD	13.6 MGD
Total Capital ($M) with Bond servicing	$122M	$122M
Total O&M ($M)	$434M	$366M
Total Cumulative Cash Flow ($M)	$557M	$488M

Table 14. Costs of Water Supply Alternatives Under Low Power Cost Escalation Scenario, (50-year cumulative cash flow)

	Surface Water with hydropower	Surface Water no hydropower	Abandon Surface Water (Groundwater only) – Low Power Escalation Scenario
Total Cumulative Cash Flow ($M)	$103M	$185M	$488M

Appendix A

D) - Projection, City of Bend

28	31	30	31	30	31	31	30	31	30	31	365		
.34%	3.69%	6.00%	11.53%	11.92%	16.63%	15.76%	13.50%	6.12%	3.59%	3.81%	100.0%		2.25
Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual (MG)	Average Day (MGD)	Max Day (MGD)
6.1	6.1	10.2	19.0	20.3	27.4	26.0	23.0	10.1	6.1	6.3	5110	14.0	31.5
6.5	6.5	11.0	20.4	21.7	29.4	27.8	24.6	10.8	6.6	6.7	5475	15.0	33.8
6.8	6.8	11.5	21.3	22.8	30.8	29.2	25.8	11.3	6.9	7.0	5736	15.7	35.4
7.1	7.1	12.0	22.3	23.8	32.2	30.5	27.0	11.8	7.2	7.4	5996	16.4	37.0
7.5	7.5	12.5	23.3	24.9	33.6	31.8	28.2	12.4	7.5	7.7	6257	17.1	38.6
7.8	7.8	13.0	24.2	25.9	35.0	33.1	29.3	12.9	7.8	8.0	6518	17.9	40.2
8.1	8.1	13.6	25.2	26.9	36.4	34.5	30.5	13.4	8.1	8.3	6779	18.6	41.8
8.4	8.4	14.1	26.2	28.0	37.8	35.8	31.7	13.9	8.4	8.6	7039	19.3	43.4
8.7	8.7	14.6	27.1	29.0	39.2	37.1	32.8	14.4	8.7	9.0	7300	20.0	45.0
9.1	9.1	15.3	28.4	30.3	40.9	38.8	34.3	15.1	9.1	9.4	7632	20.9	47.0
9.5	9.5	15.9	29.6	31.6	42.7	40.5	35.8	15.7	9.5	9.8	7964	21.8	49.1
9.9	9.9	16.6	30.8	33.0	44.5	42.2	37.3	16.4	9.9	10.2	8295	22.7	51.1
10.3	10.3	17.3	32.1	34.3	46.3	43.9	38.8	17.0	10.3	10.6	8627	23.6	53.2
10.7	10.7	17.9	33.3	35.6	48.1	45.6	40.3	17.7	10.7	11.0	8959	24.5	55.2
11.1	11.1	18.6	34.5	36.9	49.8	47.2	41.8	18.3	11.1	11.4	9291	25.5	57.3
11.5	11.5	19.3	35.8	38.2	51.6	48.9	43.3	19.0	11.5	11.8	9623	26.4	59.3
11.9	11.9	19.9	37.0	39.5	53.4	50.6	44.8	19.7	11.9	12.2	9955	27.3	61.4
12.3	12.3	20.6	38.2	40.9	55.2	52.3	46.3	20.3	12.3	12.6	10286	28.2	63.4
12.7	12.7	21.2	39.5	42.2	57.0	54.0	47.8	21.0	12.7	13.0	10618	29.1	65.5
13.1	13.1	21.9	40.7	43.5	58.7	55.7	49.3	21.6	13.1	13.4	10950	30.0	67.5
13.3	13.2	22.2	41.3	44.2	59.6	56.5	50.0	21.9	13.3	13.6	11116	30.5	68.5
13.4	13.4	22.6	42.0	44.8	60.5	57.4	50.8	22.3	13.5	13.9	11282	30.9	69.5
13.6	13.6	22.9	42.6	45.5	61.4	58.2	51.5	22.6	13.7	14.1	11448	31.4	70.6
13.8	13.8	23.2	43.2	46.1	62.3	59.1	52.3	22.9	13.9	14.3	11614	31.8	71.6
14.0	14.0	23.6	43.8	46.8	63.2	59.9	53.0	23.3	14.1	14.5	11780	32.3	72.6
14.2	14.2	23.9	44.4	47.5	64.1	60.7	53.7	23.6	14.3	14.7	11945	32.7	73.6
14.4	14.4	24.2	45.0	48.1	65.0	61.6	54.5	23.9	14.5	14.9	12111	33.2	74.7
14.6	14.6	24.6	45.7	48.8	65.9	62.4	55.2	24.2	14.7	15.1	12277	33.6	75.7
14.8	14.8	24.9	46.3	49.4	66.8	63.3	56.0	24.6	14.9	15.3	12443	34.1	76.7
15.0	15.0	25.2	46.9	50.1	67.6	64.1	56.7	24.9	15.1	15.5	12609	34.5	77.7
15.2	15.2	25.6	47.5	50.7	68.5	65.0	57.5	25.2	15.3	15.7	12775	35.0	78.8
15.3	[illegible]	25.7	47.8	51.1	69.0	65.4	[illegible]	25.4	15.4	15.8	12866	35.3	79.3
15.4	[illegible]	25.9	48.2	51.5	69.5	65.9	[illegible]	25.6	15.5	15.9	12958	35.5	79.9
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

D) - Projectic City of Bend

28	31	30	31	30	31	31	30	31	30	31	365		
.34%	3.69%	6.00%	11.53%	11.92%	16.63%	15.76%	13.50%	6.12%	3.59%	3.81%	100.0%		2.25
Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual (MG)	Average Day (MGD)	Max Day (MGD)
15.7	15.7	26.3	48.9	52.2	70.5	66.8	59.1	25.9	15.7	16.1	13140	36.0	81.0
15.8	15.8	26.5	49.2	52.6	71.0	67.3	59.5	26.1	15.9	16.2	13231	36.3	81.6
15.9	15.9	26.7	49.5	52.9	71.5	67.7	59.9	26.3	16.0	16.4	13323	36.5	82.1
16.0	16.0	26.8	49.9	53.3	72.0	68.2	60.4	26.5	16.1	16.5	13414	36.8	82.7
16.1	16.1	27.0	50.2	53.6	72.5	68.7	60.8	26.7	16.2	16.6	13505	37.0	83.3
16.2	16.2	27.2	50.6	54.0	72.9	69.1	61.2	26.8	16.3	16.7	13596	37.3	83.8
16.3	16.3	27.4	50.9	54.4	73.4	69.6	61.6	27.0	16.4	16.8	13688	37.5	84.4
16.4	16.4	27.6	51.2	54.7	73.9	70.1	62.0	27.2	16.5	16.9	13779	37.8	84.9
16.5	16.5	27.8	51.6	55.1	74.4	70.5	62.4	27.4	16.6	17.0	13870	38.0	85.5
16.6	16.6	27.9	51.9	55.5	74.9	71.0	62.8	27.6	16.7	17.1	13961	38.3	86.1
16.8	16.7	28.1	52.3	55.8	75.4	71.5	63.2	27.7	16.8	17.3	14053	38.5	86.6
16.9	16.9	28.3	52.6	56.2	75.9	71.9	63.6	27.9	16.9	17.4	14144	38.8	87.2
17.0	17.0	28.5	52.9	56.5	76.4	72.4	64.1	28.1	17.1	17.5	14235	39.0	87.8
17.1	17.1	28.7	53.3	56.9	76.9	72.9	64.5	28.3	17.2	17.6	14326	39.3	88.3
17.2	17.2	28.8	53.6	57.3	77.3	73.3	64.9	28.5	17.3	17.7	14418	39.5	88.9
17.3	17.3	29.0	54.0	57.6	77.8	73.8	65.3	28.6	17.4	17.8	14509	39.8	89.4
17.4	17.4	29.2	54.3	58.0	78.3	74.2	65.7	28.8	17.5	17.9	14600	40.0	90.0

Surface Water Availability

Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (MG)	Average (MGD)
28	31	30	31	30	31	31	30	31	30	31	365	
13.57	13.57	11.64	12.93	13.57	11.64	10.99	10.99	10.99	13.57	13.57		
6.1	6.1	10.2	12.9	13.6	11.6	11.0	11.0	10.1	6.1	6.3	3406	9.3
6.5	6.5	11.0	12.9	13.6	11.6	11.0	11.0	10.8	6.6	6.7	3518	9.6
6.8	6.8	11.5	12.9	13.6	11.6	11.0	11.0	11.0	6.9	7.0	3587	9.8
7.1	7.1	11.6	12.9	13.6	11.6	11.0	11.0	11.0	7.2	7.4	3640	10.0
7.5	7.5	11.6	12.9	13.6	11.6	11.0	11.0	11.0	7.5	7.7	3689	10.1
7.8	7.8	11.6	12.9	13.6	11.6	11.0	11.0	11.0	7.8	8.0	3737	10.2
8.1	8.1	11.6	12.9	13.6	11.6	11.0	11.0	11.0	8.1	8.3	3785	10.4
8.4	8.4	11.6	12.9	13.6	11.6	11.0	11.0	11.0	8.4	8.6	3834	10.5
8.7	8.7	11.6	12.9	13.6	11.6	11.0	11.0	11.0	8.7	9.0	3882	10.6
9.1	9.1	11.6	12.9	13.6	11.6	11.0	11.0	11.0	9.1	9.4	3944	10.8
9.5	9.5	11.6	12.9	13.6	11.6	11.0	11.0	11.0	9.5	9.8	4005	11.0
9.9	9.9	11.6	12.9	13.6	11.6	11.0	11.0	11.0	9.9	10.2	4067	11.1
10.3	10.3	11.6	12.9	13.6	11.6	11.0	11.0	11.0	10.3	10.6	4128	11.3
10.7	10.7	11.6	12.9	13.6	11.6	11.0	11.0	11.0	10.7	11.0	4190	11.5
11.1	11.1	11.6	12.9	13.6	11.6	11.0	11.0	11.0	11.1	11.4	4251	11.6
11.5	11.5	11.6	12.9	13.6	11.6	11.0	11.0	11.0	11.5	11.8	4313	11.8
11.9	11.9	11.6	12.9	13.6	11.6	11.0	11.0	11.0	11.9	12.2	4374	12.0
12.3	12.3	11.6	12.9	13.6	11.6	11.0	11.0	11.0	12.3	12.6	4434	12.1
12.7	12.7	11.6	12.9	13.6	11.6	11.0	11.0	11.0	12.7	13.0	4482	12.3
13.1	13.1	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.1	13.4	4530	12.4
13.3	13.2	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.3	13.6	4552	12.5
13.4	13.4	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.5	13.6	4569	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.	11.6	12.9	13.6	11.6	11.0	11.0	.1.0	13.6	13.6	4579	12.5

Surface Water Availability

Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (MG)	Average (MGD)
28	31	30	31	30	31	31	30	31	30	31	365	
13.57	13.57	11.64	12.93	13.57	11.64	10.99	10.99	10.99	13.57	13.57		
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5
13.6	13.6	11.6	12.9	13.6	11.6	11.0	11.0	11.0	13.6	13.6	4579	12.5

Table A-3. Surface Water Projected operation and maintenance costs (2010$) with membrane filtration / hydropower

Item	Estimated annual cost ($/yr)
Labor	257,900
Power	63,800
Chemicals and disposal	79,000
Mechanical components / membrane filter replacement	101,300
Sub-Total Membrane Filtration	**502,000**
Hydropower	55,253
Total	**557,253**
Source: WSAS, 2009	

28	31	30	31	30	31	31	30	31	30	31	365
Feb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
765,632	847,466	1,376,889	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,403,574	824,544	872,900	15,287,137
820,320	907,999	1,475,238	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,503,830	883,440	935,250	15,789,465
859,383	951,237	1,545,488	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	925,508	979,786	16,101,879
898,446	994,475	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	967,577	1,024,322	16,340,104
937,509	1,037,714	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,009,646	1,068,857	16,557,050
976,572	1,080,952	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,051,714	1,113,393	16,773,995
1,015,635	1,124,190	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,093,783	1,157,929	16,990,941
1,054,698	1,167,428	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,135,851	1,202,465	17,207,886
1,093,760	1,210,666	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,177,920	1,247,000	17,424,831
1,143,477	1,265,696	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,231,462	1,303,682	17,700,944
1,193,193	1,320,726	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,285,003	1,360,364	17,977,056
1,242,910	1,375,757	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,338,545	1,417,046	18,253,168
1,292,626	1,430,787	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,392,087	1,473,728	18,529,281
1,342,342	1,485,817	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,445,629	1,530,410	18,805,393
1,392,059	1,540,847	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,499,171	1,587,091	19,081,505
1,441,775	1,595,878	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,552,713	1,643,773	19,357,618
1,491,492	1,650,908	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,606,254	1,700,455	19,633,730
1,541,208	1,705,938	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,659,796	1,757,137	19,903,264
1,590,924	1,760,968	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,713,338	1,813,819	20,118,235
1,640,641	1,815,999	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,766,880	1,870,501	20,333,205
1,665,499	1,843,514	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,793,651	1,888,825	20,430,674
1,690,357	1,871,029	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,820,422	1,888,825	20,509,818
1,706,036	1,888,825	1,566,767	1,798,881	1,827,895	1,618,993	1,529,049	1,479,725	1,529,049	1,827,895	1,888,825	20,550,767

Table A-5. Assumed Unit Power Costs (6.22%/year escalation)

Year	Unit Power Cost ($/kWh)	Year	Unit Power Cost ($/kWh)
2010	0.051	2037	0.261
2011	0.054	2038	0.277
2012	0.058	2039	0.294
2013	0.061	2040	0.312
2014	0.065	2041	0.332
2015	0.069	2042	0.353
2016	0.073	2043	0.374
2017	0.078	2044	0.398
2018	0.083	2045	0.422
2019	0.088	2046	0.449
2020	0.093	2047	0.477
2021	0.099	2048	0.506
2022	0.105	2049	0.538
2023	0.112	2050	0.571
2024	0.119	2051	0.607
2025	0.126	2052	0.645
2026	0.134	2053	0.685
2027	0.143	2054	0.727
2028	0.151	2055	0.772
2029	0.161	2056	0.821
2030	0.171	2057	0.872
2031	0.182	2058	0.926
2032	0.193	2059	0.983
2033	0.205	2060	1.044
2034	0.218	2061	1.109
2035	0.231	2062	1.178
2036	0.245		

28	31	30	31	30	31	31	30	31	30	31	365
eb	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total ($)**
9,139	43,322	70,387	91,959	93,442	82,763	78,165	75,644	71,751	42,151	44,623	781,478
4,543	49,304	80,105	97,679	99,254	87,911	83,027	80,349	81,657	47,970	50,784	857,363
9,567	54,865	89,139	103,754	105,428	93,379	88,191	85,346	88,191	53,381	56,511	928,710
5,043	60,926	95,987	110,208	111,985	99,187	93,677	90,655	93,677	59,278	62,755	1,001,070
1,009	67,529	101,958	117,063	118,951	105,356	99,503	96,294	99,503	65,703	69,556	1,077,455
7,504	74,719	108,300	124,344	126,350	111,910	105,692	102,283	105,692	72,698	76,961	1,159,468
4,570	82,541	115,036	132,078	134,208	118,870	112,266	108,645	112,266	80,308	85,018	1,247,516
2,255	91,047	122,191	140,293	142,556	126,264	119,249	115,403	119,249	88,584	93,779	1,342,031
0,607	100,292	129,791	149,020	151,423	134,118	126,667	122,581	126,667	97,579	103,302	1,443,477
0,618	111,372	137,864	158,289	160,842	142,460	134,545	130,205	134,545	108,360	114,715	1,557,557
1,523	123,443	146,440	168,134	170,846	151,321	142,914	138,304	142,914	120,104	127,148	1,680,244
3,396	136,585	155,548	178,592	181,473	160,733	151,803	146,907	151,803	132,890	140,684	1,812,168
6,314	150,883	165,223	189,701	192,760	170,731	161,246	156,044	161,246	146,802	155,412	1,954,002
0,361	166,432	175,500	201,500	204,750	181,350	171,275	165,750	171,275	161,931	171,427	2,106,469
5,629	183,332	186,416	214,033	217,486	192,630	181,928	176,060	181,928	178,373	188,834	2,270,344
2,214	201,690	198,011	227,346	231,013	204,612	193,244	187,011	193,244	196,235	207,743	2,446,455
0,222	221,623	210,328	241,487	245,382	217,338	205,264	198,643	205,264	215,628	228,274	2,635,691
9,765	243,255	223,410	256,508	260,645	230,857	218,032	210,998	218,032	236,675	250,555	2,838,064
0,965	266,720	237,306	272,462	276,857	245,216	231,593	224,122	231,593	259,506	274,725	3,047,152
3,951	292,164	252,066	289,410	294,078	260,469	245,998	238,063	245,998	284,261	300,932	3,271,270
4,617	315,038	267,745	307,411	312,369	276,670	261,299	252,870	261,299	306,517	322,781	3,491,399
6,833	339,628	284,399	326,532	331,799	293,879	277,552	268,599	277,552	330,442	342,858	3,722,930
8,941	364,184	302,088	346,842	352,436	312,158	294,816	285,306	294,816	352,436	364,184	3,962,392
9,401	386,837	320,878	368,416	374,358	331,574	313,153	303,052	313,153	374,358	386,837	4,208,853
1,133	410,898	340,837	391,331	397,643	352,198	332,632	321,901	332,632	397,643	410,898	4,470,643
4,218	436,456	362,037	415,672	422,376	374,105	353,321	341,924	353,321	422,376	436,456	4,748,717
8,738	463,603	384,556	441,527	448,648	397,374	375,298	363,191	375,298	448,648	463,603	5,044,087
4,784	492,439	408,475	468,990	476,554	422,091	398,641	385,782	398,641	476,554	492,439	5,357,830
2,449	523,069	433,882	498,161	506,196	448,345	423,437	409,778	423,437	506,196	523,069	5,691,087
1,836	555,604	460,870	529,147	537,681	476,232	449,775	435,266	449,775	537,681	555,604	6,045,072
3,050	590,162	489,536	562,059	571,125	505,853	477,751	462,339	477,751	571,125	590,162	6,421,076
6,206	626,871	519,985	597,020	606,649	537,318	507,467	491,097	507,467	606,649	626,871	6,820,467
1,424	665,862	552,328	634,154	644,382	570,739	539,031	521,643	539,031	644,382	665,862	7,244,700
8,832	707,278	586,683	673,599	684,463	606,239	572,559	554,089	572,559	684,463	707,278	7,695,320
8,568	751,271	623,174	715,496	727,037	643,947	608,172	588,553	608,172	727,037	751,271	8,173,969
0,774	798,000	661,936	760,000	772,258	684,000	646,000	625,161	646,000	772,258	798,000	8,682,390

28	31	30	31	30	31	31	30	31	30	31	365
'eb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total ($)
i5,607	847,636	703,108	807,272	820,293	726,545	686,181	664,047	686,181	820,293	847,636	9,222,434
3,227	900,359	746,841	857,485	871,315	771,736	728,862	705,350	728,862	871,315	900,359	9,796,070
i3,810	956,361	793,295	910,820	925,511	819,738	774,197	749,223	774,197	925,511	956,361	10,405,385
7,539	1,015,847	842,638	967,473	983,078	870,726	822,352	795,825	822,352	983,078	1,015,847	11,052,600
'4,610	1,079,032	895,050	1,027,650	1,044,225	924,885	873,502	845,325	873,502	1,044,225	1,079,032	11,740,072
i5,231	1,146,148	950,722	1,091,570	1,109,176	982,413	927,834	897,904	927,834	1,109,176	1,146,148	12,470,305
)9,622	1,217,439	1,009,857	1,159,465	1,178,166	1,043,519	985,546	953,754	985,546	1,178,166	1,217,439	13,245,957
i8,019	1,293,163	1,072,670	1,231,584	1,251,448	1,108,426	1,046,847	1,013,077	1,046,847	1,251,448	1,293,163	14,069,856
l0,669	1,373,598	1,139,390	1,308,189	1,329,289	1,177,370	1,111,960	1,076,091	1,111,960	1,329,289	1,373,598	14,945,001
7,839	1,459,036	1,210,260	1,389,558	1,411,970	1,250,602	1,181,124	1,143,024	1,181,124	1,411,970	1,459,036	15,874,580
)9,809	1,549,788	1,285,538	1,475,989	1,499,795	1,328,390	1,254,590	1,214,120	1,254,590	1,499,795	1,549,788	16,861,979
36,877	1,646,185	1,365,499	1,567,795	1,593,082	1,411,016	1,332,626	1,289,638	1,332,626	1,593,082	1,646,185	17,910,794
'9,360	1,748,578	1,450,433	1,665,312	1,692,172	1,498,781	1,415,515	1,369,853	1,415,515	1,692,172	1,748,578	19,024,846
'7,597	1,857,339	1,540,650	1,768,894	1,797,425	1,592,005	1,503,560	1,455,058	1,503,560	1,797,425	1,857,339	20,208,191
i1,943	1,972,866	1,636,478	1,878,920	1,909,225	1,691,028	1,597,082	1,545,563	1,597,082	1,909,225	1,972,866	21,465,140
)2,780	2,095,578	1,738,267	1,995,788	2,027,978	1,796,209	1,696,420	1,641,697	1,696,420	2,027,978	2,095,578	22,800,272
0,511	2,225,923	1,846,387	2,119,926	2,154,119	1,907,934	1,801,937	1,743,810	1,801,937	2,154,119	2,225,923	24,218,449

Appendix B

Potential Additional Groundwater Facilities Costs Memorandum

Technical Memorandum

To: Heidi Lansdowne, PE, City of Bend

From: Bryan Black, PE

Project: Surface Water Improvement Project

Date: October 27, 2010

RE: Potential Additional Groundwater Facilities Costs, FINAL

1 Potential Additional Groundwater Facilities

The City of Bend requested that HDR evaluate the costs of replacing its surface water system with groundwater. This memorandum describes the additional facilities and costs that are anticipated to be required to integrate the additional 13.6 mgd of groundwater well capacity into the City's existing water distribution system to replace the surface water system. This memorandum does not include the cost of installing the additional wells that would be required. The complete cost evaluation is provided in a companion memorandum, and includes the cost of additional wells.

The additional actions / facilities that are anticipated to be required in addition to the wells are:

1. Water master planning
2. Land acquisition for additional wells
3. Well water transmission piping from the new wells to storage reservoirs
4. New terminal storage reservoirs for well-produced water
5. Booster pumping for water distribution
6. Additional storage in the distribution system for emergencies storage and fire flows

The City currently has plans to retain the surface water system and install new groundwater wells at the Outback site. If the surface water source is abandoned, new groundwater facilities will need to be located in relatively undeveloped areas of the City. Potential locations for these additional groundwater facilities are illustrated in **Figure 1**.

1.1 Water master planning

The City's water supply and distribution system has been developed to effectively receive and distribute surface water. If the City decides to seriously consider replacing its surface water supply with additional groundwater and wells, it should complete a thorough water master planning effort to determine the additional facilities that would be required. Water master planning efforts of this scale typically require a time period of seven to twelve months and a budget in the range of $200,000.

1.2 Land acquisition for wells

The City has reserved locations for future wells needed for the current dual-source system. Additional land will need to be acquired to site new well fields to replace surface water. Per the companion groundwater cost memorandum, 10 additional wells would be needed to provide the 13.6 mgd firm capacity. For this analysis, it is assumed that wells will be sited in two groups of three each and one group of four in Southwest Bend, as shown in **Figure 1**. It is assumed that each well will occupy one-half acre, so a total of 5 acres would be needed. The cost of land is assumed to be $50,000 per acre so $250,000 would need to be budgeted for land acquisition.

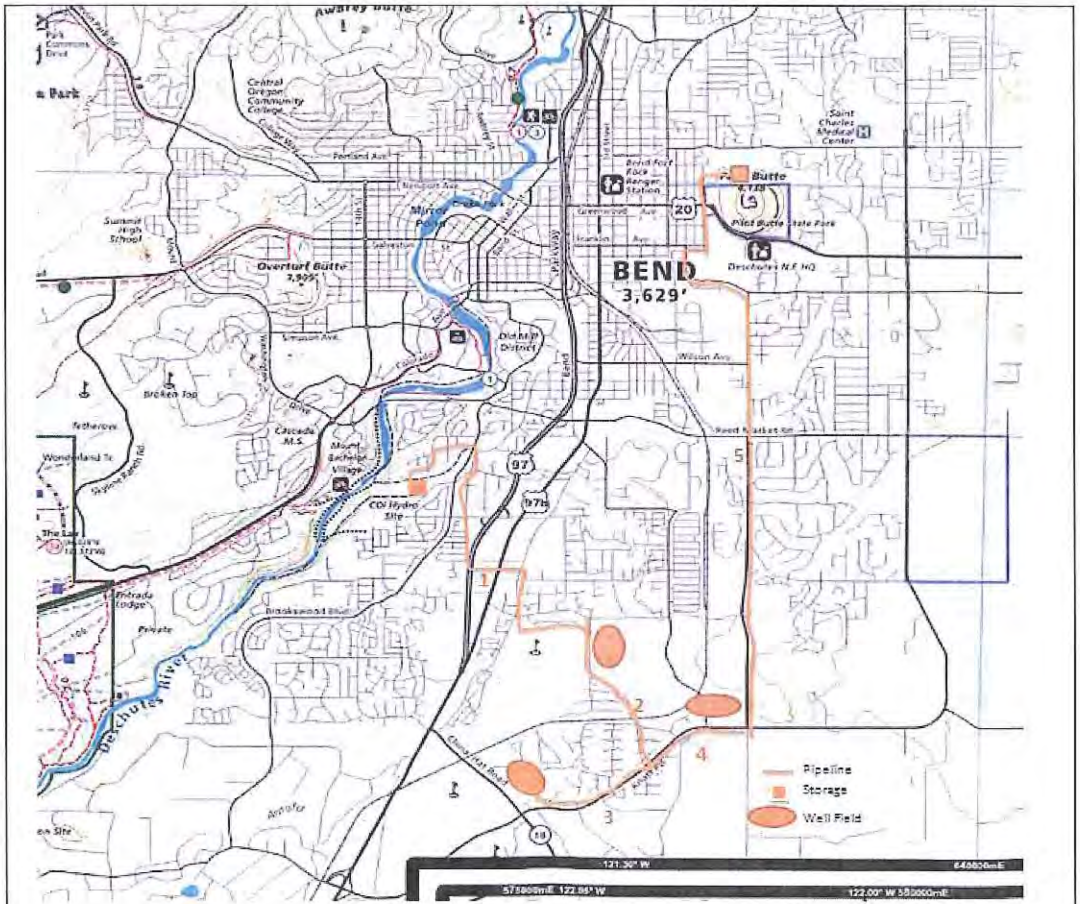


Figure 1. Potential Locations for Additional Groundwater Facilities

1.3 Well transmission piping to water storage reservoirs

The new well fields will require water transmission pipelines from the well fields to finished water storage reservoirs prior to water distribution within the

City. Finished water storage reservoirs could potentially be located on the north side of Pilot Butte State Park and at Rock Bluff. **Figure 1** shows potential transmission mains from the three wells fields to the two new proposed storage reservoirs.

Pipeline lengths, diameters, and estimated costs are presented in **Table 1**. The total estimated costs for the transmission pipelines is $22M including engineering and contingencies.

Table 1. Well Transmission Pipeline Lengths, Diameters, and Estimated Costs

Pipe Segment	Length (Feet)	Capacity (mgd)	Capacity (gpm)	Diameter (inch)	Unit Cost ($/foot)	Total Cost ($)
1	16,051	13.6	9,452	30	430	6,900,000
2	5,016	9	6,255	24	350	1,760,000
3	6,019	4.5	3,128	18	265	1,600,000
4	4,013	9	6,255	24	350	1,400,000
5	24,077	13.6	9,452	30	430	10,350,000
Total	**55,176**					**22,010,000**

Note: Unit cost from Optimatics, 2010

1.4 New terminal storage reservoirs for well-produced water

New terminal storage reservoirs are needed to equalize the flow rate produced from the new wells fields. Water will be produced by the wells at a constant rate of 13.6 mgd (9,452 gpm) but water will be consumed by customers at variable rates on a peak summer day from about 4,700 gpm to about 14,000 gpm (Optimatics 2010 indicates a peak hour demand / maximum day demand factor of 2.4). The new terminal storage reservoirs will allow the constant rate groundwater wells to meet the range of water demands in the City.

Figure 2 illustrates the constant inflow from the well fields, the variable consumption rate by City water customers, and the amount of water needed to be stored during the day to allow the wells to meet the variable customer demands.

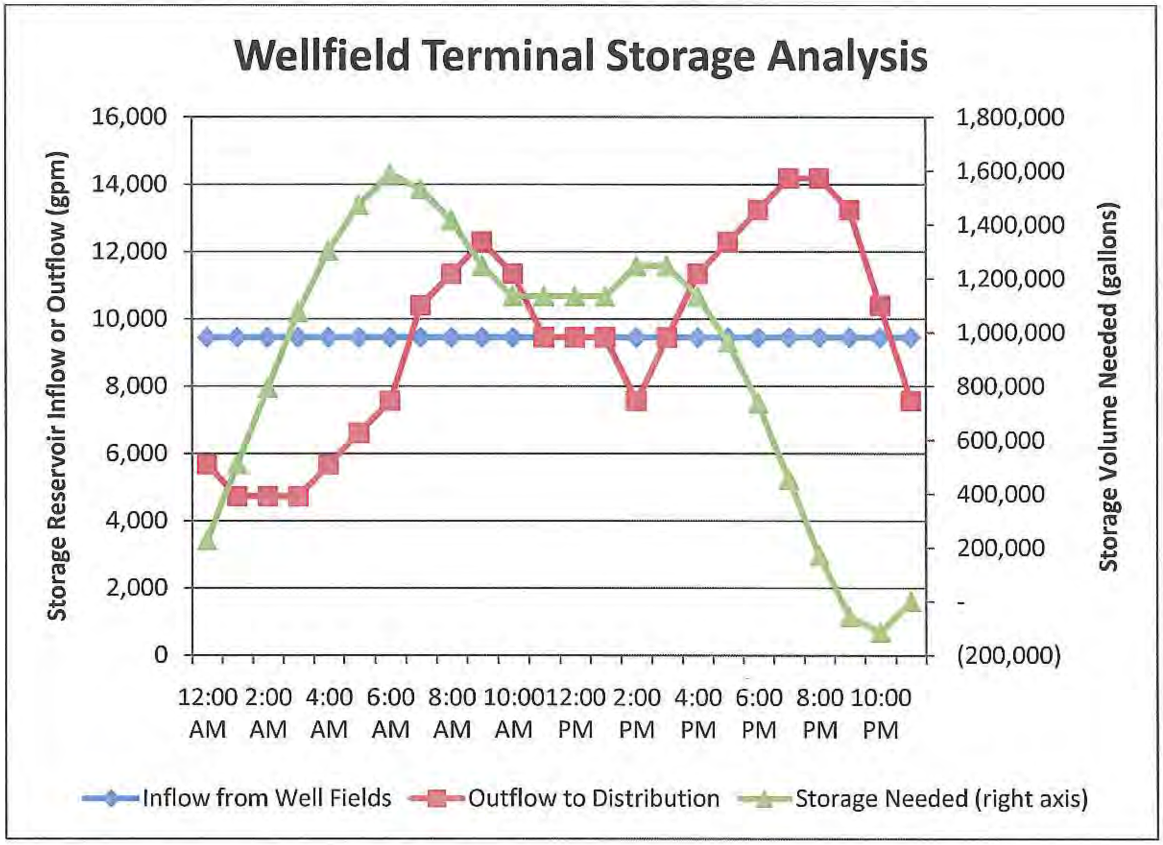


Figure 2. Storage analysis with constant well production, variable consumption, and quantity of water required to be stored

The storage analysis indicates that the terminal water storage reservoirs should be sized in the range of 1.6 million gallons each. **Attachment A, Table 1-1** provides the storage calculations used to generate **Figure 2** and the storage analysis.

The storage reservoir near Pilot Butte would be buried concrete and the reservoir at Rock Bluff would be at-grade steel construction. **Table 2** provides a summary of terminal water storage recommendations along with an estimate of probable costs.

Table 2. Summary of Storage recommendations and estimate of probable costs

Location	Volume (million gallons)	Type	Unit Cost ($M/MG)	Estimated Cost ($M)
Pilot Butte (north)	1.6	Buried Concrete	2.3	5.15
Rock Bluff	1.6	At-grade steel	1.5	3.36
Total	**3.2**			**8.51**

Note: Unit Costs from Optimatics 2010, 40% added for engineering, contingency, administration

1.5 Booster pumping for water distribution

It is currently not known if additional booster pumping capacity would be needed with installation of the anticipated volumes of terminal storage listed in Section 1.3. Further, the additional power costs for booster pumping to higher water pressure zones have not been evaluated. If the City decides to replace its surface water with additional groundwater, then the City should further investigate the costs of power for booster pumping the additional groundwater, which could be substantial, in a water master planning effort.

1.6 Additional storage in the distribution system

It is currently not known if additional distribution storage would be needed with the installation of the anticipated volumes of terminal storage listed in Section 1.3. However, additional distribution system storage may actually be required for emergency water storage or fire flows. This should be further investigated in a new water master plan if the City wants to seriously consider replacing its surface water supply with additional groundwater and wells.

2 Additional groundwater facility summary

This memorandum provided an initial review of additional facilities required to integrate a new 13.6 mgd groundwater supply into the City's water system to replace the surface water supply. Well facilities that are also required are described in a companion memorandum. Estimated costs for additional actions / facilities to support integration of new well field supplies into the City's water system are presented in **Table 3**. The estimated costs for additional actions / facilities is $28.5M.

Table 3. Additional costs required to develop 13.6 mgd additional groundwater supply to replace surface water

Action / Facility	Anticipated Cost
Water Master Plan	$200,000
Land Acquisition	$250,000
Additional Wells (Qty 10, see companion memo, "Surface Water / Groundwater Cost Comparison")	$28,500,000
Well field transmission piping	$22,010,000
New terminal storage reservoirs	$8,510,000
Booster pumping capital costs	None anticipated - needs review
Additional storage in the distribution system	None anticipated – needs review
Total	**$59,470,000**

Attachment 1
Water Storage Equalization Calculations

Table 1-1. Terminal Storage Analysis for Additional Groundwater Wells

Hour	Inflow (gpm)	Outflow (gpm)	Peaking	Stored (gallons)
12:00 AM	9452	5671	0.6	226,848
1:00 AM	9452	4726	0.5	510,408
2:00 AM	9452	4726	0.5	793,968
3:00 AM	9452	4726	0.5	1,077,528
4:00 AM	9452	5671	0.6	1,304,376
5:00 AM	9452	6616	0.7	1,474,512
6:00 AM	9452	7562	0.8	**1,587,936**
7:00 AM	9452	10397	1.1	1,531,224
8:00 AM	9452	11342	1.2	1,417,800
9:00 AM	9452	12288	1.3	1,247,664
10:00 AM	9452	11342	1.2	1,134,240
11:00 AM	9452	9452	1	1,134,240
12:00 PM	9452	9452	1	1,134,240
1:00 PM	9452	9452	1	1,134,240
2:00 PM	9452	7562	0.8	1,247,664
3:00 PM	9452	9452	1	1,247,664
4:00 PM	9452	11342	1.2	1,134,240
5:00 PM	9452	12288	1.3	964,104
6:00 PM	9452	13233	1.4	737,256
7:00 PM	9452	14178	1.5	453,696
8:00 PM	9452	14178	1.5	170,136
9:00 PM	9452	13233	1.4	(56,712)
10:00 PM	9452	10397	1.1	(113,424)
11:00 PM	9452	7562	0.8	-
	226,848	226,848	24.00	

Appendix C

Power Use Calculations for Groundwater

Pumping energy and costs

The groundwater pumping power, energy and costs can calculated as follows:

Power (kW) = 0.0001886 * flow (gpm) * head (feet) / efficiency %

Where: Efficiency = 80%

Head = Hydraulic Grade Line Outback (4,011 ft) – Static groundwater elevation (2,880 ft)

= 1,131 feet

Flow = monthly flow assumed to be pumped from groundwater (gpm)

Energy (kWh) = Power (kW) * time (hours)

Where: Time = days per month * 24 hours / day

Cost ($/month) = Energy *(kWh/month) * unit power cost ($/kWh)

Where: Unit power cost ($/kWh) = 0.05112 in 2010 and escalates at 6.22% annually

The power cost calculation method described above was compared to observed power costs by the City of Bend. Observed power costs in 2008 are listed in **Table C-1**.

Table C-1. City of Bend Observed Annual Power Costs for Wells in 2008

Facilities	2008 Annual Cost Pacific Power
Bear Creek Wells 1 & 2	$80,700
Copperstone Well	$42,800
Hole 10 Wells	$67,100
Outback 6,7,8	$27,700
Outback Wells 1,2	$40,500
Outback Wells 3,4,5	$91,200
Pilot Butte Wells 1,3	$74,900
North River Well	$29,200
South River Well	$74,700
Rock Bluff Well 1,2,3	$50,300
Shilo Wells	$16,300
Westwood Well	$7,600
Total	**$603,000**

Operating costs include energy and demand charges
for water facilities in the main system. Does not include costs associated with:

Surface water	Irrigation
Reservoirs	Airport system
Disinfection	

The 2008 power cost of $603,000 was associated with operating the wells to produce 2,628 million gallons in 2008, resulting in a power cost per million gallons of $230/MG.

Observed well production was obtained to understand the relationship with pumping energy to evaluate the predictive capability of the power cost calculation method. Observed well production and predicted power, energy, and associated costs are presented in **Table C-2**.

Table C-2. Predicted power costs using the calculation method described

	Observed	Predicted		
Month	**Well production (MG/month)**	**Power (kW)**	**Energy (kWh)**	**Cost ($)**
Jan-08	60	365	266,847	$ 13,641
Feb-08	25	152	111,186	$ 5,684
Mar-08	20	122	88,949	$ 4,547
Apr-08	42	255	186,793	$ 9,549
May-08	380	2309	1,690,028	$ 86,394
Jun-08	442	2685	1,965,770	$ 100,490
Jul-08	580	3524	2,579,517	$ 131,865
Aug-08	466	2831	2,072,508	$ 105,947
Sep-08	380	2309	1,690,028	$ 86,394
Oct-08	80	486	355,795	$ 18,188
Nov-08	68	413	302,426	$ 15,460
Dec-08	85	516	378,033	$ 19,325
Total	**2628**		**11,687,879**	**$ 597,484**

The total annual predicted power cost of $597,484 corresponds well with the observed 2008 power cost of $603,000 so the power cost calculation confirms this method of analysis.

Appendix D
Summary of Water Demand Forecast Methodology

Summary of Water Demand Forecast Methodology

Future water demands were projected for the City of Bend's master planning effort (Future Demand section of the *Water Model Development Documentation for Water System Optimization* by MSA, Dec 2009). The demand forecast included a comprehensive analysis of available data pertaining to historical demand and population information, current and future land use, and near-term developer plans to generate water demand projections for the year 2020 and for the Build-out situation. Two specific data sets – the *Buildable Lands Inventory (BLI)* database and the *Parcel Inventory & Alternative 4A UGB Proposal Data for the Area Outside the Existing UGB (Framework Plan)* provide future land use zoning for parcels within the City, as well as low (min), mean, and high (max) dwelling unit per acre density estimates. In the 2007 Master Plan Update, expected demand growth was distributed within the existing UGB through infill of under-developed areas up to the maximum number of potential dwelling units for the relevant zoning designation. The same philosophy has been applied in the most recent demand projection where MSA has used the low, medium and high dwelling unit per acre density values to develop future demand estimates.

Resolution to Adopt 2012-2017 Capital Improvement Program
Exhibit A

Water
Five Year Capital Improvement Program (CIP) Schedule

	Class Level	2012-13	2013-14	2014-15	2015-16	2016-17	5 yr. Budget Total
			INFRASTRUCTURE REPAIRS, REPLACEMENT & UPGRADES				
Water Line Rehabilitation	N/A	$ 449,000	$ 750,000	$ 750,000	$ 500,000	$ 500,000	$ 2,949,000
Pump Station Replacement	N/A	80,000	80,000	80,000	80,000	80,000	400,000
Communications (SCADA Upgrade)	5	237,300	200,000	200,000	200,000	200,000	1,037,300
Total Repair & Maintenance		$ 766,300	$ 1,030,000	$ 1,030,000	$ 780,000	$ 780,000	$ 4,386,300
				GROWTH RELATED			
Continuing Projects:							
Water Resources							
WA0422 Water Rights Acquisition	N/A	$ 230,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	830,000
WA10DA Water MCP	N/A	-	75,000	75,000	75,000	75,000	300,000
Water Infrastructure							
WA0405 Outback Reservoir #3	5	100,000	-	-	-	-	100,000
WA0902 Surface Water Improvement*	2	19,461,800	5,057,580	-	-	-	24,519,380
WA10FA Water Modeling	N/A	100,000	100,000	100,000	100,000	100,000	500,000
New Projects:							
Water Infrastructure							
[illegible]ashington / Simpson Waterline	5	360,000	-	-	-	-	360,000
[illegible]3AA Mtn. High Waterline Ext.	4	937,100	1,100,000	-	-	-	2,037,100
Pilot Butte to 11th St. Waterline Ext.	5	-	-	-	-	271,400	271,400
WA12AA 18th St. Waterline Ext. JR	3	85,000	-	-	-	-	85,000
Total Growth Related		$ 21,273,900	$ 6,482,580	$ 325,000	$ 325,000	$ 596,400	$ 29,002,880
TOTAL Water CIP		**$ 22,040,200**	**$ 7,512,580**	**$ 1,355,000**	**$ 1,105,000**	**$ 1,376,400**	**$ 33,389,180**

* Pipe and Intake Only

The City of Bend uses the cost estimate classification system from the Association for the Advancement of Cost Engineering International (AACE). The AACE provides cost estimate ranges (1-5) for the various stages of project development. Class 5 estimate is based on conceptual design (least amount of information) which make it subject to a wider range of costs due to the inherent uncertainty at this stage of project development. Class 1 estimate is based on final design (most amount of information) which make it subject to a narrower range of costs due to a higher degree of certainty associated with final design. CIP projects in the construction phase after final design are still subject to change anywhere from five to ten percent for reasons including but not limited to; owner requested schedule adjustments, equipment availability or non-availability, weather, ROW purchase/sale delays, operational issues and other unknowns that are only found during construction and could not be predicted in the design phase of the project. In addition, Public Works can not guarantee that the construction costs estimated in any given year are spent in that year. Construction costs may be higher in any given year of the project if the contractor is able to construct more than previously thought or planned. In the case of a utility project, this expedited construction schedule could impact any pre-planned utility rates for upcoming years.

AACE Cost Estimate Classification System:
Class 5 (0% - 2%) = +100%/-50%
Class 4 (1% - 15%) = +50%/-30%
Class 3 (10% - 40%) = +30%/-20%
Class 2 (30% - 70%) = +20%/-15%
Class 1 (50% - 100%) = +15%/-10%

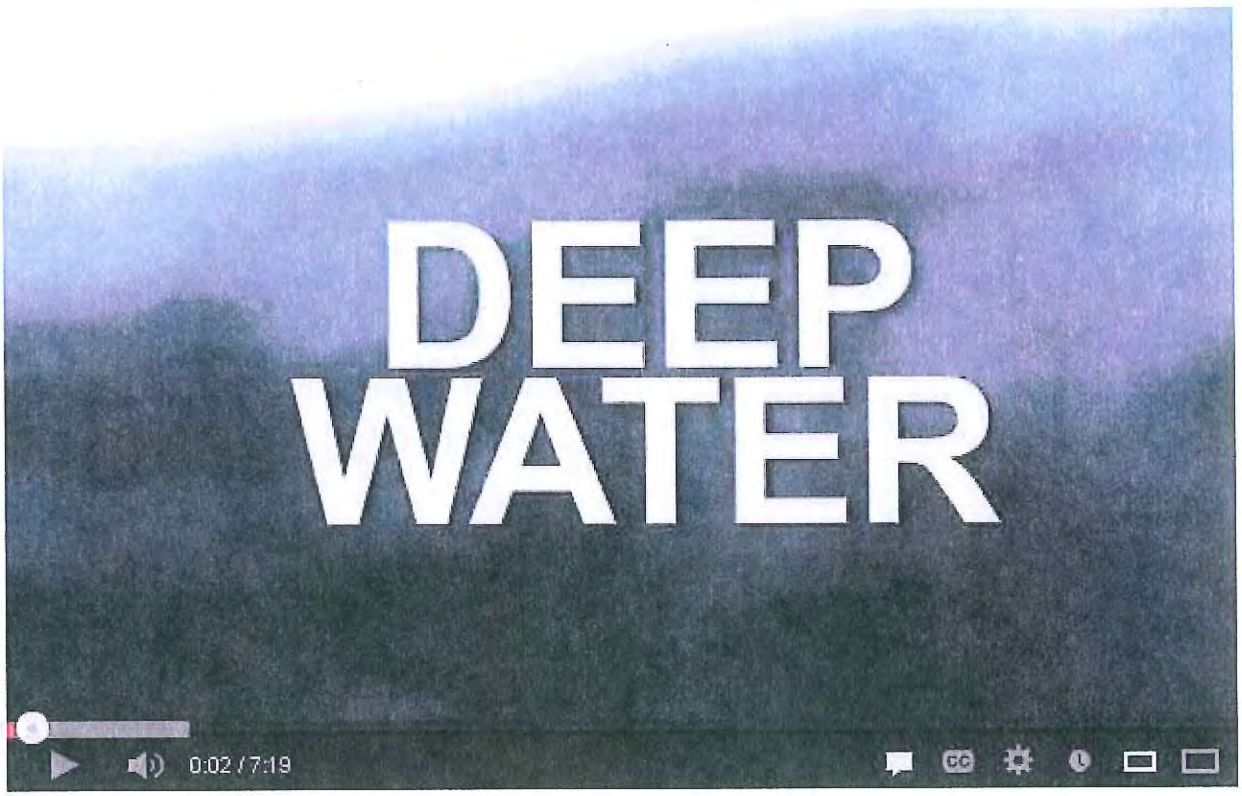
Project Definition 3% - 5%
[illegible]matic Design 15% - 20%
[illegible]n Development 35% - 45%
Construction Documents 90% - 100%

Construction Cost Summary
Bridge Creek Pipeline/Intake

	Estimates	Project Increase/(Decrease)
30% Estimate (pipeline & Intake)	$26,600,000	
Steel Pipe Bid		($1,700,000)
Design Changes from VE		($2,200,000)
60% Estimate (pipeline & Intake)	$22,700,000	
Design Changes 60% to 90%		$623,000
90% Estimate GMP (pipeline & Intake)	$23,300,000	
HDPE Pipe		($330,000)
HDPE Pipe Installation		($464,000)
Steel Pipe Installation		($3,155,000)
EA/Permits/Survey/Geotech		$562,000
Current Project Estimate (pipeline & intake)	**$20,700,000**	**($5,900,000)**

Link for Central Oregon Land Watch Video on Groundwater:

http://www.youtube.com/watch?v=rQ6gCTQtnDU



Deep Water: Protecting Spring Waters and Native Fish of the Deschutes County

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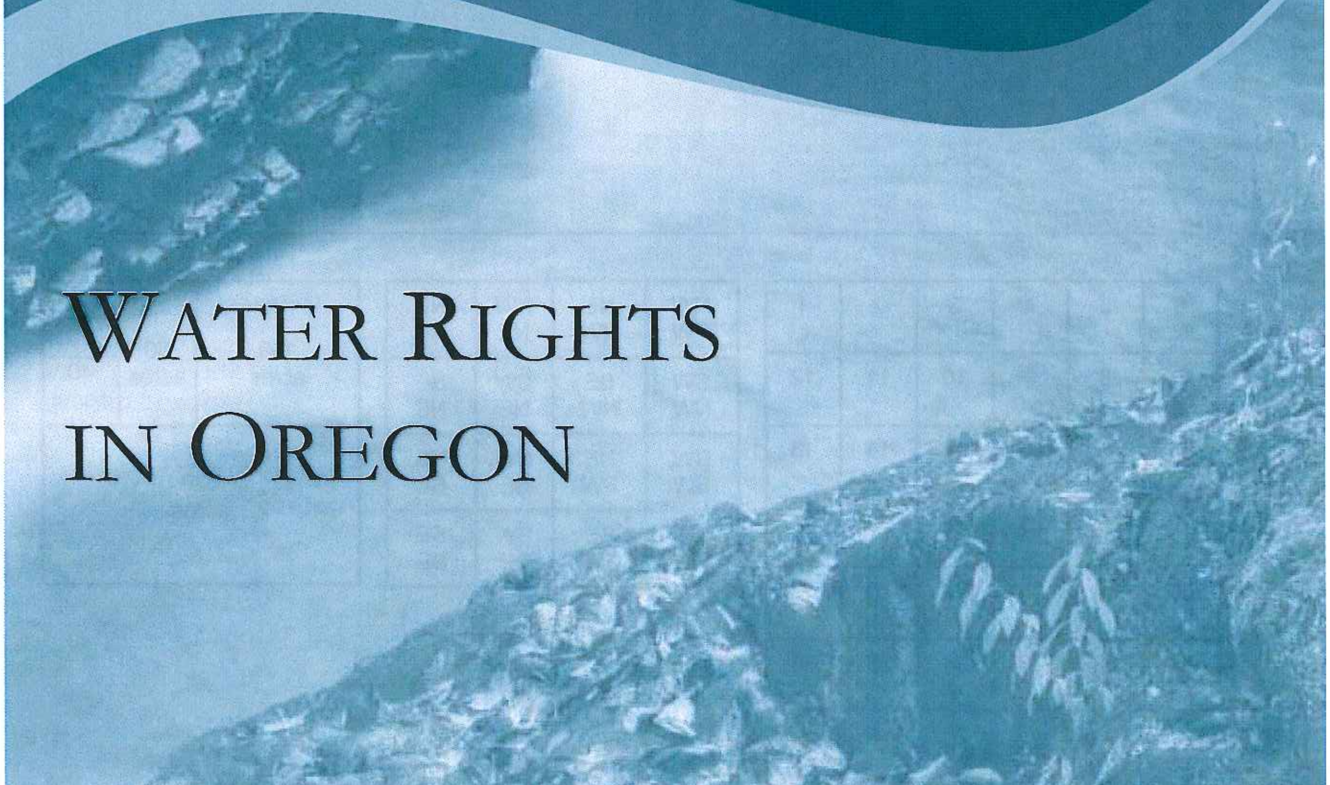
An Introduction to Oregon's Water Laws

WATER RIGHTS IN OREGON



Oregon Water Resources Department
Centennial Edition ~ September 2009

Water Quantity Conversion Table

Water measurements are generally described using rate and volume. When applying for a permit to use water, an applicant is required to submit all measurements in one of the following terms.

When referring to a rate to be diverted, the terms commonly used are cubic feet per second (cfs) or gallons per minute (gpm). When discussing volumes of water, such as amount applied to land, reservoir storage capacity, or yearly consumption, the term used is acre-feet (af). Applications for water use specify the appropriate measurement to use when providing information to the Department.

Rates of Flow

One (1) cubic foot per second (cfs) is a rate of water flow that will supply one cubic foot of water in one second and is equivalent to flow rates of:

1 cfs =	7.48 gallons per second
	448.8 gallons per minute
	646,272 gallons per day
	1.98 acre-feet per day

Volume Measurement

One (1) acre-foot is the volume of water that will cover one acre to a depth of one foot and is equal to:

1 af =	43,560 cubic feet
	325,851 gallons

Land Subdivision

- - - - -Range 6 miles- - - - -

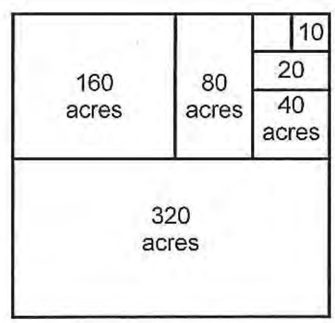
6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

- - - - -Township 6 miles- - - - -

NW NW	NE NW	NW NE	NE NE
SW NW	SE NW	SW NE	SE NE
NW SW	NE SW	NW SE	NE SE
SW SW	SE SW	SW SE	SE SE

Section

1 Mile
640 acres



CONTENTS

The Water Resources Commission and Department

"To serve the public by practicing and promoting responsible water management."

The Water Resources Commission is a seven-member citizen body established by statute to set water policy for the state and oversee activities of the Water Resources Department in accordance with state law. Members are appointed by the Governor, subject to confirmation by the Oregon Senate, for four-year terms. One member is appointed from each of five regional river basin management areas, and two "at large" members from east and west of the Cascades.

The Water Resources Department is the state agency charged with administration of the laws governing surface and ground water resources. The Department is organized into five divisions— Field Services, Technical Services, Water Rights and Adjudications, Administrative Services, and the Director's Office—all operating under the immediate authority of the Director.

The Director is appointed by the Governor to serve a four-year term, subject to confirmation by the Oregon Senate. The Director is charged with applying the Commission's adopted policies and rules through Department programs. In addition, the Director has independent responsibility for general stream adjudications.

"The original thinking behind the Oregon Water Code was quite sound. Although the Code has adapted over the years to meet society's changing needs, it remains a functional and effective system, providing certainty to Oregon's communities and protecting more water instream than any other western state." **~ Phillip C. Ward, Director of the Water Resources Department**

1. OREGON WATER LAWS

water management in Oregon

The Water Code

Under Oregon law, all water is publicly owned. With some exceptions, cities, farmers, factory owners, and other water users must obtain a permit or water right from the Water Resources Department to use water from any source—whether it is underground, or from lakes or streams. Generally speaking, landowners with water flowing past, through, or under their property do not automatically have the right to use that water without a permit from the Department.

For more information refer to ORS 537.110

Prior Appropriation

Oregon's water laws are based on the principle of prior appropriation. This means the first person to obtain a water right on a stream is the last to be shut off in times of low streamflows. In water-short times, the water right holder with the oldest date of priority can demand the water specified in their water right regardless of the needs of junior users. If there is a surplus beyond the needs of the senior right holder, the water right holder with the next oldest priority date can take as much as necessary to satisfy needs under their right and so on down the line until there is no surplus or until all rights are satisfied. The date of application for a permit to use water usually becomes the priority date of the right.

With some exceptions, a water right, permit, or license is required to withdraw the waters of Oregon. The water must be used for a beneficial purpose, without waste.

East of the Mississippi, the riparian doctrine usually applies. Under the riparian doctrine, only landowners with water flowing through their property have claims to the water. The prior appropriation doctrine is the basis of water law for most of the states west of the Mississippi River. In Oregon, the prior appropriation doctrine has been law since February 24, 1909, when passage of the first unified water code introduced state control over the right to use water. Before then, water users had to depend on themselves or local courts to defend their rights to water.

OREGON'S WATER CODE

four fundamental provisions

- **Beneficial purpose without waste**
  Surface or ground water may be legally diverted for use only if it is used for a beneficial purpose without waste.

- **Priority**
  The water right priority date determines who gets water in a time of shortage. The more senior the water right, the longer water is available in a time of shortage.

- **Appurtenancy**
  Generally, a water right is attached to the land described in the right, as long as the water is used. If the land is sold, the water right goes with the land to the new owner.

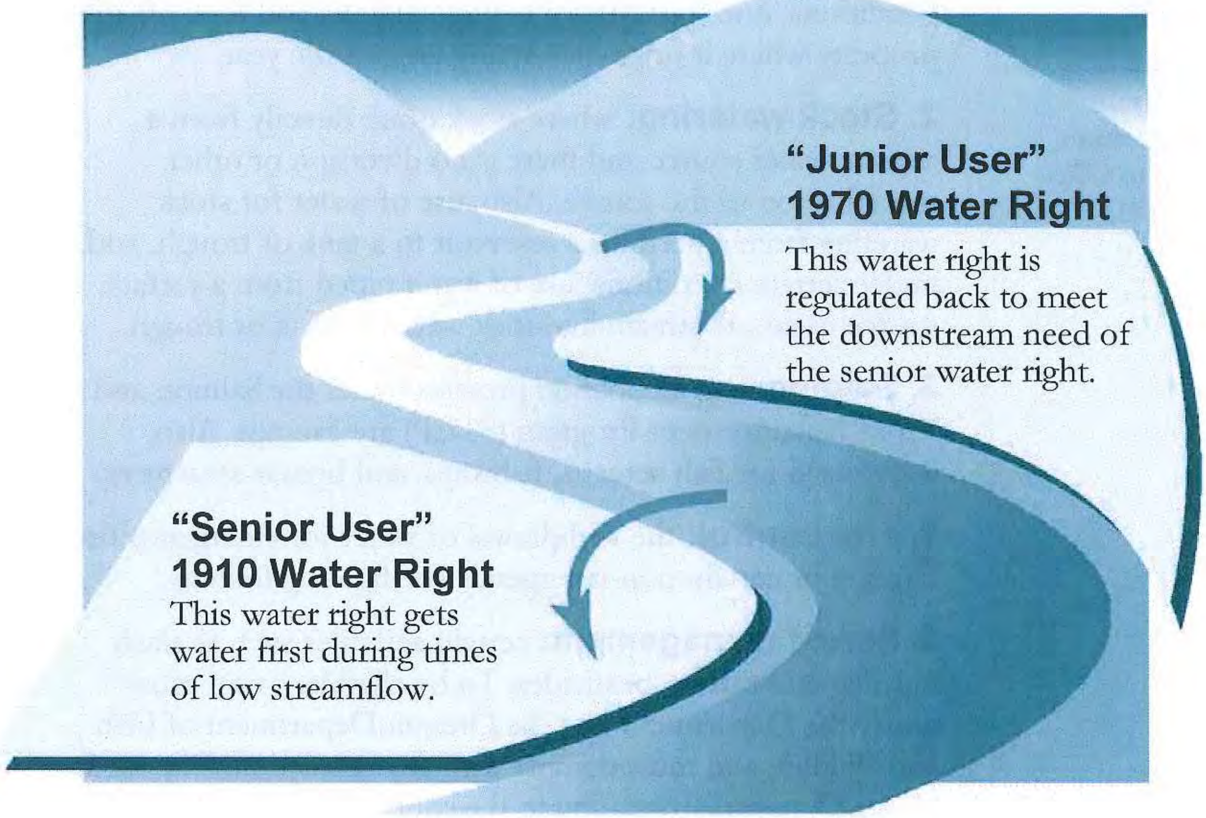
- **Must be used**
  Once established, a water right must be used as provided in the right at least once every five years. With some exceptions established in law, after five consecutive years of non-use, the right is considered forfeited and is subject to cancellation.

Generally, Oregon law does not provide a preference for one kind of use over another. If there is a conflict between users, the date of priority determines who may use the available water. If the rights in conflict have the same date of priority, then the law indicates domestic use and livestock watering have preference over other uses. However, if a drought is declared by the Governor, the Department can give preference to stock watering and household consumptive purposes, regardless of the priority dates.

Some uses of water are exempt from the requirement to obtain a permit. These are called "exempt uses."

Prior Appropriation: an example

"First in time, first in right"



An example of prior appropriation at work

Prior appropriation ensures that the first water user to obtain water rights has first access to water in times of shortage. If a "downstream" landowner has the earlier priority date (they initiated their water right in 1910) the "upstream" landowner may have to let the water pass unused to meet the needs of the senior, downstream water right holder.

Exempt uses of surface water include:

For more information, refer to ORS 537.141.

1. Natural springs: use of a spring that, under natural conditions, does not form a natural channel and flow off the property where it originates at any time of the year.

2. Stock watering: where stock drink directly from a surface water source and there is no diversion or other modification to the source. Also, use of water for stock watering from a permitted reservoir to a tank or trough, and, under certain conditions, use of water piped from a surface source to an off-stream livestock watering tank or trough.

3. Salmon: egg incubation projects under the Salmon and Trout Enhancement Program (STEP) are exempt. Also, water used for fish screens, fishways, and bypass structures.

4. Fire control: the withdrawal of water for emergency fire fighting or certain non-emergency fire fighting training.

5. Forest management: certain activities such as slash burning and mixing pesticides. To be eligible, a user must notify the Department and the Oregon Department of Fish and Wildlife and must comply with any restrictions imposed by the Department relating to the source of water that may be used.

6. Certain land management practices: where water use is not the primary intended activity.

7. Rainwater: collection and use of rainwater from an artificial impervious surface (like a parking lot or a building's roof).

For more information, refer to ORS 537.545.

Exempt uses of groundwater include:

1. Stock watering.

2. Lawn or noncommercial garden: watering of not more than one-half acre in area.

3. Single or group domestic purposes: not exceeding 15,000 gallons per day.

4. Single industrial or commercial purposes: not exceeding 5,000 gallons per day. Does not include irrigation or watering to promote plant growth.

5. Down-hole heat exchange uses.

6. Watering school grounds: ten acres or less, of schools located within a critical ground water area.

Note: While these water uses do not require a permit, the use is only allowed if the water is used for a "beneficial purpose without waste" and may be subject to regulation in times of water shortage.

Wells supplying water for exempt groundwater uses must comply with Oregon's minimum well construction standards for the construction, maintenance, and abandonment of any well.

2. WATER PROTECTIONS AND RESTRICTIONS

managing water appropriations

Basin-by-Basin Water Use Restrictions

Some waters within the state may be closed to new appropriation by legislative action or restricted by an administrative rule or order of the Water Resources Commission. These restrictions on new uses from streams and ground water aquifers are adopted to assure sustained supplies for existing water users and to protect important natural resources. Except in very severe situations (e.g., critical groundwater areas), these restrictions do not affect existing water uses, only the Department's ability to authorize new uses in these basins.

Basin Programs

The Water Resources Commission adopts basin programs to set policies for managing river basins. A river basin includes all the land area, surface water bodies, aquifers, and tributary streams that drain into the major namesake river. A map of the state's river basins is on the last page of this booklet.

Water measurement is an essential component of distributing water to senior rights during low stream-flows.

These measurements help the Department monitor the state's water resources and plan for future needs in each basin.

Basin programs include water-use "classifications" that describe the types of new water right applications that may be considered by the Department. Applicants should check with the Department before submitting an application to determine what classifications have been adopted on the proposed source of water.

The Commission has adopted basin programs for all but two of the state's 18 major river basins. Although the Commission has not adopted comprehensive basin programs for the Klamath and Malheur Lake basins, use of water in those basins is still subject to other administrative rules. The Commission may revise classifications in basin programs when the lack of available water or other factors indicate that new appropriations should not be allowed.

Any change in the classification of a stream or aquifer restricts only new uses of water.

Critical Groundwater Areas

The law requires that when pumping of groundwater exceeds the long-term natural replenishment of the underground water reservoir, the Water Resources Com-mission must act to declare the source a critical groundwater area and restrict water use. The law is designed to prevent excessive declines in groundwater levels. The order setting the limits of the critical area may also provide for certain users of water to have preference over other users, regardless of established water right priority dates. Critical groundwater areas also can be declared if there is interference between wells and senior surface water users or deterioration of groundwater quality.

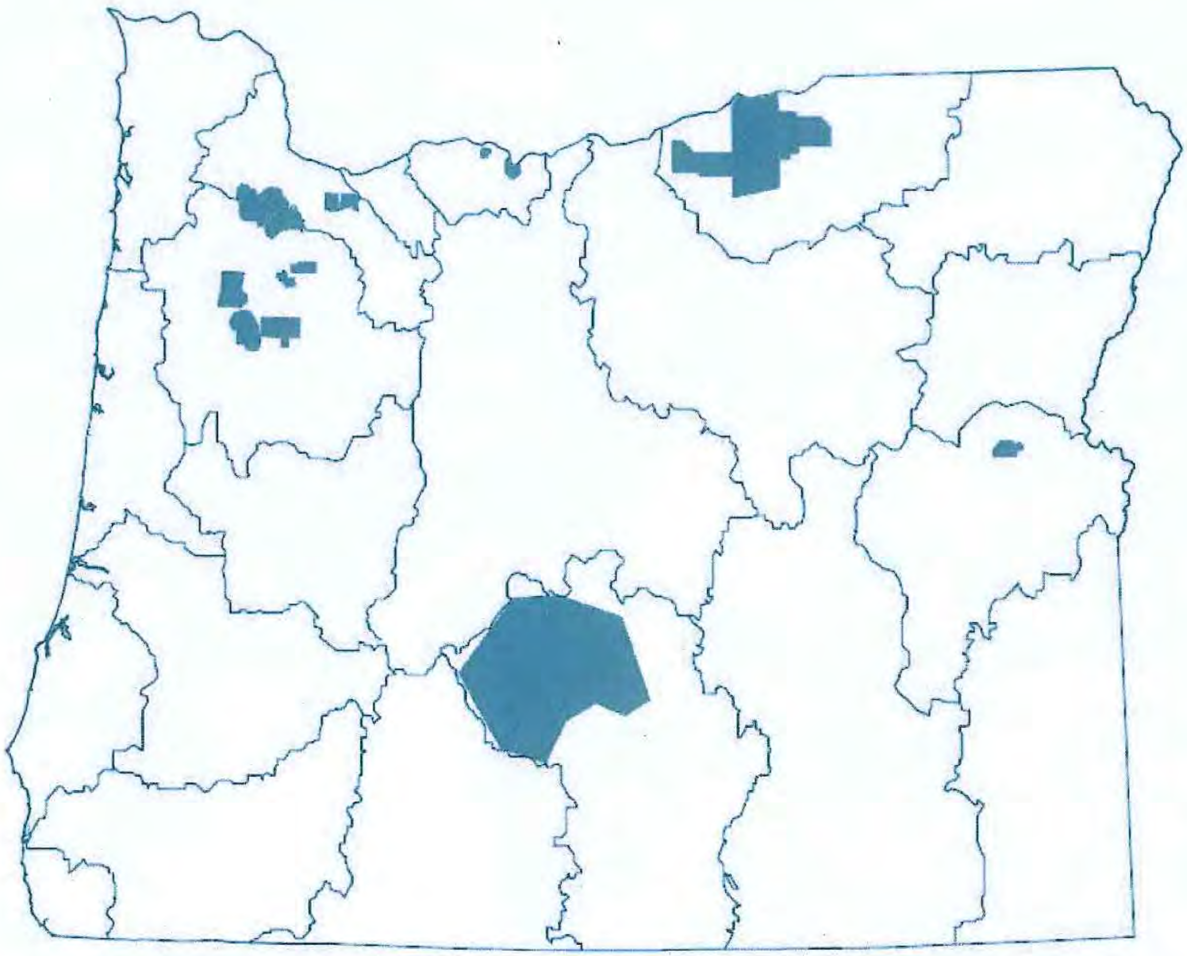
Once a critical groundwater proceeding is initiated by the Commission, no new well permits are issued during the course of the proceeding. The final order may restrict both existing and future uses in order to stabilize the resource.

To date, Oregon has declared seven critical groundwater areas. The critical areas are Cow Valley near Vale; The Dalles in Wasco County; Cooper Mountain-Bull Mountain southwest of Beaverton and Tigard; and the Butter Creek, Ordnance (alluvial and basalt) and Stage Gulch areas in Morrow and Umatilla Counties.

Groundwater Limited Areas

The northern Willamette Valley and much of the Colum-bia River plateau contain many sources of groundwater that are isolated in volcanic rock. These aquifers are in the Columbia River Basalt group, or basalt for short. Heavy pumping from the basalt and another geologic unit, the Troutdale Formation, have caused declines in these areas.

The Commission has established 12 "groundwater limited areas" in the northern Willamette Valley. These areas are in the following approximate locations: Sandy-Boring, Damascus, Gladtidings, Kingston, Mt. Angel, Sherwood-Dammasch-Wilsonville, Stayton-Sublimity, Parrett Mountain, Chehalem Mountain, Eola Hills, South Salem Hills, and Amity Hills-Walnut Hill. The Willamette and Sandy Basin programs list the limitations. Outside the Willamette Valley are the Fort Rock and Ella Butte limited areas. Through changes to the basin programs, new water rights in these areas are restricted to a few designated uses.



■ **MANAGEMENT AREA** Restricted Classification, Limited Areas, Critical Areas

For more information, refer to OAR 690-502.

The Department's role is to protect existing water rights by preventing excessive groundwater declines, restoring aquifer stability, and preserving aquifers with limited storage capacity for designated high public value uses. As more wells are drilled, the Department may find other areas where use from basalt and other aquifers must be limited. Such limitation applies to the specific aquifer that a well is tapping. In some cases, water may still be available at a different depth from a different geologic formation.

Groundwater Closure

The Commission may close aquifers to new withdrawals where additional use is not sustainable. The Victor Point area near Silverton is the only area closed at this time.

3. Obtaining New Water Rights

gaining authorization to use water

Most water rights are obtained in a three-step process. The applicant first must apply to the Department for a permit to use water. Once a permit is granted, the applicant must construct a water system and begin using water. After water is applied, the permit holder must hire a certified water right examiner to complete a survey of water use and submit to the Department a map and a report detailing how and where water has been applied. If water has been used according to the provisions of the permit, a water right certificate is issued after evaluation of the report findings.

In most areas of the state, surface water is no longer available for new uses on a year-round basis. Ground water supplies may also be limited in some areas. Allocation of new uses of water is done carefully to preserve the investments already made in the state, whether in farms, factories, or improvement of fish habitat.

Water rights are not automatically granted. Opportunities are provided for other water right holders and the public to protest the issuance of a permit. Water users can assert that a new permit may injure or interfere with their water use, and the public can claim that issuing a new permit may be detrimental to the public interest. This provides protection for both existing water users and public resources.

Water-Use Permits

The First Step: requesting a water-use permit

A permit is the authorization from the Department necessary to begin constructing a water system and begin using water. Once the Department issues a permit, if the user complies with the conditions of the permit and develops their water right, the Department cannot later decide to revoke or change the permit or impose new standards for the use.

For more information, refer to ORS 537.130 and ORS 537.535.

For an application to be considered, an applicant must submit a completed application to the Department along with other information and maps, as required by statute. Types of information that may be required:

Applications and more detailed instructions are available at all Department offices and on the Department's website at *www.wrd.state.or.us.*

1. A legal description of the property involved (may be found on a deed, land sales contract, or title insurance policy).

2. A map showing the features of the proposed use and proposed source located according to township, range, and section including any roads or other right of ways crossed by proposed diversion works.

3. In most cases, a statement declaring whether the applicant has written authorization permitting access to land not owned by the applicant (including land crossed by proposed diversion works).

4. The names and addresses of any other property owners that may be affected by the proposed development.

5. Land use information obtained from the affected local government planning agency.

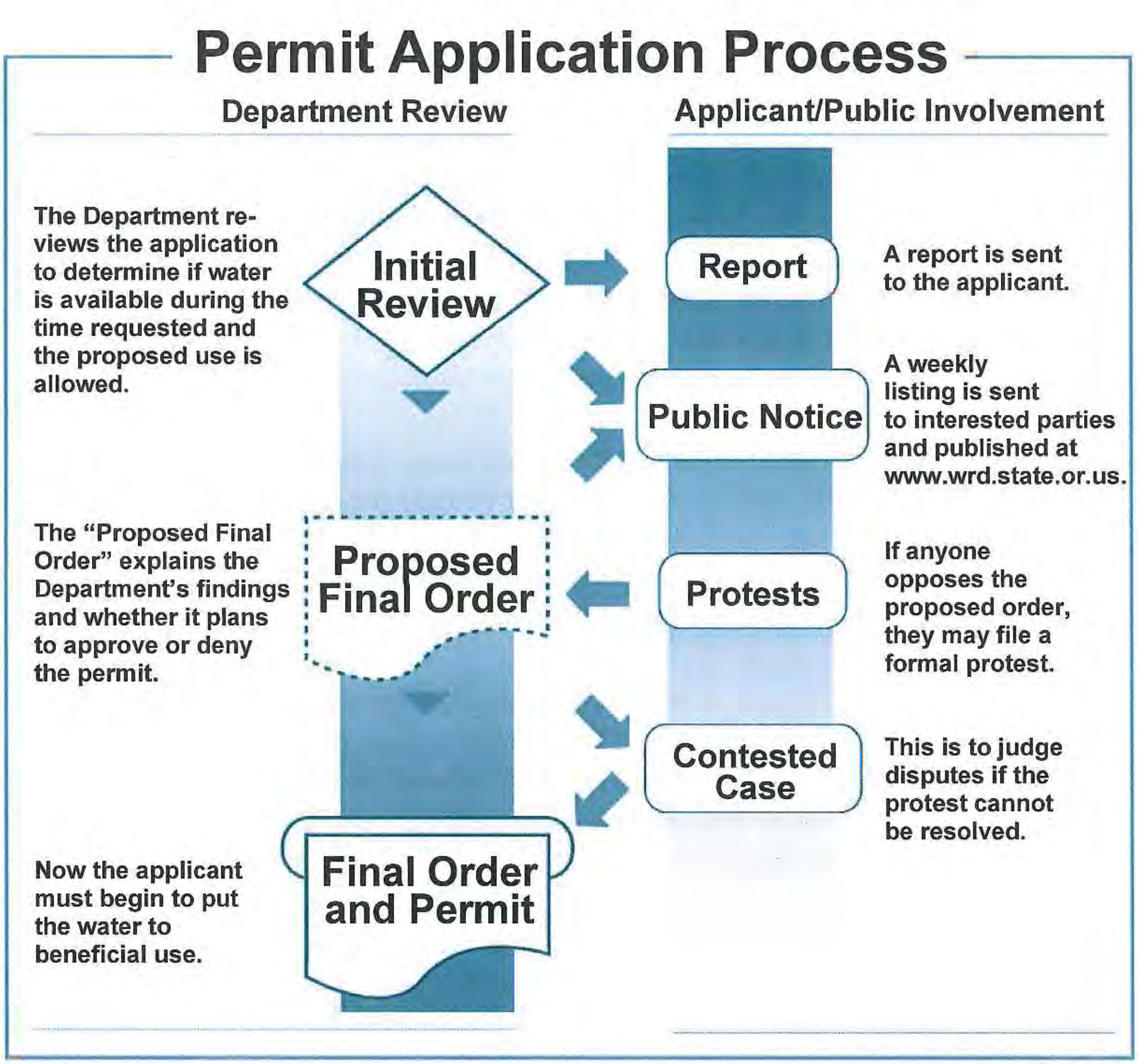
6. Supplemental Form (if necessary) such as Form I for irrigation or Form M for a municipal right.

Oregon law also requires that the applicant pay a fee set by statute. This fee contributes to the costs of reviewing and handling the application. A fee schedule is available from the Department on request and can be found online at *www.wrd.state.or.us.*

It is important that application instructions are carefully followed. If application materials are incomplete, they will be returned to the applicant.

The requirements outlined in the Oregon statutes and the Department's administrative rules generally require the Department to issue a final order approving or denying the application within eight months.

However, if protests are filed, the Department may schedule a contested case hearing to resolve issues raised



in the protest(s). A contested case hearing often extends the process beyond eight months.

Pre-application consultation

Applicants with complex requests, or applicants who are unfamiliar with the application process, are encouraged to contact the Department to schedule a "pre-application conference." The Department's Water Rights Section staff are available to meet with applicants about their proposed project.

To inquire about a pre-application conference, please contact the Salem office at: (503) 986-0900.

Application review

During the application review stage, applications are examined by the Department to ensure that allowing the proposed use will not cause injury to other users or public resources. The Department also determines if water is likely to be available for use and considers many other

factors in its analysis of the application. These factors include basin plan restrictions that might prohibit certain uses or further appropriations, local land use restrictions, water quality, and other state and federal rules.
For example, when considering a water right application in or above a state scenic waterway, the Department is required by law to find that the proposed use will not impair the recreational, fish, and wildlife values in the scenic waterway. The Department has prepared estimates of the streamflow levels needed to satisfy these uses. These flows may be used in determining whether new water rights in or above a scenic waterway should be authorized.

Also during the application review stage, other water right holders, government agencies, and the public may comment on or protest the application. For example, the Department consults with the Oregon Department of Fish and Wildlife to evaluate impacts on sensitive, threatened or endangered species, and ensure instream values are protected.

When applicants seek to use stored water only, the application will receive an expedited review leading directly to a final order, unless public interest issues are identified following the public notice of filing. If such issues are raised adequately, the application will undergo the standard review process to allow thorough public participation.

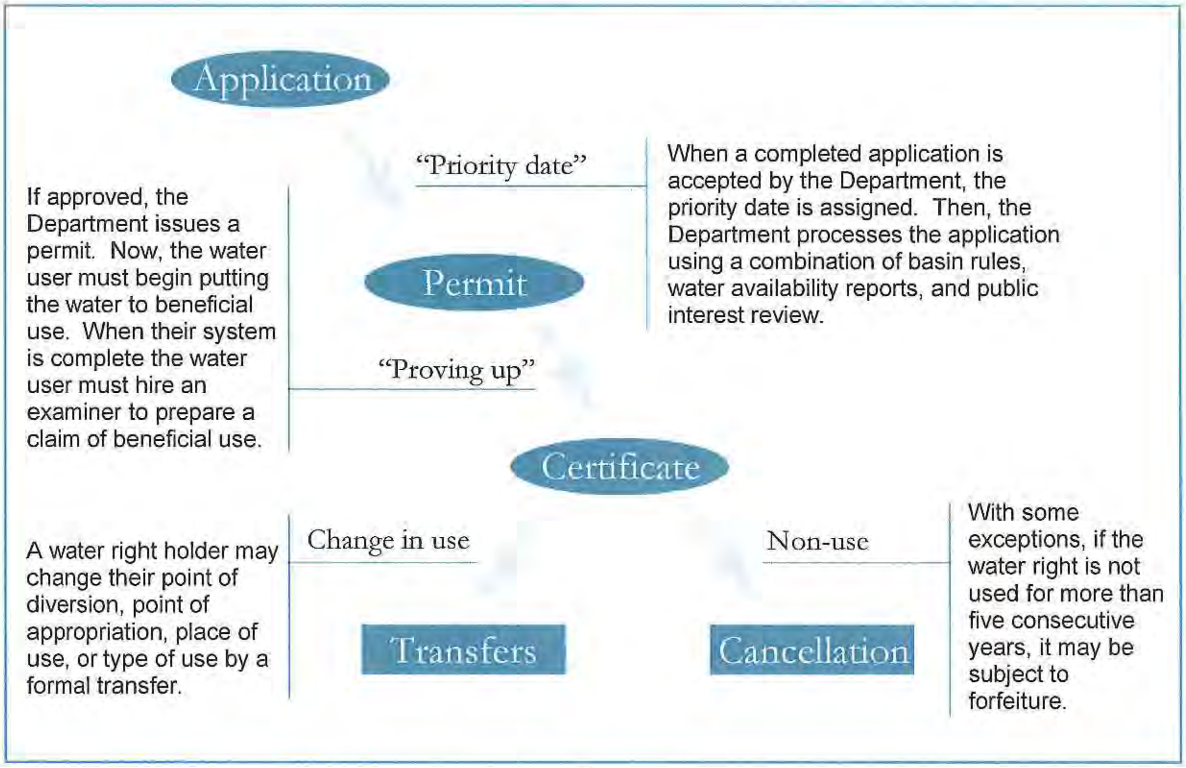
The Second Step: constructing the system and using water

Once the Department determines that a new water use can be allowed, a permit is issued. The permit will contain time limits to develop the water use. Other conditions may also be placed on the permit, such as a requirement for metering the water use, reporting water use, or installing and maintaining fish screens.

Permits generally require the water user to develop the water use within four or five years. The permit holder may apply for an extension of time to fully develop the water use. The Department considers each request for an extension of time on a case-by-case basis. If there is good cause for not completing the water use in a timely manner and the permit holder has shown diligence in trying to meet the requirements of the permit, an extension may be granted.

Changing or modifying a permit

The point of diversion or the place of water use under a permit may be changed by submitting an application to the Department. The application is similar to a transfer application (discussed on pages 29-33), except the required map does not have to be prepared by a certified water right examiner. The change in the permit will be allowed only if it will not cause injury to other water rights. Under certain,



limited circumstances, permit holders may also change a surface water point of diversion to a nearby ground water source. The other terms and conditions in the permit cannot be changed.

The Third Step: "proving up" the water use

Once the water project is completed, the permit holder must send notice to the Department that work has been completed. The permit holder is then required to submit proof of water use to the Department.

Except for certain small ponds, as described on pages 22-23, a water user must hire a certified water right examiner (CWRE) to survey the extent of water use, and within one year of completion (or the completion date, whichever is sooner) submit a map and claim of beneficial use to the Water Resources Department. This allows the Department to evaluate the extent of water use developed within the terms and conditions of the permit. Certified water right examiners are registered, professional surveyors, geologists, or engineers who have passed a test given by the Oregon State Board of Examiners for Engineering and Land Surveying. For a list of CWREs, call the Department in Salem at (503) 986-0900 or your local watermaster listed on pages 40-41.

In some instances, personnel from the Department may conduct a brief field inspection of the completed appropriation to check the accuracy of the survey supplied by the CWRE. The inspector may want to check the size and type of equipment or verify that the amount of water requested has been put to use according to the permit. If necessary, water measurements may be taken. In some cases, applicants inadvertently ask for too much water or simply use less water than originally intended. Oregon's water law provides that a certificate may be issued only for the quantity of water that is used beneficially: the quantity of water that can be applied without waste or the amount allowed by the permit, whichever is less.

Final Certificates: the "perfected" water right

With the final proof survey map and water-use report, the Department will determine if the permit holder has met the conditions of the permit. If so, a water right certificate is issued. The water right certificate will continue to be valid as long as the water is used according to the provisions of the water right at least once every five years. (For exceptions to this requirement, see pages 33-34 on cancellation of water rights.)

The amount of water allowed in the certificate will be an instantaneous rate and/or an annual volume. The appropriator may divert a certain maximum rate, but may not exceed the total amount allowed for the year. The instantaneous rate is usually expressed in cubic feet per second (cfs) or gallons per minute (gpm) and the annual amount in acre-feet (af). A conversion table for cfs, gpm, and af is located on the inside cover of this booklet.

A water right permit or certificate will not guarantee water for the appropriator. Under the prior appropriation doctrine, the water right authorizes diversion of water only to the extent water is available. The amount of water available to a water right holder depends on the water supply and the needs of senior water rights, including water rights for instream use.

Water Dedicated to Instream Uses

For more information, refer to ORS 537.336.

The Department also approves water rights for protecting fish, minimizing the effects of pollution, or maintaining recreational uses. These water rights are called "instream water rights". Instream water rights establish flow levels to remain in a stream on a month-by-month basis and are usually set for a certain stream reach and measured at a specific point on the stream. Instream water rights have a priority date and are regulated in the same way as other water rights.

Instream water rights were established by the 1987 Legislature. This law allows the Departments of Fish and Wildlife, Environmental Quality, and Parks and Recreation to apply for instream water rights. The law gives instream water rights the same status as other water rights. However, in a Governor-declared drought, Oregon law allows the Department to give preference to human consumption and livestock watering over other uses, including instream uses.

Instream water rights are not guarantees that a certain quantity of water will be present in the stream. When the quantity of water in a stream is less than the instream water right, the Department will require junior water right holders to stop diverting water. However, under Oregon law, an instream water right cannot affect a use of water with a senior priority date.

For more information, refer to ORS 537.348 and OAR 690-077 & OAR 690.380.

Oregon law also allows water right holders to sell, lease, or donate water rights to be converted to instream water rights. This is done through a short-term lease agreement or by a formal transfer of the existing right from the current use to a new type of use. Instream leases and transfers are discussed on pages 29-33.

Rights to Store Water

Reservoirs and Ponds

For more information, refer to ORS 537.400.

The construction of a reservoir or pond of any size to store water requires a permit from the Department. A permit to construct a reservoir allows storage of streamflow and is usually filled from higher streamflows that occur during the winter months.

A permit for a reservoir with the sole purpose of storing water is considered the primary permit. Permittees intending to divert and use or maintain water stored in the reservoir or pond, will need an additional, or secondary, water use permit.

A holder of a water right to the natural flow of a stream has no right to water stored in the reservoir of another water right holder. A reservoir water right holder usually does not have to release stored water to satisfy the needs of senior, natural flow rights on the same stream system. The operator of the reservoir must, however, provide some means of passing natural streamflow through or around the reservoir to satisfy downstream prior water right holders and instream water rights.

Reservoirs with a dam 10 feet or greater in height and that store 9.2 acre-feet or more of water must submit a map prepared by a CWRE, as well as engineering plans and specifications for approval by the Department before the reservoir is constructed. Smaller reservoirs and dams do not require CWRE application maps or engineered designs and plans; however, the Department highly encourages dam builders to seek the Department's technical review of plans before beginning construction. This will help ensure a sound dam with the necessary safeguards in place for the protection of downstream property owners.

Alternate review process for smaller reservoirs

An alternative permit application process is available to persons interested in building small reservoirs storing less than 9.2 acre-feet of water or in reservoirs with dams less than 10 feet in height.

For more information, refer to ORS 537.409.

This process involves an expedited review and requires the Department to grant a permit or deny the application within six months. Fees for this type of permit are generally lower than those required for other types of permits. For certain reservoirs or ponds filed under this process, those that store less than 9.2 acre-feet and do not have a secondary permit to use the stored water, a CWRE survey is not required to receive a water right certificate. Instead, permittees may submit information on the dimensions, capacity, and location of such reservoirs to the Department. If you have questions about which type of application process is best for you, please call the Department at (503) 986-0900 or contact your local watermaster (see pages 40-41).

4. OTHER WATER RIGHTS

authorizations for water use

Rights Through Customary Use

If water was used prior to enactment of the 1909 water code and has been used continuously since then, the property owner may have a "vested" water right. Because a water right is attached to the place of use, this is true even if the ownership of the property has changed.

A claim to a vested water right can be determined and made a matter of record only through a legal process known as an "adjudication proceeding." The responsibility of the Department in the adjudication process is to gather information about the use of water and present its findings to the circuit court in the county where the water is used. The court then issues a decree that states who has the right to use water, the amount and location of water use, and the priority date for each right. The Water Resources Department then issues a water right certificate for each decreed right. The date of priority for a right determined through an adjudication proceeding is usually the date construction of the project began or the date when water was first used on the property.

Adjudication proceedings have been completed for most of the major stream systems in eastern and southern Oregon and a few of the larger tributaries to the Willamette River. Nearly 100 decrees have been issued on individual streams in Oregon. Water right certificates have been issued for most of the decreed rights. An adjudication proceeding is underway in the Klamath Basin, which involves private water users, the Bureau of Reclamation, other federal agencies, and the Klamath Tribes.

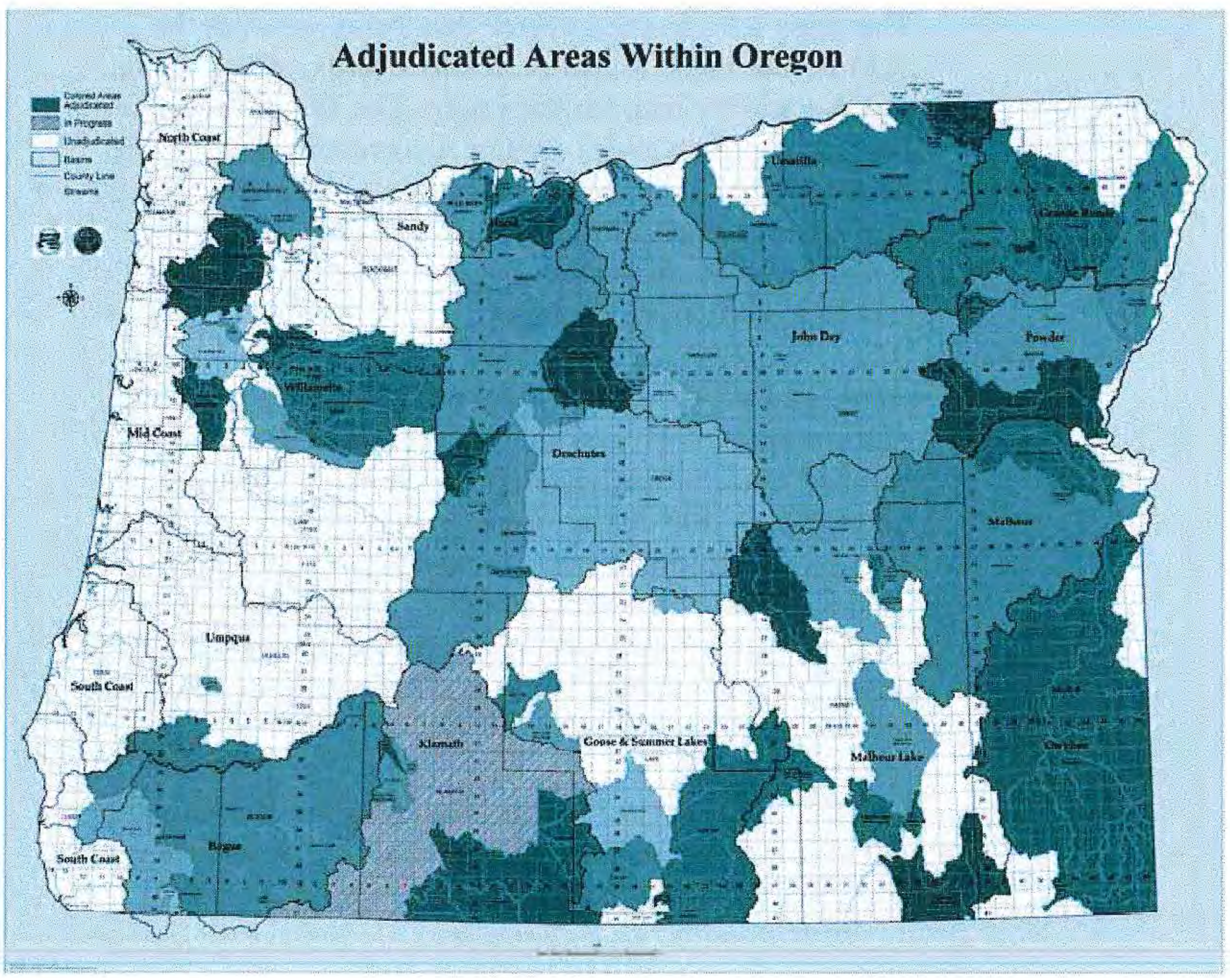
For more information, refer to ORS 539.240.

Legislation passed in 1987 required persons claiming pre-1909 rights in areas not yet adjudicated to file surface water registration statements before December 31, 1992.

For more information, refer to ORS 539.300.

Failure to file this registration statement by the deadline created the rebuttable presumption that the person had no claim to a water right. These statements do not automatically assure rights will be granted to those who have filed. Each vested right will be determined through the courts in an adjudication proceeding.

Adjudication proceedings are also used to determine the water rights for federal reservations of land. This includes Indian reservations and other federal reservations. Legislation passed in 1987, and amended in 1993, allows the Director of the Department to act on behalf of the State of Oregon to negotiate settlements for these rights. These negotiations allow the Director to include claimants, state and federal agencies, other water users, and public interest groups in discussions that resolve and quantify the use of the water on these reservations.



Limited Licenses

Oregon law also provides a method for obtaining permission to divert and use water for a short-term or fixed duration. Under current law, certain types of uses can be allowed using a "limited license", provided that water is available and the proposed use will not injure other water rights. These authorizations allow landowners and developers to use water for purposes that do not require a permanent water right. A limited license may be available as soon as three weeks after filing an application with the Department.

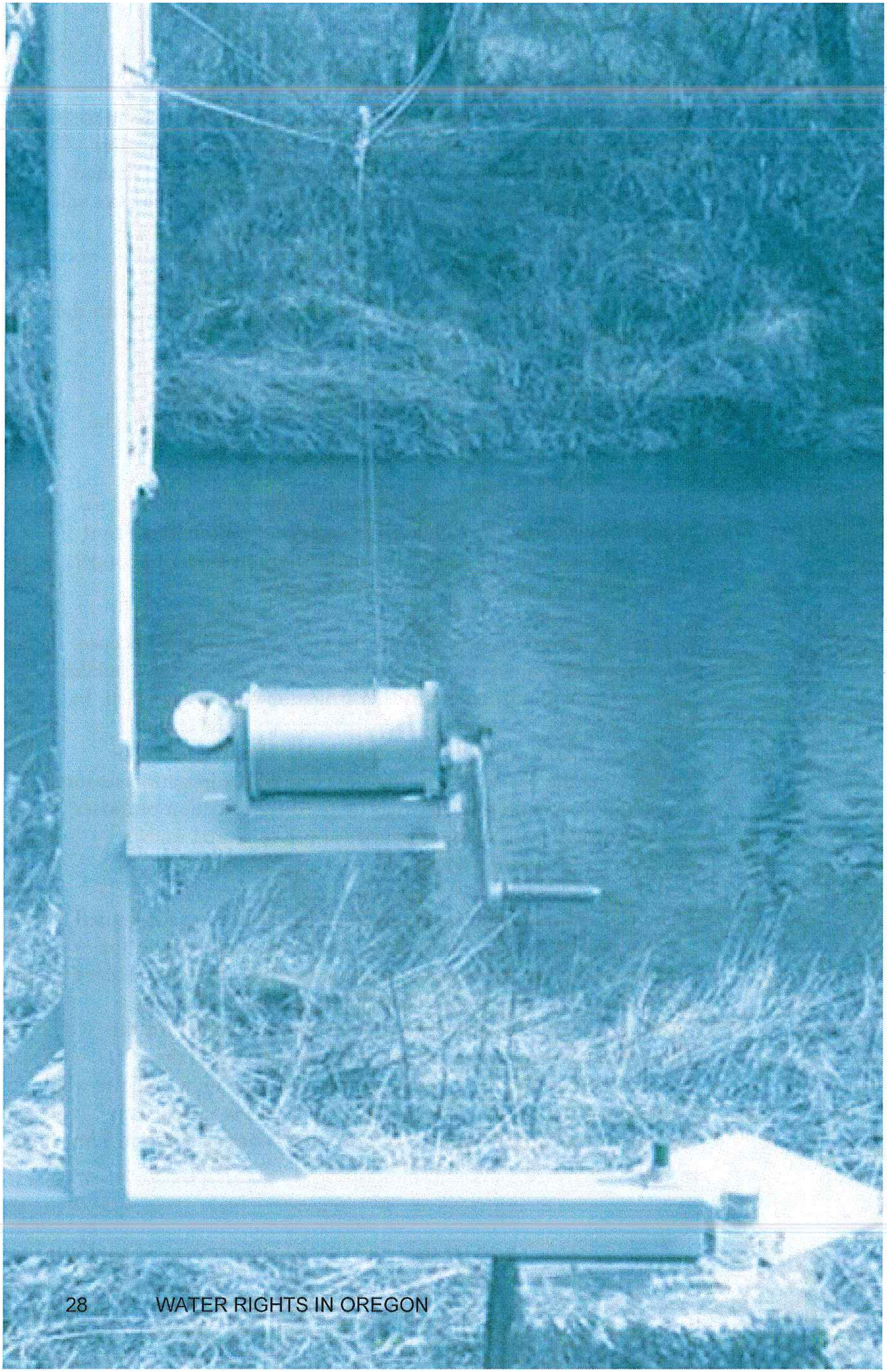
For more information, refer to ORS 537.143 & OAR 690-340.

Limited licenses are "junior" to all other uses and subject to revocation at any time. There is no guarantee that water will be available.

Uses under a limited license may include, but are not limited to, road construction, fire fighting, general construction, rangeland management, and emergency use authorization. Uses of a longer duration may also qualify for limited licenses.

Generally, irrigation uses are not allowed under a limited license. In some cases, however, a limited license may be used to establish a crop that will not require further irrigation once established. In cases of severe drought, the Department may issue limited licenses so landowners can avoid irreparable crop damage by continuing the use of water after the close of the irrigation season. In addition, a limited license may be used for irrigation purposes in cases where the license is issued for use of stored water, provided certain criteria are met.

The Department conducts a review of an application for limited license to assess the proposed use, diversion, and location for water availability and public interest concerns such as threatened or endangered fish, water quality limited streams or scenic waterways. The Department provides an opportunity for the public to comment on a proposed limited license. If the Department finds that water is available and the proposed use will not impair the public interest, a limited license is issued with terms and conditions similar to those of a water use permit. The license includes a condition that specifies when it expires.



5. Transferring Water Rights

existing rights for new uses

The use of water under a water right is restricted to the terms and conditions described in the water right certificate: place of use, point of diversion, and type of use. For example, if a water right holder establishes the right to irrigate a particular 20-acre tract of land, the water cannot be diverted from a different point or source, nor can it be used to irrigate other land. It cannot be used for any other purpose than the type of use indicated in the water right.

The water right holder must file a transfer application with the Department to change a point of diversion, point of appropriation, type of use, place of use, or any combination of these.

Watermasters use bank operated cableways to take stream measurements on rivers too large or unsafe to wade. Gathering streamflow information is an important part of the Department's commitment to protect water rights and Oregon's water resources.

Permanent Transfers

An application for a permanent transfer generally requires a map prepared by a certified water right examiner (CWRE). The applicant must submit an application describing the current water right, the proposed change, and provide evidence of water use, land ownership or consent by the landowner, and, in most cases, compliance with local land use plans. The water may continue to be used in accordance with the current water right until the transfer is approved. Use as proposed may only occur once the transfer order is issued.

To approve a transfer application, the Department must determine that the proposed change will not injure other water rights. The public is offered a chance to comment and protest a proposed transfer if they believe an existing water right would be injured. The Department, working with the applicant, may attach conditions to an approval order to eliminate potential injury to other water rights. If conditional approval will not eliminate injury, the application is denied.

For more information, refer to ORS 540.510 & 540.520.

After the transfer is approved, the applicant must make the change. In the case of a change in use or place of use, any portion of the water right involved in the transfer that is not changed is lost. Following completion of the change, a CWRE must prepare a final proof map and site report to be submitted with the applicant's claim of beneficial use. The map and claim of beneficial use describe the completed change and the extent of the modified water right. A new water right certificate will be issued to confirm the modified water right.

Temporary Transfers

For more information, refer to ORS 540.523 & OAR 690-380.

A water user may temporarily change the place of use of a water right to allow a right attached to one parcel of land to be used on another parcel. A temporary transfer may not exceed a period of five years. This type of transfer is typically used for crop rotations or other rotational uses of water. The application for a temporary transfer is the same as the permanent transfer, however the required map does not have to be prepared by a CWRE.

Except under limited circumstances, Oregon law does not authorize a temporary change in the type of use of a water right. A temporary point of diversion change may be made if it is necessary to convey water for a temporary change in place of use. The Department can revoke a temporary transfer if the change results in injury to other water rights.

Other Transfers

If a government action causes a change in surface water levels that impairs the use of an authorized point of diversion, a special transfer process is available to change the point of diversion. This process is available for both certificated water rights and permits.

If an individual (not a company, government body, or other entity) has been using a diversion point for over ten years that is not the authorized point of diversion, the individual may request an abbreviated transfer process to change the certificated point of diversion to the current point of diversion. This change may only be made if there have been no complaints about the alternate point of diversion and if the change can take place without causing injury to other water rights.

District Transfers

Irrigation districts and certain other districts that deliver water may apply for a specific kind of transfer that allows the district to make several transfers in a single annual application. Districts may take control and transfer unused water rights within the district after specific notification to the landowner. Districts may also transfer a point of diversion for one irrigation season in the event that an emergency prevents the district from diverting at the authorized point of diversion.

For more information, refer to ORS 537.570 and ORS 540.580 & OAR 690-385.

Transfers and Leases for Instream Use

Water rights may be transferred or leased for instream uses. Instream transfers and leases must show that injury will not occur and that a beneficial use will be made of the water, such as fishery habitat or flow augmentation to improve water quality. Instream transfers and leases carry the priority date of the original right. The water may not be diverted by any junior user while it is an instream right or lease.

For more information, refer to ORS 537.348.

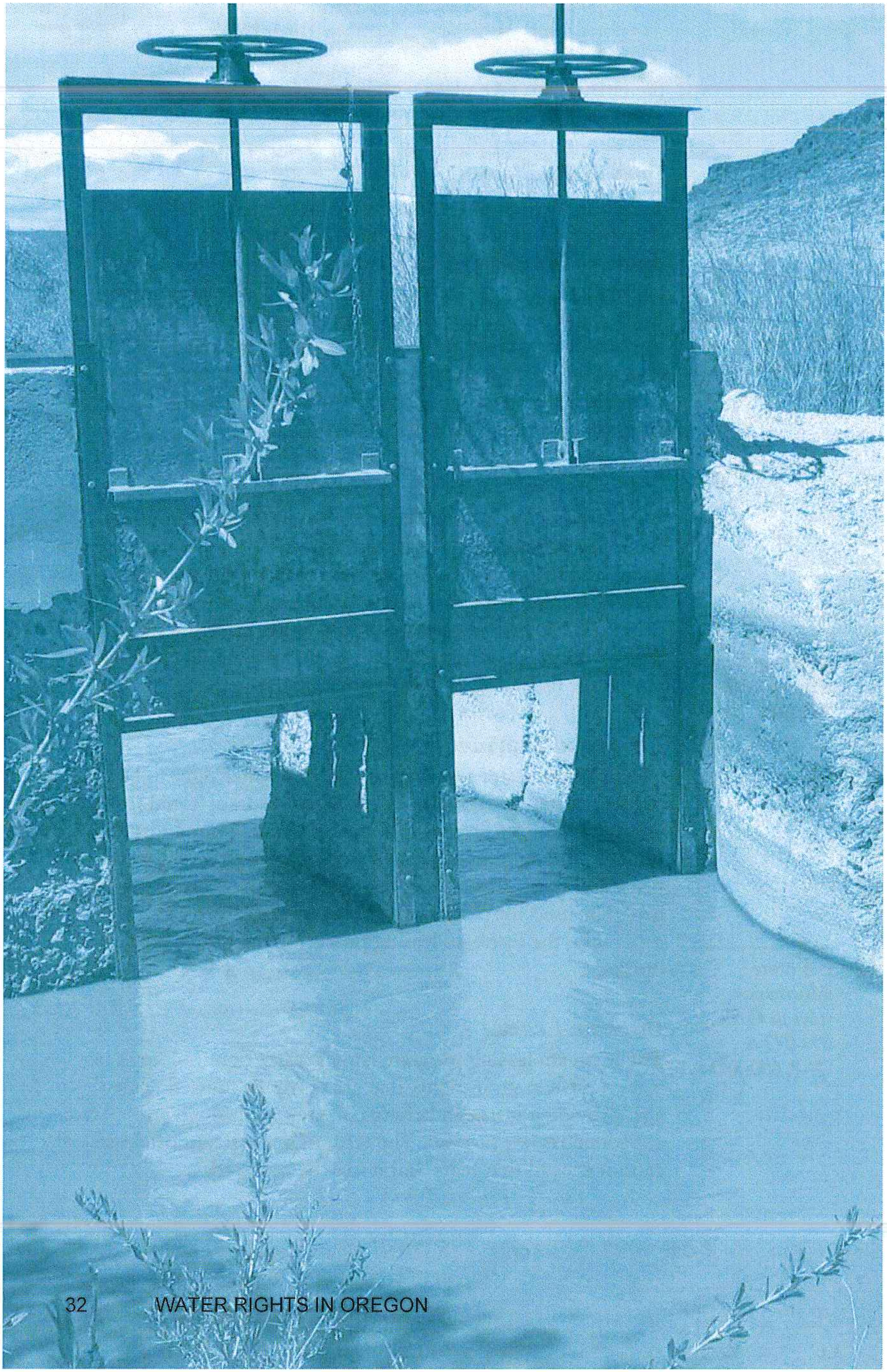
Permanent Instream Transfers

The instream water right statutes allow a water right to be permanently transferred to instream use or transferred for a specific period of time. At the end of a time-limited instream transfer, the right automatically reverts back to its original place and type of use. Time-limited instream transfers are generally used for periods of time exceeding five years; otherwise, the instream leasing process is the preferred option.

For more information, refer to OAR 690-077 & OAR 690-380.

Instream Leasing

The instream leasing program allows water right holders a way to protect water rights that are currently unused while also providing instream benefits. Leases go through an expedited review process. The term of an instream use lease cannot exceed five years, but it may be renewed.



Split season leasing allows for both instream and existing uses to occur from the same water right, but at different times of the year with appropriate measurement and monitoring to prevent enlargement or injury.

Water rights for surface water use, storage, the use of stored water, and water saved through the conserved water program (see page 37) may be leased instream.

Ground Water Registration Modifications

For more information, refer to ORS 537.585 to 537.610 & OAR 690-382.

Ground water registrations are claims for rights to use ground water established prior to 1955 and for which the Department has issued certificates of registration. The Department may recognize a change in use, place of use, or point of appropriation for a ground water registration if the Department determines that the change will not injure other water rights.

Headgates control the flow of water through ditches and canals that serve water users throughout Oregon. As new water rights are more difficult to obtain - due to lack of water availability in many Oregon streams - water will be gained by transferring older, existing rights.

Recognition of a modification in a ground water registration does not confirm the right, which can only be confirmed in a future adjudication proceeding. Pending that determination, the holder of a registration may use ground water as described in the certificate of registration, or as modified by the Department's recognition of changes.

6. CANCELLING WATER RIGHTS

loss of water rights through non-use

A water right remains valid as long as it is not cancelled and beneficial use of the water is continued without a lapse of five or more consecutive years. According to Oregon law, except for municipal rights and in certain other cases, if any portion of a water right is not used for five or more consecutive years, that portion of the right is presumed to have been forfeited and is subject to cancellation.

For more information, refer to ORS 540.610.

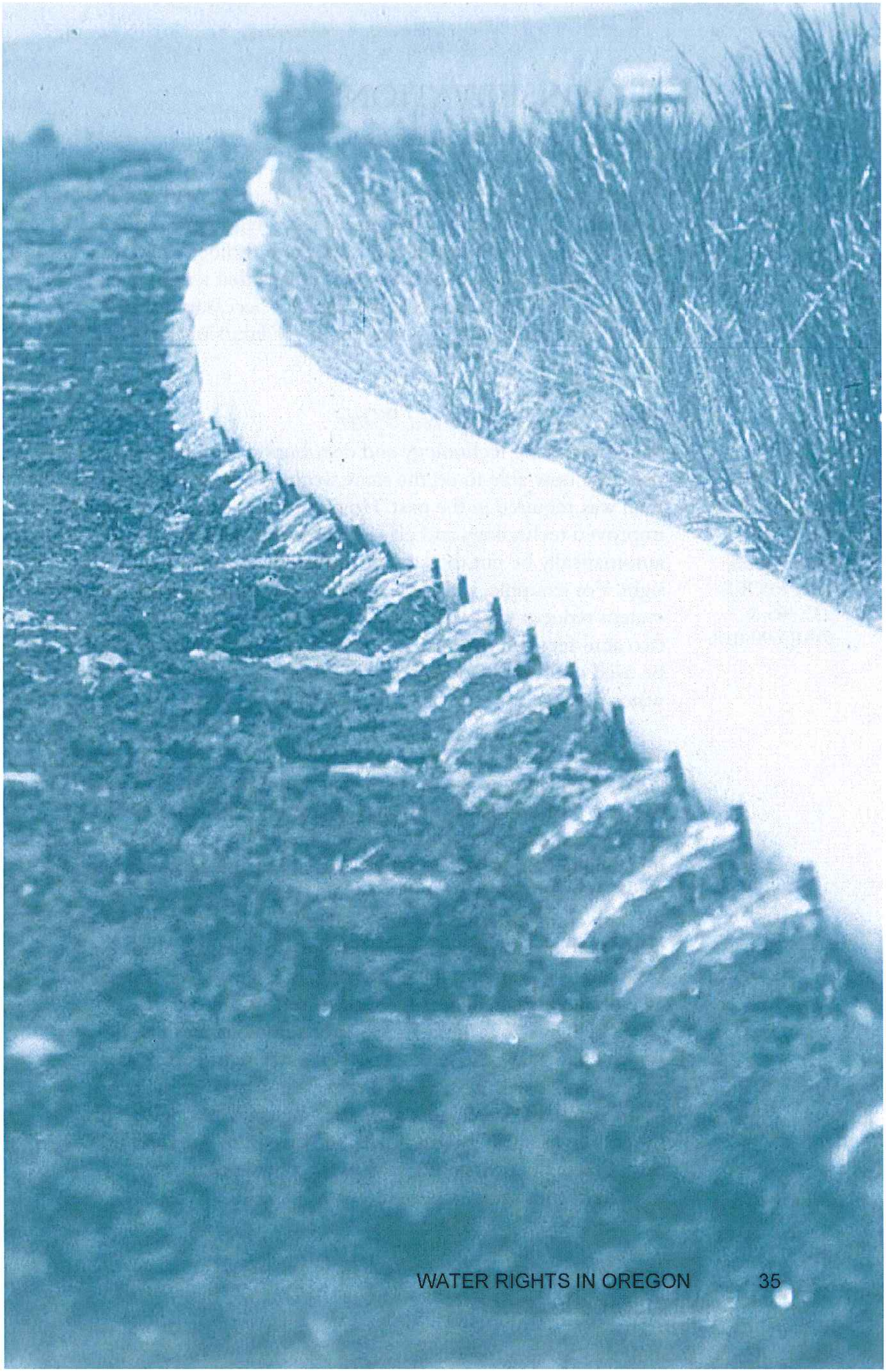
For example, if your water right is for irrigation of 40 acres and you irrigate only 20, the portion of land not irrigated for five consecutive years is subject to cancellation. However, diverting less than the full amount of water allowed under your right to irrigate the full 40 acres will not result in forfeiture, if you are ready, willing and able to use the full amount. If you have reduced the capacity of your water delivery system, you may lose any water not used beyond the capacity of your system.

Once a water right has been unused for five consecutive years or more, it is subject to cancellation even if the property owner begins to use the water again. Under the law, the right is presumed to be forfeited and reuse does not reinstate the right. This is true even if the current owner did not own the property when use was discontinued. Under certain conditions, however, such as extreme drought and federal set-aside programs, non-use may exceed five consecutive years without forfeiture of the right.

Cancellation of a forfeited water right is not automatic. Cancellation requires a legal proceeding to determine whether or not the period of non-use has occurred. If more than 15 years have passed since the period of non-use, the water right is not subject to cancellation. A legal proceeding is not necessary if the landowner voluntarily authorizes cancellation.

Administrative proceedings to determine the validity of a water right may be initiated by the Department. This usually happens when individuals with firsthand knowledge of non-use come forward and provide sworn affidavits asserting non-use.

Once a water right is cancelled, a landowner must apply for and obtain a new water right permit before using the water. A new application for a water right permit is subject to current laws and rules.



7. CONSERVATION

encouraging efficient water use

The Department encourages the efficient use of water and practices that conserve water resources. Oregon law requires that all water that is diverted by water right holders be used beneficially and without waste. This means that a right holder is required by law to use only the amount necessary for the intended purpose and no more, up to the limits of the water right.

Allocation of Conserved Water

With improving technology and distribution methods, water users are now able to do the same work with much less water than was required in the past. However, the water saved by improved technology and efficient practices cannot automatically be put to uses beyond those specified in a water right. For example, if the installation of an improved irrigation system reduces water use from six acre-feet per year to only two acre-feet per year, the four acre-feet that is saved cannot be used on other lands or for other purposes under the existing water right.

For more information, refer to ORS 537.465 & OAR 690-018.

State law does allow a water right holder to submit a conserved water application to the Department and receive authorization to use a portion of the conserved water on additional lands, apply the water to new uses, or dedicate the water to instream use. The percentage of saved water that may be applied to new uses or lands depends on the amount of state or federal funding contributed to the conservation project. The law requires that the remaining percentage of the saved water be returned to the stream for improving instream flows, if needed. The original water right is reissued to reflect the quantity of water being used with the improved technology and the priority date stays the same. Another water right certificate is issued for the new use with either the same priority date or a priority date of one minute after the original water right. This process gives a water right holder the option of extending the use of their right without applying for a new permit or transferring an existing permit.

Water Management and Conservation Planning

Some agricultural and municipal water suppliers are required to prepare water management and conservation plans. Development of these plans involves a step-by-step evaluation of the water supply alternatives available to the supplier and an evaluation of the role that water conservation can have in meeting the supplier's water needs. In addition, the assessments of conservation measures required for the plans helps to ensure that the supplier's use is not wasteful. Department staff provide workshops and other technical assistance to water suppliers preparing water management and conservation plans.

A meter is used to determine how much water is being used.

8. FINDING WATER RIGHTS

determining if you have a water right

All legally established water rights, whether they are under permits, undetermined claims through ground water registration or vested right statements, or certificated rights, are on record in the Salem office of the Water Resources Department. Records of water rights are also maintained in the local watermasters' offices. Contact the Department or your watermaster to determine if there are water rights of record for property you own or want to purchase. You may need to pay a fee if you want the Department to research and copy water right files. Please contact the Department to obtain a current fee schedule or look on the web at *www.wrd.state.or.us.*

You will need to provide a copy of the legal description or a current county assessor's tax lot map of the property. If the property lies within a platted and recorded subdivision, a copy of the recorded plat should accompany the legal description. Any maps submitted need to include the township, range, and section of the property involved and have a reference corner such as a section corner.

For more information, refer to ORS 537.330.

You might also find the Department's online interactive mapping utility to be helpful in locating water rights. It can be found at *www.wrd.state.or.us.*

Keep in mind that while the Department or watermaster can tell you if there is a water right on file for your tract of land, they cannot guarantee that the water has been used continuously and that the right is not subject to cancellation. If you intend to purchase property with a water right of record, it is a good idea to check with neighbors of the property owner to see whether the water right went unused for five consecutive years over the last 15 years.

9. WATER DISTRIBUTION AND ENFORCEMENT

watermasters and field staff protecting rights and resources

In order to protect the rights of water users, and to ensure that water laws are obeyed, personnel from the Water Resources Department, in cooperation with land owners, inspect wells and water diversion systems. Inspections are usually conducted by watermasters and well inspectors who are employees of the Department.

Watermasters respond to complaints from water users and determine in times of water shortage, which generally occur every year, who has the right to use water. Each summer as streamflows drop, they regulate junior users to provide water to more senior users. On some streams, by the end of summer, there is only enough water to supply users with rights established in the 1800s. All of the more recently established rights will have been regulated off by the watermaster. Watermasters work with all of the water users on a given water system to ensure that the users voluntarily comply with the needs of more senior users. Occasionally, watermasters take more formal actions to obtain the compliance of unlawful water users or those who are engaged in practices that "waste" water. The waste of water means the continued diversion of more water than is needed to satisfy the specific beneficial use for which the right was granted.

Watermasters and field staff also provide general information to the public, oversee enforcement of instream water rights, inspect wells and dams for safety violations, and measure and monitor streamflows for management and planning needs.

10. Region Offices and Watermaster Districts

Region Offices

WESTERN
Bill Ferber,
Region Manager
725 Summer St NE, Ste A
Salem, OR 97301
Phone: (503) 986-0893
Fax: (503) 986-0903

NORTH CENTRAL
Michael Ladd,
Region Manager
116 SE Dorion Ave
Pendleton, OR 97801
Phone: (541) 278-5456
Fax: (541) 278-0287

EASTERN
Ivan Gall,
Region Manager
Baker County Courthouse
1995 3rd St, Ste 180
Baker City, OR 97814
Phone: (541) 523-8224 x24
Fax: (866) 214-3493

SOUTH CENTRAL
Kyle Gorman,
Region Manager
1128 NW Harriman St
Bend, OR 97701
Phone: (541) 388-6669
Fax: (541) 388-5101

SOUTHWEST
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Deputy Region Manager
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The Dalles, OR 97058
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DISTRICT 9
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DISTRICT 10
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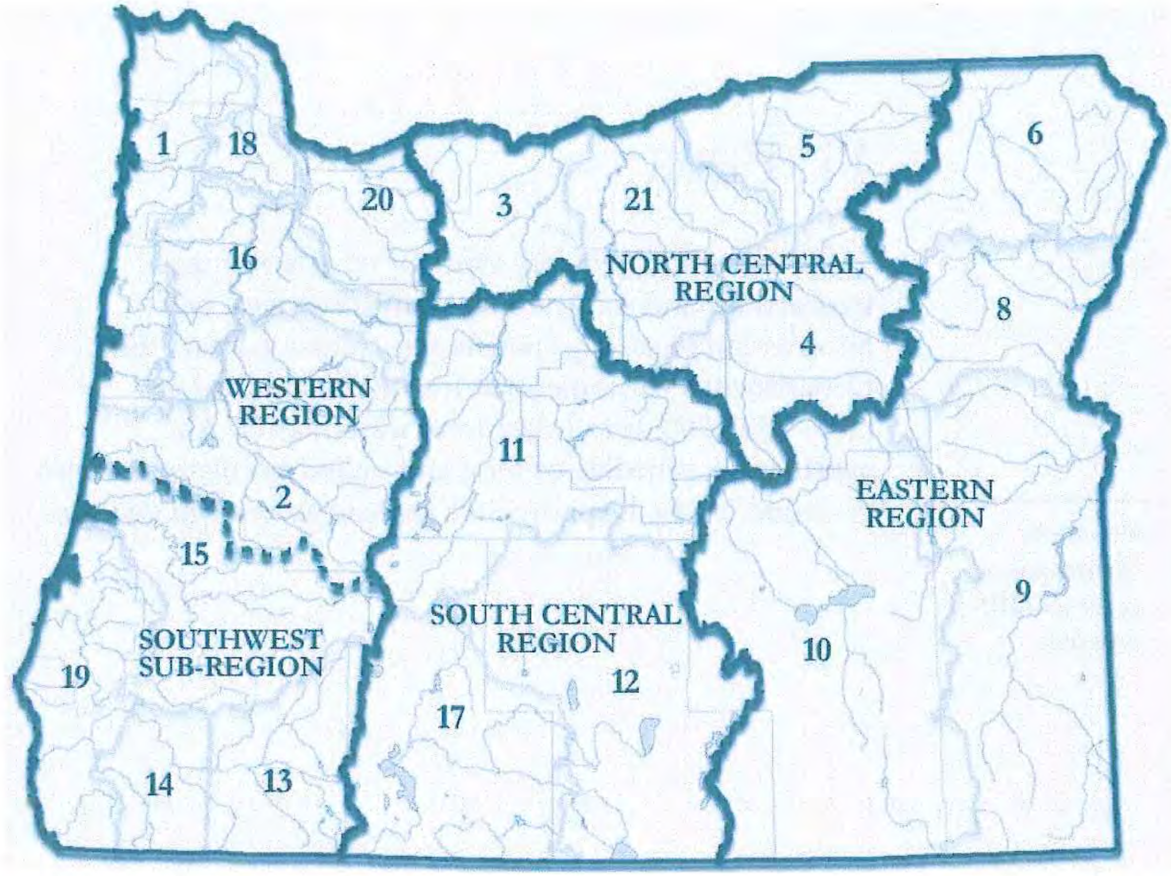

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Salem, OR 97301
Phone: (503) 986-0889
Fax: (503) 986-0903

DISTRICT 17
Vern Church
5170 Summers Ln
Klamath Falls, OR 97603
Phone: (541) 883-4182 x223
Fax: (541) 885-3324

DISTRICT 18
Darrell Hedin
1400 SW Walnut St, Ste 240
Hillsboro, OR 97123
Phone: (503) 846-7780
Fax: (503) 846-7785

DISTRICT 19
Mitch Lewis
Coos Co. Courthouse Annex
290 N Central St
Coquille, OR 97423
Phone: (541) 396-1905
Fax: (541) 396-1906

DISTRICT 20
Sabrina White
1678 S Beavercreek Rd, Ste L
Oregon City, OR 97045
Phone: (503) 722-1410
Fax: (503) 722-5926

DISTRICT 21
Scott White
221 S Oregon St
PO Box 427
Condon, OR 97823
Phone: (541) 384-4207
Fax: (541) 384-2167

11. FEES

The Department requires a fee for most water use transactions and some administrative services. For information regarding specific fees, please contact the Department's Customer Service Representatives at (503) 986-0900 or call your local watermaster. An explanation, schedule of fees, and online calculator can also be found on the Department's website at *www.wrd.state.or.us.*

For more information, refer to ORS 536.050.

APPENDIX A
other development permits

Developing a water right often entails grading, trenching, or other types of construction in waterways, riparian areas, and wetlands. In addition to a water use permit, other permits from local, state, or federal agencies may be required. Check first with your local city or county planning office.

Activities in Wetlands and Waterways are Regulated by:

•*The Department of State Lands* (DSL) under the state Removal-Fill Law (503) 378-3805

•*The U.S. Army Corps of Engineers* (Corps) under the federal Clean Water Act and Rivers and Harbors Act (503) 808-4373

•*The Oregon Department of Forestry* under the Forest Practices Act (503) 945-7470

•*The U.S. Natural Resource Conservation Service* (NRCS) under the Food, Agriculture, Conservation and Trade Act—check government listings

•Some city and county land use ordinances

What Areas are Regulated?

•Rivers, streams, and most creeks

•Estuaries and tidal marshes

•Lakes and some ponds

•Permanent and seasonal wetlands

Regulations apply to all lands, public or private. A wetland does not have to be mapped by the state or otherwise "designated" to fall under the regulations. If you are uncertain if there are regulated wetlands on your property, contact DSL for assistance.

What Activities are Regulated?

- Placement of fill material
- Alteration of stream bank or stream course
- Ditching and draining
- Plowing/disking non-farmed wetlands
- Excavation or dredging of material
- In-water construction (may also require a DSL lease)
- For some activities, joint application forms can be obtained from DSL or the Corps

What Activities are Exempt?

- Some routine maintenance activities
- Established, ongoing agricultural activities and grazing
- Some minor projects involving small amounts of fill or removal

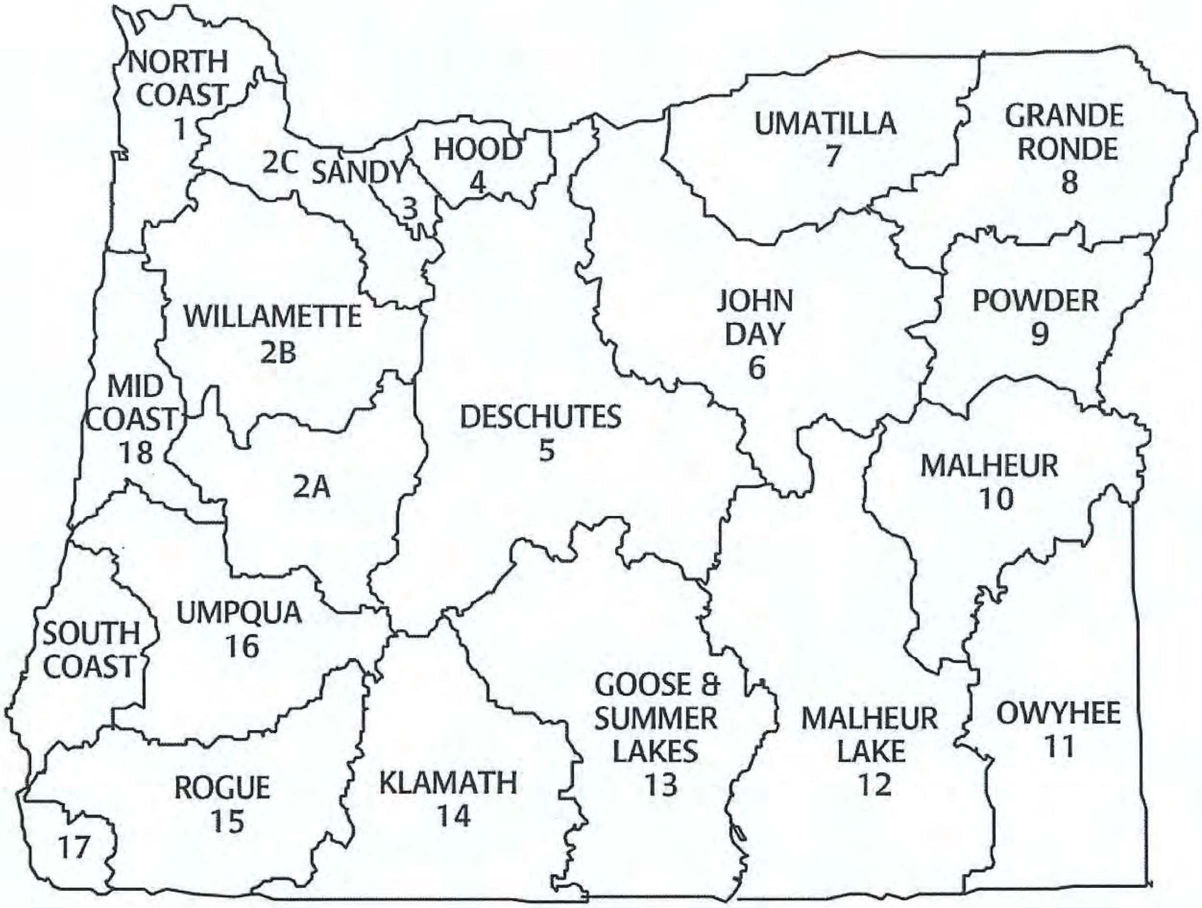
How are Laws Enforced?

The best enforcement is to prevent illegal wetland alterations through information and education. However, when violations do occur, a variety of enforcement tools may be used, including restoration orders, fines, civil and/ or criminal charges.

Contact your local city or county planning office, DSL or the Corps for details and clearance to proceed with your project and to determine if you are impacting an area that is regulated.

A list of licenses, permits, and registrations in Oregon can be found on the web at *LicenseInfo.Oregon.gov.*

Oregon's Major River Basins

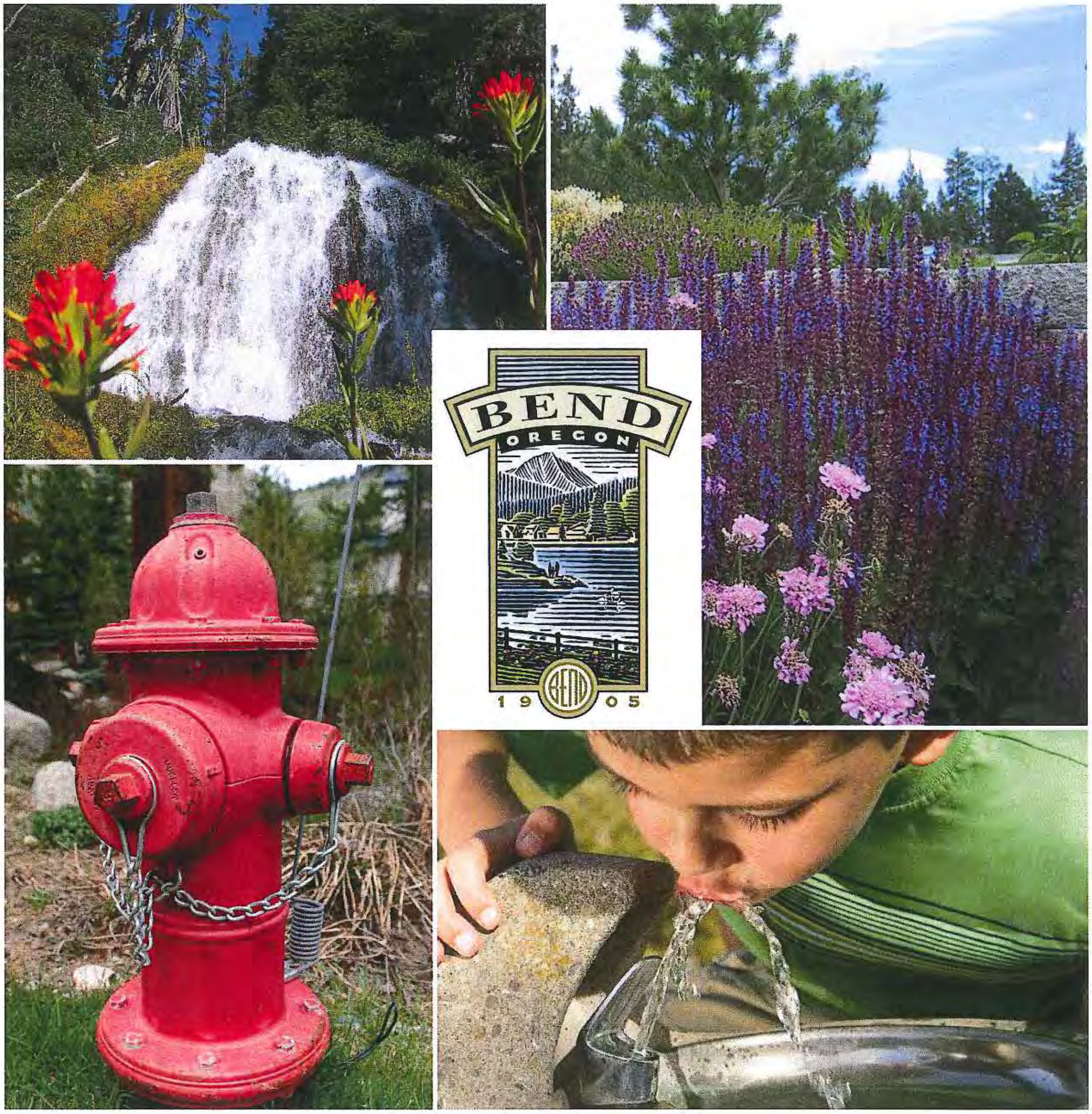


Oregon has 18 designated river basins that are managed by the Department under the guidance of the Commission. Oregon also shares three basins with neighboring states–the Columbia, Snake, and Klamath Rivers. A river basin generally includes all the land area, surface water bodies, aquifers, and tributary streams that drain into the namesake river.

State of Oregon
Water Resources Department
725 Summer St NE, Suite A
Salem, OR 97301-1266
(503) 986-0900
www.wrd.state.or.us

Water Management and Conservation Plan

June 2011



Prepared for
City of Bend, Oregon

Prepared by

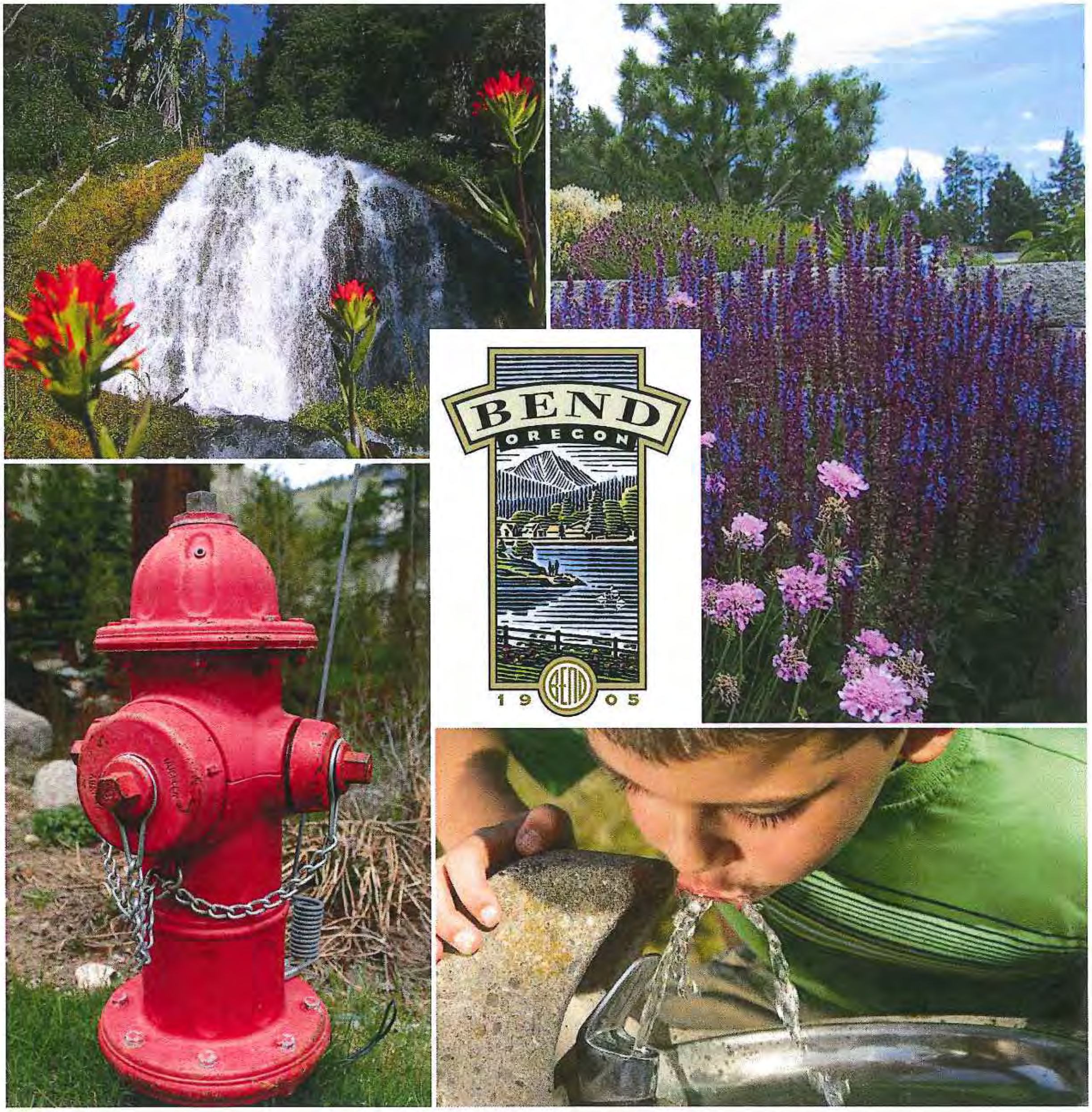
HDR

MSA
Murray, Smith & Associates, Inc.
Engineers/Planners

GSI
Water Solutions, Inc.

Water Management and Conservation Plan

June 2011



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Executive Summary

The City of Bend (City) completed its first Water Management and Conservation Plan (WMCP or the "Plan") in August 1998. The purpose of the Plan is to guide the development, financing, and implementation of water management and conservation programs and policies to ensure sustainable use of publicly owned water resources while the City plans for its future water needs. Development of this Plan was required by the City's Permits G-11379 and G-11380. The Oregon Water Resources Department (OWRD) issued a final order approving the City's Plan in May 1999, and required an update in 2004. The City submitted an updated WMCP on December 30, 2004. On February 28, 2005, OWRD issued a final order approving the updated Plan and requiring the next update by January 10, 2010.

This WMCP also was developed to meet the requirements of the City's Permits G-16177 and G-16178, which are conditioned to require an updated WMCP by January 1, 2010. Finally, the City's WMCP is submitted to meet the requirements of the final order approving an extension of time for the City's Permit G-8565. The November 15, 2007 final order required the City to submit a WMCP within 3 years from the date of the order. On September 29, 2009, OWRD extended the above-described deadlines for submitting the City's WMCP to January 3, 2011.

This WMCP fulfills the requirements of the Oregon Administrative Rules (OAR) adopted by the Water Resources Commission in November 2002 (OAR Chapter 690, Division 86). This Plan describes water management, water conservation, and curtailment programs to guide the wise use and stewardship of the City's water supply. The City also is submitting this Plan to gain access to water under its "extended permit" G-8565.

The Plan is organized into the following sections, each addressing specific sections of OAR Chapter 690, Division 86. Section 2 is a self-evaluation of the City's water supply, water use, water rights, and water system. The information developed for Section 2 is the foundation for the sections that follow. The later sections use this information to consider how the City can improve its water conservation and water supply planning efforts.

EXHIBIT ES-1
WMCP Organization

Section	*Requirement*
Section 1 – Water Supplier Plan	*OAR 690-086-0125*
Section 2 – Water Supplier Description	*OAR 690-086-0140*
Section 3 – Water Conservation Element	*OAR 690-086-0150*
Section 4 – Water Curtailment Element	*OAR 690-086-0160*
Section 5 – Water Supply Element	*OAR 690-086-0170*

Description of Municipal Water Supplier

The City's service area includes the City's current urban growth boundary (UGB), which includes most of the City of Bend, as well as the Tetherow Development and Juniper Ridge Development Phases 1 and 2. Two private water utilities, Avion Water Company and Roats Water System, Inc., serve the portions of the area within the UGB not served by the City's water system. The City's water system had approximately 22,000 meters serving residential and non-residential customers in 2009 and an estimated service area population of approximately 62,800.

The City's primary water sources are groundwater from the Deschutes Aquifer and surface water from Bridge Creek and Tumalo Creek. The City currently appropriates groundwater from the Deschutes Aquifer using 21 production wells associated with water rights. Groundwater levels in the City's wells are stable.

The City's surface water intake is located 11.5 miles west of the city limits on Bridge Creek in the Bridge Creek watershed. The surface water supply system was developed in the 1920s as an unfiltered, gravity-operated system. It provides approximately half of the City's annual water supply. Water diverted at the Bridge Creek intake facility consists of flows from the Bridge Creek watershed and flows from natural springs within the Tumalo Creek watershed that are conveyed into Bridge Creek. The City's Bridge Creek intake facility consists of a diversion structure that spans Bridge Creek and diverts water into two transmission mains. The diverted water is conveyed to the City's Outback site, which then sends the water to the onsite disinfection facility and into the City's water service area and distribution system. The City is now entering the design phase of a project to build a new treatment facility for the water it diverts from Bridge Creek and to replace the existing supply pipes.

The City holds 12 groundwater rights that authorize the use of groundwater at a rate of up to 68.2 cubic feet per second (cfs); 44.1 million gallons per day [mgd]) for municipal purposes: 7 certificates and 5 permits. In addition, the City holds six surface water rights that authorize a total use of up to 36.1 cfs (23.3 mgd) from Bridge Creek and Tumalo Creek for municipal purposes. The City's existing water right capacity is sufficient to meet its current peak water demands. The City's current water supply, however, is limited by stream flow, surface water right regulation, volume limitations on water rights, system capacity, and mitigation requirements in the Deschutes Groundwater Study Area.

Water Conservation

OWRD's WMCP rules require cities to have 5-year benchmarks for initiating or expanding conservation measures related to the following required conservation programs. A summary of the 5-year benchmarks is provided below, and in Exhibit ES-4 at the end of this Executive Summary.

Annual water audits. A water audit involves an accounting of all water entering and leaving the water distribution system to identify system leakage, as well as authorized or unauthorized water uses. For example, the City does not have a system to track unbilled consumption and its billing by customer class is unreliable. To resolve these issues, the City has established the following benchmarks.

5-year Benchmarks:

- The City will develop and implement an annual water audit program within the next 5 years. As part of this effort, the City will develop a method to calculate and track unbilled authorized consumption, which may include development of additional measurement methodology, to more accurately determine revenue and non-revenue water.
- The City also will reorganize and update customer classes and service codes, as well as work toward equipping all water meters with automated metering infrastructure (AMI).

System metering. The City's water system became fully metered in December 2004. In addition, all hydrant use within the Bend service area now requires metering, resulting in better tracking of non-fire-related hydrant water use.

5-year Benchmark:

- The City will continue to install meters at all new service connections.

Meter testing and maintenance. The City is testing and rebuilding all meters that exceed 2 inches. Each of these meters is checked and calibrated every 2 years or checked through computer analysis of customer usage each month. The City tests meters if requested by customers, and if the tested meter is found to be 3 percent above or below the proper reading, the meter is repaired or replaced.

Most residential meters are relatively new because of recent efforts to meter all residences. The City also is working to update its meters and expects to install 12,500 AMI by December 2010. Residential meters typically are replaced on a 15- to 20-year basis in accordance with American Water Works Association (AWWA) guidelines. The City is eliminating the 5/8 x ¾ inch meter so that base meters for residential units will be ¾ inch.

In 2008, the City installed a new master meter at the end of the Bridge Creek transmission line to measure the amount of surface water that it conveys into the distribution system.

5-year Benchmarks:

- The City will continue to replace all existing meters with the new AMI standard within the next 5 years.
- The City will use improved technology when upgrading or replacing existing source meters during the next 5 years.

Unit-based billing program. The City's customers are billed on the basis of the quantity of water use metered and a base fee. Customers pay a base fee based on meter size, which includes a quantity allowance of up to 4 ccf (ccf = 100 cubic feet). Customers also pay a per ccf unit rate for their monthly water use exceeding 4 ccf.

5-year Benchmarks:

- The City will continue to bill customers based, in part, on the quantity of water metered.

- The City intends to reduce the base quantity allowance from 4 ccf to zero ccf within the next 5 years.

Leak detection and repair. Most of the distribution system water mains are relatively new ductile iron pipe with low potential for excessive leakage, which were put in place during the City's recent period of rapid growth. Since 2004, City staff and contractors have conducted leak detection surveys of 45 to 50 miles of water mains. During 2005-2006, contractors conducting leak detection surveys found no sizable leaks, but did discover and repair two meters with small leaks. City staff have conducted leak detection using in-house electronic equipment and tested for leaks during valve and hydrant maintenance activities. In February 2009, the City tested the Bridge Creek transmission line for leakage. The City also works cooperatively with customers when leaks are discovered on the customer side of the meter, typically in the older galvanized service lines.

5-year Benchmarks:

- The City will continue to carry out leak detection surveys to monitor changes in pipe integrity over time.
- The City will continue to monitor customer consumption records for evidence of leaks and to work cooperatively with customers when leaks are discovered.
- The City will install AMI data technology at all of its meters, which will record hourly consumption and radio transmit that information to the City. This "real-time" information will help the City find and address leaks in the system on the customer side of the meter.

Public education. The City provides water conservation information through numerous media and programs. The City's WaterWise Web site (www.waterwisetips.org) focuses on water conservation and includes information on indoor water use, xeriscaping, rain gardens, and landscape watering. The City sponsored or participated in at least four public events per year during the last 5 years including school events, various summer fairs, and outdoor events throughout the spring, summer, and fall. The City also continues to provide conservation information to the public using fact sheets, publications, bill stuffers, City Edition Videos, and related outreach in partnership with the City Communications Manager. Finally, the City re-establish a position in its 2010 fiscal year budget to manage the City's water conservation benchmarks and to help develop, implement, and track related projects.

5-year Benchmarks:

- The City will continue to provide water efficiency and conservation outreach information to the public using print materials, radio, and video.
- The City will continue to update its Web site and outreach materials as needed.
- The City will explore the potential for development of cost-share partnerships between the City's three water utilities: water; stormwater, and wastewater. The water and stormwater utilities have the potential to jointly hire an employee that can serve both programs.

Technical and financial assistance. The City's technical and financial assistance program has had three components: large landscape program partnerships, large customer water audits, and indoor water use, which includes toilet tank leak detection and shower timers. The City has developed partnerships with customers that have large landscapes requiring irrigation to help them improve their water conservation efforts. The City helps these partners by providing technical and financial assistance in a variety of formats.

Water audits for large customers analyze a customer's water use and identify ways to make water use more efficient. However, the City and water conservation studies[1] have found that audits generally are not cost-effective because customers are reluctant to pay for the audits or recommended improvements. As a result, the expense did not materialize into actual water savings.

The indoor water use component of the City's technical and financial assistance program has two components: toilet tank leak detection dye tablets and shower timers. To decrease leaks that occur on customer premises, the City distributed more than 2,500 toilet tank leak detection dye tablets per year during the past few years. Shower timers are intended to reduce both water and energy use by making shower users aware of their time in the shower. The City distributed more than 1,500 shower timers at schools and public events, and in the display booth set up in City Hall. They are also available by phone and e-mail request.

5-year Benchmarks:

- The City will continue efforts to develop and maintain WaterWise partnerships with large use customers during the next 5 years.
- The City will continue to distribute toilet tank leak detection dye tablets, shower timers, and related information to customers during the next 5 years.
- The City will conduct cost analyses aimed at the creation of cost-effective rebate programs within the next 5 years.
- The City will develop a pilot program for creation of water budgets for targeted customer groups, based on evapotranspiration data.
- The City will continue to fund and promote the use by all customers of the Agrimet weather station and its Web site, including a pilot project to place real time evapotranspiration data on the City Web site for use in creation of outdoor water use budgets.

Retrofit/replacement of inefficient fixtures. The City manages and maintains 136 landscape sites covering 439 acres, many of which require irrigation. Maintenance and management plans have been completed for all of these landscape sites. The City has retrofitted 66 of these sites with smart irrigation controllers. The City recently retrofitted 14 of those 66 sites as part of the City Landscape Retrofit Project. The sites of the 14 retrofits had their irrigation systems and/or landscapes altered or completely rebuilt to decrease maintenance and meet irrigation water savings goals, which often included reducing the area irrigated and xeriscaping.

[1] HDR Technical Memorandum, *Conservation Program for Water Management and Conservation Plan,* December 8, 2010.

5-year Benchmarks:

- The City will continue to pursue greater irrigation efficiency of its existing City-owned landscapes and all new landscapes so they will meet the latest specification and standards, which includes the use of smart irrigation controller technology, xeriscaping principles and other sustainable landscape practices.
- The City will study the cost effectiveness of implementing a toilet rebate replacement or incentive program based on the new voluntary federal high efficiency toilet (HET) standard.
- The City will become a partner in the U.S. Environmental Protection Agency (EPA) Water Sense Program and make related information available through its Web links, bill stuffers, and other methods.
- The City will provide a list of qualifying toilets that meet the various flush standards along with the creation of a toilet efficiency fact sheet.

Reuse, recycling, and non-potable water opportunities. The Resort at Pronghorn, located downhill of the City's wastewater treatment plant, obtains recycled water from the City. Class A (Level IV) to Class C (Level II) effluent from the wastewater treatment plant enters infiltration ponds and an irrigation system that waters two golf courses during the irrigation season. The resort is not within the City's existing drinking water service area.

In July 2010, the City completed a scope of work for a full-scale feasibility study that will investigate increasing the use of recycled water both inside and outside the City's service area.

5-year Benchmark: During the next 5 years, the City will continue to look for opportunities to increase the use of recycled water.

Other measures.

- *Irrigation Restrictions:* The City currently has even-odd irrigation restrictions and time of day water restrictions in place. Even house numbers irrigate on even-numbered days and odd house numbers irrigate on odd-numbered days. Irrigation hours are 5 a.m. to 10 a.m. and 4 p.m. to 10 p.m. These policies were put in place many years ago when the City used a flat rate water billing system and were designed to keep reservoirs from being drained by unlimited water use. Code changes are now under consideration in the next fiscal year and may include a recommendation to move away from the even-odd day irrigation restriction system. The City would like to move exclusively to a time of day restriction that aims to provide an enforceable program that incentivizes smart water use, as well as off-peak irrigation time periods, to prevent or reduce the need for costly engineering improvements necessary to meet maximum demands in the morning and evening peaking periods.

  5-year Benchmark: Within the next 5 years, the City will evaluate adoption of modified irrigation restrictions based on time of day (hours that promote efficient water use).

- *City Standards and Specifications:* The City recognizes that conservation and water efficiency standards need to be included in City contracts with landscaping and irrigation work, so the City currently is upgrading its related standards and specifications. The City also created a landscape standard.

5-year Benchmark: The City will continue to implement current landscape standards through related approval processes during the next 5 years.

- *Collaboration among the City's water utility programs:* The City has three water-related utilities and several areas of regulatory responsibilities, including water utility, water reclamation, and stormwater programs, that are related to more efficient use of water and the benefits of conservation. The City has implemented a communication effort encompassing all of these areas, which it has promoted as "WaterWise" programs. Collaborations include exploring how to combine funds from different programs to hire staff and present information on stormwater, safe drinking water, water conservation, and industrial pretreatment programs within the homepage of the City's WaterWise Web site and related efforts.

  5-year Benchmark: The City will continue to look for coordination opportunities to more efficiently communicate and implement related programs.

- *Hydrant Meter Program for temporary and permanent water uses:* Use of hydrants now requires a permit and use of a temporary metered fill station that also includes backflow protection. All water is measured and billed. In addition, the City has installed one permanent fill station that has the added feature of a card-lock billing system to address the use of multiple users at one location. Contractors have the option of bringing their own water trucks to the fill stations to fill up with water as needed, or using the portable hydrant meter boxes.

  5-year Benchmark: The City will continue to implement the hydrant meter program and related fill station.

- *Review and implementation of the Water Conservation Analysis Project:* In 2010, HDR Engineering (HDR) conducted a water conservation analysis project for the City to examine opportunities to enhance its existing water conservation program. HDR compiled demographic information for the City's service area, applied assumptions for customer participation rates for each conservation measure, calculated the savings achieved by shifting to more efficient hardware or behavior, and calculated the direct costs for those shifts. HDR developed four "conservation packages." These packages included (1) a conservation potential assessment of 37 of the 49 analyzed measures that were not mutually exclusive, which included both behavioral and "hardware" based measures; (2) hardware measures for both indoor and outdoor water conservation; (3) hardware measures for outdoor water conservation only; and (4) hardware measures for indoor conservation only.

  5-year Benchmark: During the next 5 years, the City will work with its Engineering Department and the City Council to develop capital improvement and conservation budgets to identify which conservation measures to fund and implement.

Water Curtailment

In the event of a water shortage, the City needs a detailed response plan based on predetermined objective criteria. The curtailment plan describes how the City will respond to specific water-shortage conditions. The City's curtailment plan presented in this WMCP has four distinct stages, each of which is triggered by one or more identified events. The four stages, increasing in order of severity, are summarized in **Exhibit ES-2**. Any of the initiating conditions described in Exhibit ES-2 will trigger the appropriate curtailment stage. Initiating conditions and response actions are described in detail in Section 4 of this WMCP.

EXHIBIT ES-2
Curtailment Stages 1 through 4

Curtailment Stages	Initiating Conditions
Stage 1: Water Shortage Alert	• Forecasts of below normal summer streamflows • Forecasts of above normal temperatures • Minor damage to transmission mains or distribution system • Minor mechanical or electrical malfunction at one to three wells
Stage 2: Mild Water Shortage **Demand Reduction Target:** **10 percent of MDD**	• Supply capacity is 91 to 100 percent of demand • Mechanical or electrical malfunction at four to seven wells • Extended periods of above normal temperatures or below normal streamflows • Declaration of drought by Governor pursuant to ORS 536.720 • Extensive damage to water supply infrastructure
Stage 3: Serious Water Shortage **Demand Reduction Target:** **20 percent of MDD**	• Supply capacity is 81 to 90 percent of demand • Mechanical or electrical malfunction at 8 to 12 wells • Imminent terrorist threat against supply system • Multiple failures to transmission mains or distribution system
Stage 4: Severe Water Shortage **Demand Reduction Target:** **40 percent of MDD**	• Supply capacity is less than 81 percent of demand • Loss of utility electrical service to wells • Fire in Bridge Creek watershed or near wells • Contamination of source of supply • Extensive damage to transmission, pumping, or treatment processes caused by natural disaster • Intentional acts or fire, contamination of source, or any other event resulting in an immediate, sustained deprivation of water supply

MDD = maximum day demand.
ORS = Oregon Revised Statute.

Water Supply

Consistent with the Optimatics Master Plan Update projections, the City used its Buildable Lands Inventory (BLI) database and water use data to develop demand projections. For the 2020 demand projection, the estimated number of dwelling units at medium density was multiplied by the estimated per capita usage. Then the demand for the non-residential areas along with Tetherow and Phase 1 of Juniper Ridge Developments were included to provide the projected 2010 average day demand (ADD) of 21.7 mgd. This equates to a yearly increase in average day demand of 0.74 mgd between 2010 and 2020. The projected 2030 ADD was developed by increasing demand by 0.74 mgd per year, which results in a 29.1 mgd ADD. Maximum day demands (MDD) were developed by applying a 2.25 MDD to ADD factor. The future demands are summarized in **Exhibit ES-3.**

EXHIBIT ES-3
Future Demands for the City's Water Service Area (mgd)

Year	ADD	MDD
2010	14.3	32.2[1]
2020	21.7	48.8
2030	29.1	65.5

[1] The City's actual 2010 MDD was approximately 20 percent less than the projected MDD for that year. The reduced demand compared to the projections is likely due to the cool, wet weather during the spring and summer of 2010, the City's recent efforts to optimize system operations, as well as less demand becanse of the current economic downturn.

The City holds surface water rights that authorize the use of up to 36.1 cfs (23.3 mgd). For the purposes of planning for the amount of surface water available to meet peak needs, the City evaluated historic stream flows in Tumalo Creek to establish a likely low-flow scenario. Under that evaluation it was determined that a stream flow of 42.5 cfs and a proportional share for the City of 11.5 cfs (7.4 mgd) should be the "firm" planning-level peak demand surface water supply. The City also holds groundwater rights authorizing use of 68.2 cfs (44.1 mgd).
The City may need up to approximately 65.5 mgd to meet its MDD by 2030. The water supply provided by the City's existing water rights, however, currently can be relied upon only to provide approximately 51.8 mgd of supply during periods of high demand. Consequently, the City will need to fully exercise its existing water rights and may need additional water supply to meet its projected 2030 MDD.

Based on projected water demand growth, the City anticipates fully exercising all of its existing surface water and groundwater rights during the next 20-year planning period.

Exhibit ES-4 provides a summary of the City's water management and conservation measure 5-year benchmarks.

EXHIBIT ES-4
Summary of Water Management and Conservation Measure 5-year Benchmarks

Annual Water Audit

- Develop and implement an annual water audit program. As part of this effort, develop a method to calculate and track unbilled authorized consumption, to more accurately determine revenue and non-revenue water.
- Reorganize and update customer classes and service codes, as well as work toward equipping all water meters with automated metering infrastructure (AMI).

System-Wide Metering

- Continue to install meters at all new service connections.

Meter Testing and Maintenance

- Continue to replace all existing meters with the new AMI standard.
- Use improved technology when upgrading or replacing existing source meters.

Rate Structure and Billing Program

- Continue to bill customers based, in part, on the quantity of water metered.
- Continue to reduce the base quantity allowance from 4 ccf to zero ccf.
- Continue to send monthly bills and to provide water efficiency and conservation information to the public with periodic bill stuffers and electronic messaging with related conservation information and links to the City's conservation Web site.

Leak Detection and Repair

- Continue to conduct leak detection surveys to monitor changes in pipe integrity over time.
- Continue to monitor customer consumption records for evidence of leaks and to work cooperatively with customers when leaks are discovered.
- Install AMI data technology at all of its meters, which will record hourly consumption and radio transmit that information to the City. This "real-time" information will help the City find and address leaks in the system on the customer side.

Public Education

- Continue to provide water efficiency and conservation outreach information to the public using print materials, radio, and video.
- Continue to update the City Web site and outreach materials as needed.
- Explore the potential for development of cost-share partnerships between the City's three water utilities: water, stormwater, and wastewater. The water and stormwater utilities have the potential to jointly hire an employee that can serve both programs.

Technical and Financial Assistance

- Continue efforts to develop and maintain WaterWise partnerships with large use customers.
- Continue to distribute toilet tank leak detection dye tablets, shower timers, and related information to customers.
- Conduct cost analysis aimed at the creation of cost-effective rebated programs.
- Develop a pilot program for creation of water budgets for targeted customer groups, based on evapotranspiration data.
- Continue to fund and promote the use by all customers of the Agrimet weather station and its Web site, including a pilot project to place real time evapotranspiration data on the City Web site for use in creation of outdoor water use budgets.

Retrofit/Replacement of Inefficient Fixtures

- Continue to pursue greater irrigation efficiency of its existing City-owned landscapes and all new landscapes so they will meet the latest specification and standards, which include the use of smart irrigation controller technology, xeriscaping principles, and other sustainable landscape practices.
- Study the cost effectiveness of implementing a toilet rebate replacement or incentive program based on the new voluntary federal High Efficiency Toilet (HET) standard.
- Become an EPA Water Sense Program partner and make related information available through its Web links, bill stuffers and other methods.
- Provide a list of qualifying toilets that meet the various flush standards along with the creation of a toilet efficiency fact sheet.

Reuse, Recycling, and Non-Potable Water Opportunities

- Continue to look for opportunities to increase the use of recycled water.

Other Measures

- **Irrigation Restrictions** - Evaluate adoption of modified irrigation restrictions based on time of day (hours that promote efficient water use).
- **City Standards and Specifications** - Continue to implement current landscape standards through related approval processes.
- **WaterWise Partnerships** - Continue to seek appropriate partnership opportunities based on current project priorities, budget, and staff time.
- **Collaboration Among City's Water Utilities** - Continue to look for coordination opportunities to more efficiently communicate and implement related programs.
- **Hydrant Meter Program for Temporary and Permanent Water Uses** - Continue to implement the hydrant meter program and related fill station.
- **Review and Implementation of Water Conservation Analysis Project** - Work with the City Council and the City's Engineering Department to develop capital improvement and conservation budgets to identify which conservation measures to fund and implement.

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1. Municipal Water Supplier Plan Elements

This section satisfies the requirements of OAR 690-086-0125.

This rule requires a list of affected local governments to whom the Plan was made available, and a proposed date for submittal of an updated Plan.

Introduction

The City of Bend (City) is located in Central Oregon at the eastern foothills of the Cascade Range. The City is noted for its scenic setting, year-round recreational activities, and growing economy. City residents benefit from a reliable supply of high-quality water for public health and sanitation, fire protection, recreation, and economic development. In recent years, the City has experienced significant growth, which has increased its demands for water. Effective water management and dedicated implementation of conservation measures can reduce water consumption, delay the need to develop additional water supplies, and reduce the volume of new water needed for municipal purposes.

The City completed its first Water Management and Conservation Plan (WMCP or the "Plan") in August 1998. Development of this Plan was required by the City's Permits G-11379 and G-11380. The Oregon Water Resources Department (OWRD) issued a final order approving the City's Plan in May 1999, and required an update in 2004. The City submitted an updated WMCP on December 30, 2004. On February 28, 2005, OWRD issued a final order approving the updated Plan and requiring the next update by January 10, 2010.

This WMCP also was developed to meet the requirements of the City's Permits G-16177 and G-16178, which are conditioned to require an updated WMCP by January 1, 2010. Finally, the City's WMCP is submitted to meet the requirements of the final order approving an extension of time for the City's Permit G-8565. The November 15, 2007 final order required the City to submit a WMCP within 3 years from the date of the order.

On September 29, 2009, OWRD extended the above-described deadlines for submitting the City's WMCP to January 3, 2011.

Plan Organization

This WMCP fulfills the requirements of the Oregon Administrative Rules (OAR) adopted by the Water Resources Commission in November 2002 (OAR Chapter 690, Division 86). This Plan describes water management, water conservation, and curtailment programs to guide the wise use and stewardship of the City's water supply. The City also is submitting this Plan to gain access to water under its "extended permit" G-8565.

The Plan is organized into the following sections, each addressing specific sections of OAR Chapter 690, Division 86. Section 2 is a self-evaluation of the City's water supply, water use, water rights, and water system. The information developed for Section 2 is the foundation for the sections that follow. The later sections use this information to consider how the City can improve its water conservation and water supply planning efforts.

Section	*Requirement*
Section 1 – Water Supplier Plan	*OAR 690-086-0125*
Section 2 – Water Supplier Description	*OAR 690-086-0140*
Section 3 – Water Conservation Element	*OAR 690-086-0150*
Section 4 – Water Curtailment Element	*OAR 690-086-0160*
Section 5 – Water Supply Element	*OAR 690-086-0170*

Affected Local Governments

OAR 690-086-0125(5)

The following governmental agencies may be affected by this WMCP:

- Deschutes County

Thirty days before submitting this WMCP to OWRD, the City made the draft Plan available for review by the affected local government listed above along with a request for comments related to consistency with the local government's comprehensive land use plan. The letter requesting comment and any comments received are in **Appendix A.**

Plan Update Schedule

OAR 690-086-0125(6)

The City anticipates submitting an update of this Plan within 10 years of the final order approving this Plan. As required by OAR Chapter 690, Division 86, a progress report will be submitted within 5 years of the final order.

Time Extension

OAR 690-086-0125(7)

The City is not requesting an extension of time to implement metering or a benchmark established in a previously approved Plan.

2. Municipal Water Supplier Description

This section satisfies the requirements of OAR 690-086-0140.

This rule requires descriptions of the City's water sources, service area and population, water rights, and adequacy and reliability of the existing water supply. The rule also requires descriptions of the City's customers and their water use, the water system, interconnections with other water suppliers, and quantification of system leakage.

Water Sources

OAR 690-086-0140(1)

The City's primary water sources are groundwater from the Deschutes Aquifer and surface water from Bridge Creek and Tumalo Creek. The City also obtains water from the Arnold Irrigation District (AID) for irrigation use within the former Juniper Utility service area.

Surface Water

The City's surface water intake is located 11.5 miles west of the city limits on Bridge Creek in the Bridge Creek watershed. This watershed lies within the Deschutes National Forest, which is owned by the U.S. Forest Service (USFS). The City has a 1926 agreement with the U.S. Department of Agriculture that designates municipal use as the highest and best use of the watershed. In addition, the City has a memorandum of understanding with the USFS that provides clear communication channels between signatories, controls human activity, and protects water quality through regulations and restrictions.

The City's surface water supply system was developed in the 1920s as an unfiltered, gravity-operated system. It provides approximately half of the City's annual water supply. Water diverted at the Bridge Creek intake facility consists of flows from the Bridge Creek watershed and flows from natural springs within the Tumalo Creek watershed that are conveyed into Bridge Creek. The City's Bridge Creek intake facility consists of a diversion structure that spans Bridge Creek and diverts water into two transmission mains, one of which was built in the 1920s and the other was built in the 1950s. The current combined capacity of these two mains is 18.2 cubic feet per second (cfs). The diverted water then is conveyed to the City's Outback site, which sends the water to the onsite disinfection facility and into the City's water service area and distribution system.

As a result of new U.S. Environmental Protection Agency (EPA) regulatory requirements, the City must begin to treat its surface water by October 2012. Consequently, the City must build a new surface water treatment facility. In addition, the pipes that supply the City's surface water are deteriorating and must be replaced. The City has completed a water supply alternatives analysis and now is entering the design phase of this project.

Groundwater

The City currently appropriates groundwater from the Deschutes Aquifer using 21 production wells associated with water rights. The City's records show that groundwater levels in the City's wells are stable.

Other Supply

The AID provides a portion of the water used for irrigation within the former Juniper Utility service area. Water from AID is delivered to ponds and mixed with groundwater supplied by the City. The City delivers the water to the irrigation customers. This irrigation water is non-potable and is transported in pipes separate from the drinking water supply system.

Avion Water Company (Avion) provides water to the Bend Municipal Airport, which is owned by the City, but is 8 miles outside of the current urban growth boundary (UGB). Avion provides water for this small water supply system, which provides water for domestic, commercial, fire protection, limited irrigation, and other typical municipal water uses within the Airport planning area. This system is not connected to the rest of the City's water supply system.

Interconnections with Other Systems

OAR 690-086-0140(7)

The City's drinking water system has one interconnection with the Roats Water System (Roats), which is located at the southern boundary of the City's system. Although this connection originally allowed Roats to serve domestic water in the former Juniper Utility service area, the City no longer purchases water from Roats. The interconnection is now considered for emergencies only.

The City also has one interconnection with Avion, which is located at the intersection of 27th Street and Bear Creek Road. The purpose of this interconnection is for emergencies only. It allows either utility to provide water to the other. Construction of the interconnection occurred in 2003. The City has yet to convey water through this interconnection except for flow testing purposes and will not rely on Avion to supply water to the City's customers on a day-to-day basis.

Water Supply Contracts

OAR 690-086-0140(1)

The City has a wholesale water supply contract with Avion. Under this contract, Avion provides wholesale water service only to the Bend Municipal Airport. The airport has a small isolated water system, which the City operates with water supplied by Avion.

The City does not have exchange agreements or intergovernmental cooperative agreements.

Current Service Area Description

OAR 690-086-0140(2)

The City's current service area appears in **Exhibit 2-1**. For purposes of making demand projections for this WMCP, the area shown is also the projected future service area. The City's service area includes the City's current UGB, which includes most of the City, as well as the Tetherow Development and the Juniper Ridge Development, Phases 1 and 2. Two private water utilities, Avion and Roats, serve the portions of the area within the UGB not served by the City's water system. According to 2009 billing data, the City's water system had approximately 22,000 meters serving residential and non-residential customers.

Although Certificate 85414 includes a place of use at the Bend Municipal Airport, and Airport Well #2 as an authorized point of appropriation, as described above, Avion provides water to the airport. Further, the water supply system at the airport does not connect with the City's municipal supply system because it is approximately 8 miles outside of the City's current UGB and the water service area. As a result, the water demands at the airport are not considered as part of this WMCP.

The City's 2009 service area population was estimated to be approximately 62,791. This population figure was developed using the following methodology. The estimated population for the City was obtained from Portland State University (PSU). Next, the populations for the Avion and Roats service areas within the City were determined as follows. The number of residential units was determined using county tax rolls plus approved 2008 building permits. The estimated number of residential units within these areas was multiplied by the occupancy rate of 94 percent and the average household size of 2.4 persons, which is based on 2000 census information. The City's service area population figure was reduced by these estimated populations residing in the Avion or Roats service areas within the City. For 2009, the PSU population estimate for the City is 82,280. The population within the City that is served by Avion or Roats was estimated to be 19,489. As a result, the estimated 2009 service area population for the City is 62,791 (82,280 - 19,489 = 62,791).

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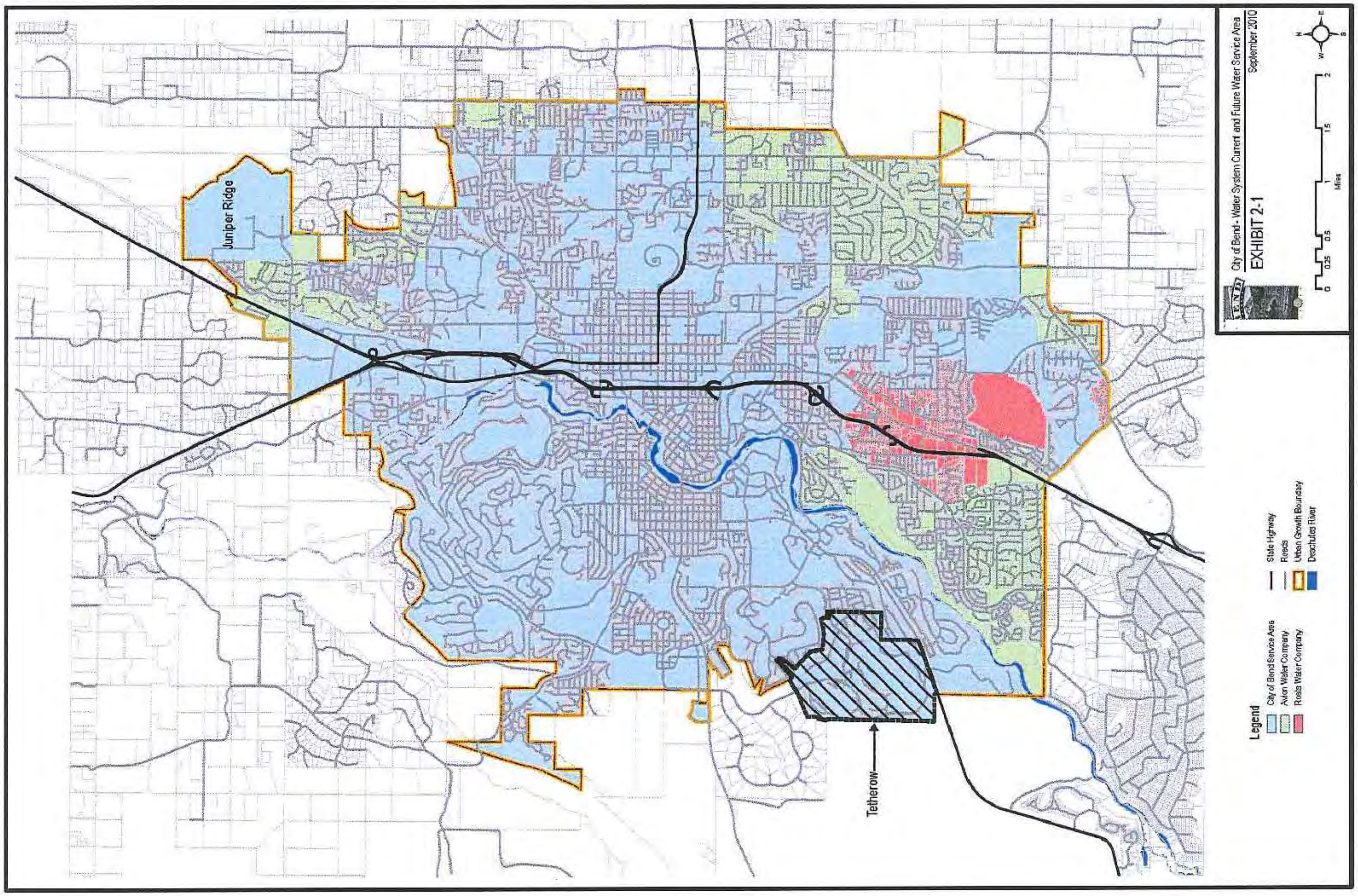
City of Bend - Water System Current and Future Water Service Area
EXHIBIT 2-1
September 2010
Juniper Ridge
Tetherow
Legend
City of Bend Service Area
Avion Water Company
Roats Water Company
State Highway
Roads
Urban Growth Boundary
Deschutes River
Miles
0 0.25 0.5 1 1.5 2
N
W
E
S

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Records of Water Use

OAR 690-086-0140(4) and (9)

Methodology

The International Water Association (IWA) and the American Water Works Association (AWWA) have published and promoted a water audit methodology that has been widely recognized and adopted throughout the water industry.[2] This method provides definitions and classifications for annual water production and consumption as shown in **Exhibit 2-2**. Knowing the magnitude of each category can assist a utility in estimating the financial impact of production, billing, and leak detection practices.

System input, shown in Column A of Exhibit 2-2, refers to the total quantity of water delivered to a distribution system from all sources: for example, water treatment plants or wells. The quantity of water generally is measured using large master meters located at key entry points into the distribution system. System input also is known as "production" and "demand." The system input volume must equal the sum of the authorized consumption and water losses that occur in the system (Column B of Exhibit 2-2).

EXHIBIT 2-2
Components of the IWA/AWWA Water Balance

<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><td rowspan="4">System Input Volume = Production = System Demand (measured at Master Meters)</td><td rowspan="2">Authorized Consumption</td><td>Billed Authorized Consumption</td><td>Billed metered consumption (including water exported to another system).
Billed unmetered consumption.</td><td>Revenue Water</td></tr>
<tr><td>Unbilled Authorized Consumption</td><td>Unbilled metered consumption.
Unbilled unmetered consumption.</td><td rowspan="3">Non-Revenue Water</td></tr>
<tr><td>Water Losses</td><td>Apparent Losses</td><td>Unauthorized consumption.
Data handling error.
Metering Inaccuracies.</td></tr>
<tr><td></td><td>Real Losses</td><td>Leakage from transmission and/or distribution mains.
Leakage and overflows at storage tanks.
Leakage from service connections up to a point of customer metering.</td></tr>
</table>

*AWWA. Manual of Water Supply Practices M36. *Water Audits and Loss Control Programs, Third Edition*, 2009.

Authorized consumption is divided into billed and unbilled categories. Billed authorized consumption is equivalent to revenue water. Unbilled authorized consumption contributes to

[2] AWWA. Manual of Water Supply Practices M36. *Water Audits and Loss Control Programs, Third Edition*, 2009.

non-revenue water and includes uses such as hydrant flushing and system flushing. Unbilled authorized consumption can be either metered or unmetered.

Water losses include both apparent losses and real losses. Apparent losses result from meter inaccuracies, errors introduced by data entry or manipulation, and unauthorized consumption (such as illegal connection to the system). Real losses result when water is lost because of leaks, reservoir overflow and evaporation. All water systems have some degree of real losses. OWRD's Water Management and Conservation Planning rules set a goal for municipal systems to have "system leakage" (real losses) equal to or less than 15 percent of total system input or demand, and if feasible less than 10 percent.

Terminology

Production refers to the quantity of water delivered to a distribution system. By definition, production equals system demand.

Generally, demands and consumption in municipal systems are summarized in units of million gallons per day (mgd), but also may appear as cfs or gallons per minute (gpm). Annual or monthly values typically are reported in million gallons (MG). Water use per person or per capita typically is expressed in gallons per capita per day (gpcd).

The following terms are used to describe system demands:

- Average day demand (ADD) equals the total annual demand divided by 365 days.
- Maximum day demand (MDD) equals the highest system demand that occurs on any single day during a calendar year. It is also called the 1-day MDD or peak day demand.
- The 3-day maximum day demand (3-d MDD) equals the average of the daily demands that occurred on the day before, the day of, and the day after the MDD.
- Monthly demand refers to demand during a calendar month. This demand can be expressed as the total volume of water produced in a month, or as a daily demand value by dividing the total monthly volume by the number of days in the month.
- Maximum monthly demand (MMD) equals the highest monthly demand during a calendar year.
- Peaking factors are the ratios of one demand value to another. The most common and important peaking factor is the ratio of MDD to ADD.

Historic Water Demands

Water demands for the City's system from 2004 through 2009 appear in **Exhibit 2-3**. The data illustrate an increasing trend from 2004 through 2008, with a decline in demand during 2009.

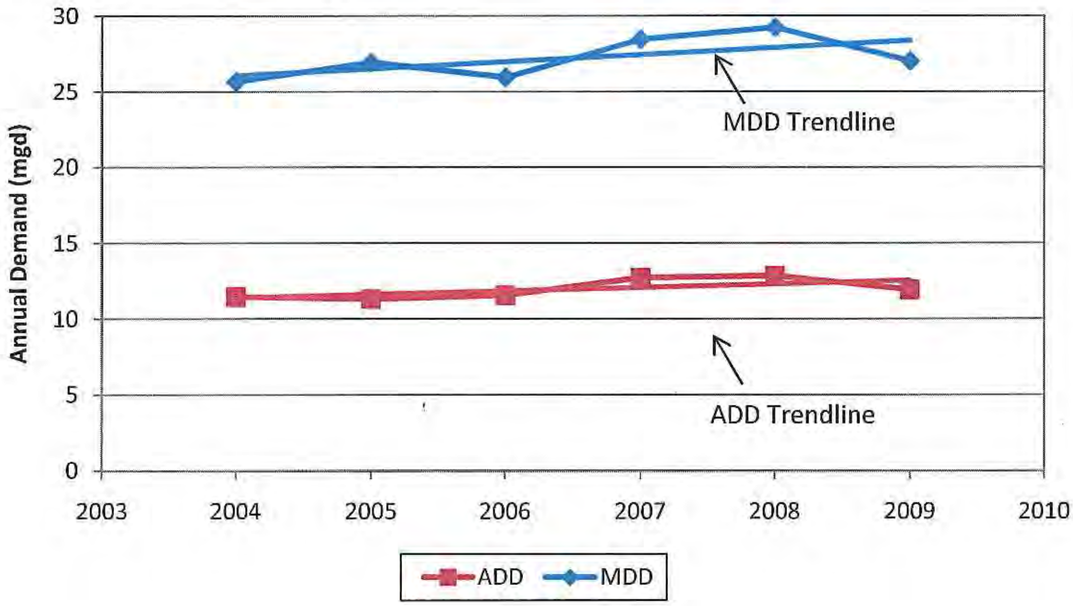
EXHIBIT 2-3
Historical Average Day, Maximum Day, 3-day Maximum Day Demands, and Peaking Factors

Year	Annual Volume Produced (MG)	ADD (mgd)	MDD (mgd)	3-d MDD (mgd)	Peaking Factor MDD:ADD
2004	4,195	11.5	25.7	25.5	2.2
2005	4,131	11.3	26.9	26.3	2.4
2006	4,222	11.6	26.0	25.8	2.2
2007	4,643	12.7	28.5	27.3	2.2
2008	4,700	12.8	29.2	27.9	2.3
2009	4,353	11.9	27.0	26.2	2.3
Average	**4,374**	**12.0**	**27.2**	**26.5**	**2.3**
Maximum	**4,700**	**12.8**	**29.2**	**27.9**	**2.4**

MG = million gallons
ADD = average day demand
mgd = million gallons per day
MDD = maximum day demand

Exhibit 2-4 displays the historic data and linear trends of the ADD and MDD from 2004 to 2009 for the system.

EXHIBIT 2-4
Historic and Trend Line ADD and MDD

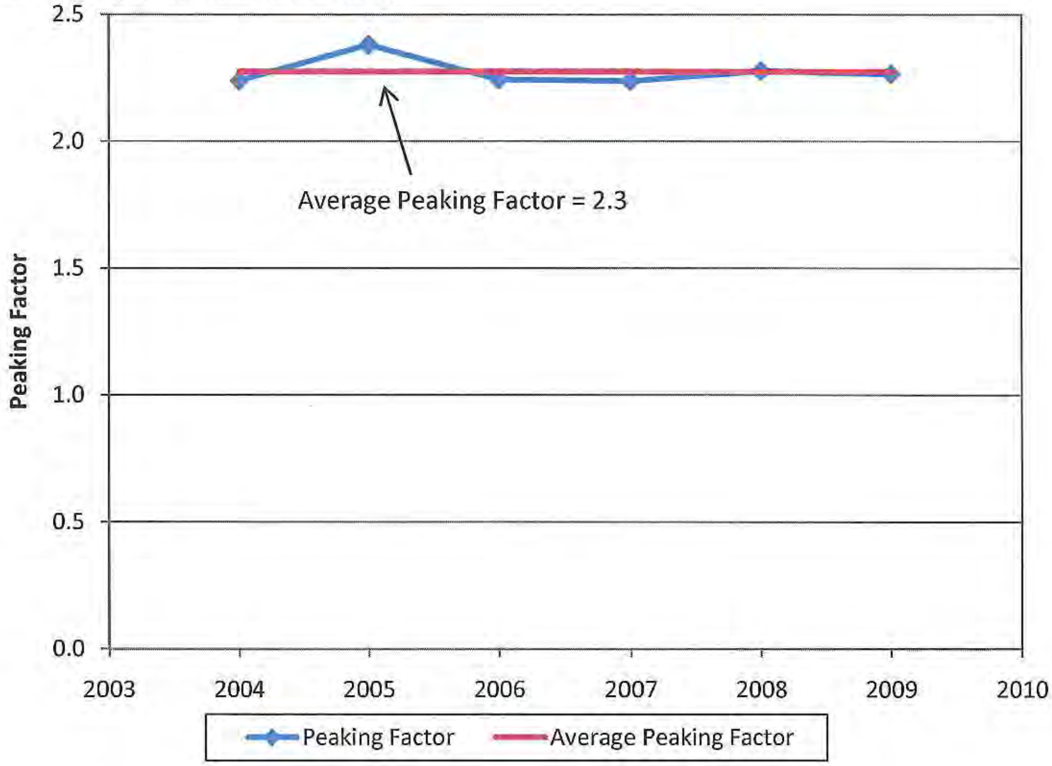


From 2004 to 2009, the ADD ranged from 11.3 to 12.8 mgd, with an average of 12.0 mgd. For the same period, the MDD ranged from 25.7 to 29.2 mgd, with an average of 27.2 mgd. As anticipated with municipal water systems, there is greater variation in the MDD than the ADD because of the sensitivity of the MDD to weather patterns. Hot and dry weather often results in more outdoor irrigation during that period, resulting in higher MDD values. Similarly wet, cool weather can cause the MDD to drop for a particular year.

If production approaches capacity for a short period of time, such as a single day, systems generally can use storage to meet demand. However, if high demand continues for a longer period, water shortages may result. The 3-day MDD gives an indication of the duration of the maximum demand period. From 2004 to 2009, the 3-day MDD ranged from 95 percent to 99 percent of the single MDD with an average 3-day MDD that was 97 percent of the single MDD. This indicates that periods of high demand typically last longer than a single day and that in its water supply planning efforts the City should make preparations to address maximum demand for multiple days.

Exhibit 2-5 graphically represents the ratio of the MDD to ADD for the years 2004 to 2009, which are the peaking factors from Exhibit 2-3. The peaking factor ranged from 2.2 to 2.4 with an average of 2.3. For use in projecting future demand in Section 5 of this WMCP, a peaking factor of 2.25 is used; this is a typical peaking factor for Central Oregon municipal water providers.

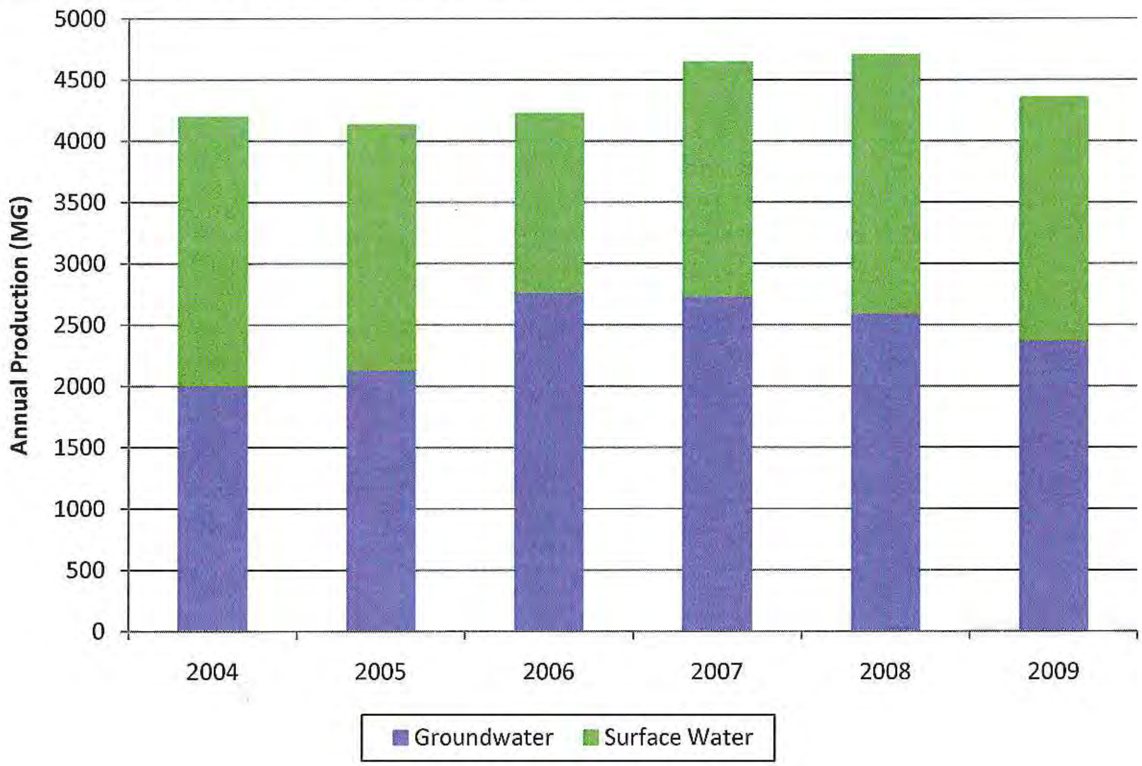
EXHIBIT 2-5
Historic Peaking Factor (MDD to ADD Ratio)



Annual and Monthly Production

Exhibit 2-6 illustrates the annual production of surface water and groundwater. On average from 2004 through 2009, groundwater represented 56 percent of production, and surface water provided the remaining 44 percent. However, the ratio of groundwater to surface water production varies by time of the year.

EXHIBIT 2-6
Annual Production of Surface Water and Groundwater



As previously described, the City's surface water and groundwater sources each provide about one-half of the City's annual water supply. Surface water is used year-round to meet the City's base water demands, and groundwater is used when sufficient surface water supplies are not available. **Exhibit 2-7** illustrates the monthly production volumes from 2004 through 2009. Surface water provided the majority of the water supply during the fall and winter months. The percent of groundwater use increased substantially during the spring and summer months because of the rise in turbidity of the surface water, which limits usability; low flows in the surface water sources; and higher overall demand. As expected, the overall demand peaks in the summer months as a result of outdoor uses such as irrigation. The average MMD during the period from 2004 through 2009 was 732 MG.

EXHIBIT 2-7
Monthly Production of Surface Water and Groundwater

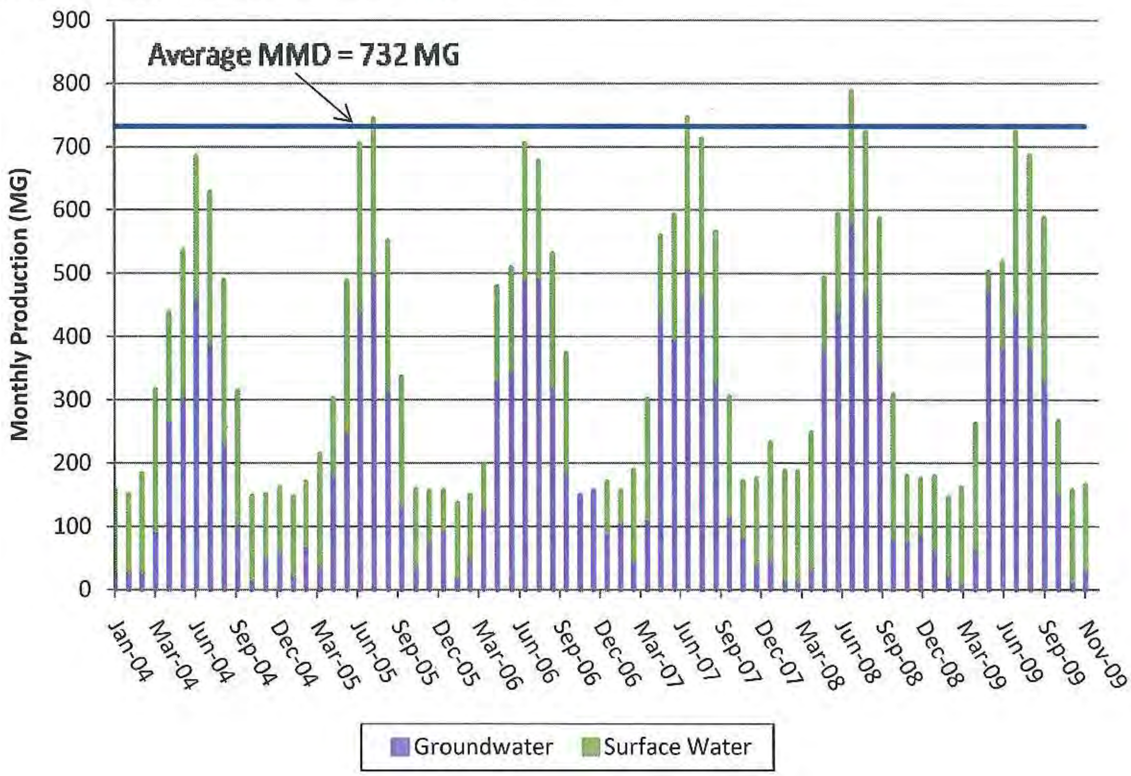
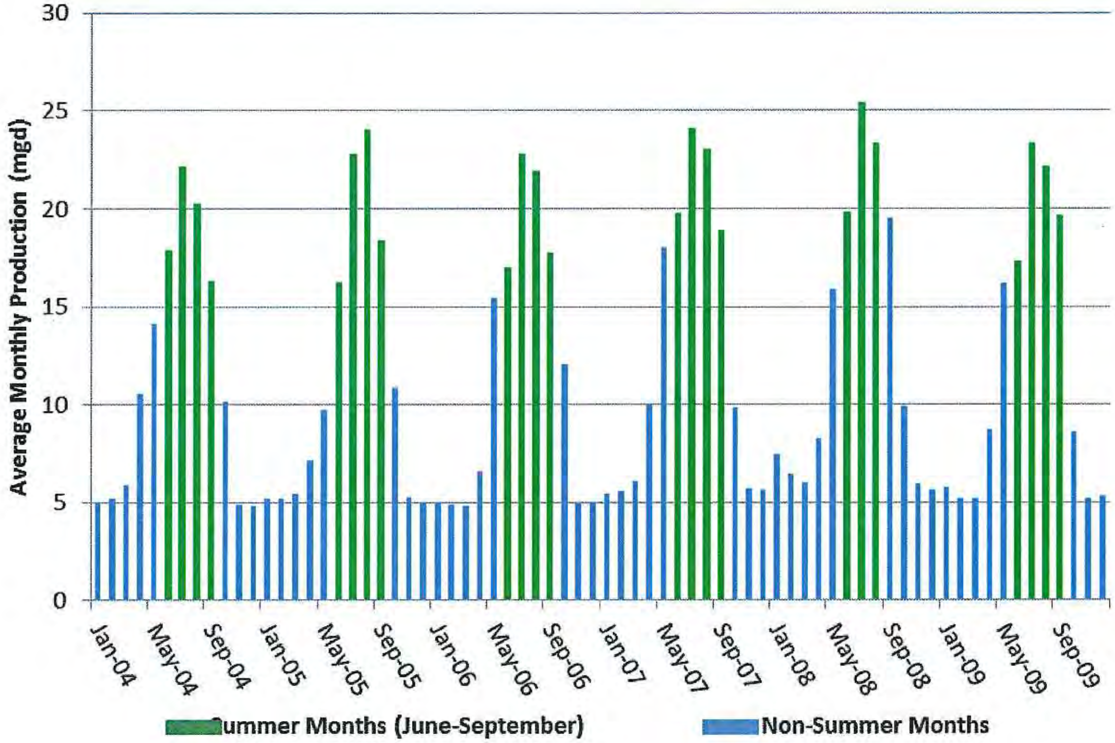


Exhibit 2-8 shows the average monthly demand, with the peak water use months from June through September highlighted in green. The average MMD was 23.6 mgd (732 MG) during the 6-year period and the peak month occurred in July every year except 2005, when it occurred in August. The peak summer period accounted for an average of 57 percent of demand, with the remaining demand spread across the other 8 months of the year.

EXHIBIT 2-8
Average Monthly Production



Per Capita Demands

Exhibit 2-9 shows the estimated ADD per capita demand within the City's water service area. The ADD represents use by all customer categories. Because the per capita demand includes all use by commercial, industrial, and municipal customers as well as residential customers, the calculated per capita demand values exceed the amounts of water actually used by a typical individual. Because of this fact, per capita demand calculations may show year-to-year trends, but are a poor metric to compare customers' water use to that of other communities. Moreover, per capita demand may not accurately portray year-to-year water use because the calculation does not take into account the difference in customer mix, climate, rainfall, current economic conditions, or specifics such as changes in hotel occupancy or large commercial or industrial uses that may not have any relationship to population or actual efficiency of use.

EXHIBIT 2-9
ADD Per Capita Demand

Year	ADD (mgd)	Population Served by City System	ADD per Capita (gpcd)
2004	11.5	51,535	222
2005	11.3	54,525	208
2006	11.6	57,443	201
2007	12.7	59,198	215
2008	12.8	61,736	207
2009	11.9	62,791	190

ADD = average day demand
mgd = million gallons per day
gpcd = gallons per capita per day

Authorized Consumption

Authorized consumption is equal to the metered and certain unmetered water use within the system. All customers are metered, however, authorized water consumed for activities such as fighting fires and system maintenance currently are not metered by the City. Maintenance use and water used for water quality purposes such as system flushing are tracked informally by the operations staff. To obtain a more accurate determination of revenue and non-revenue water, the City intends to review and develop a program to calculate and track unbilled authorized consumption as part of its water audit program, as further described in Section 3.

The City currently has two major customer categories - residential and non-residential. For 2008 and 2009, 86 percent of accounts were residential with the remaining 14 percent classified as non-residential. Residential customers include single-family and multi-family accounts, and non-residential customers include commercial, laundry, park, and school accounts. The City is working to improve the accuracy of its data and changes have been made to improve the 2008 and 2009 billing record data. The use of detailed consumption data before 2008 or with more customer class specificity was not used in developing this WMCP. The City understands the current shortcomings of its detailed consumption data and is making this a point of emphasis in its water management and conservation benchmarks regarding annual water audits. (See Chapter 3 for more details.)

Customer Characteristics and Water Use Patterns

OAR 690-086-0140(6)

Understanding the characteristics of customers within the system is important when analyzing water use and forecasting future demand and consumption patterns. **Exhibit 2-10** shows the number of meters by customer category for 2008 and 2009. The annual metered consumption by retail accounts during this period is shown in **Exhibit 2-11.** Although the quality of the City's data is not sufficient for detailed evaluation of water use by customer class, note that the City's *2005 Housing Needs Analysis City of Bend Residential Lands Study* indicated that 72 percent of households were single-family, leaving 28 percent that were multi-family.

The percent of total water used by the two major customer categories in 2009 is illustrated in the pie chart in **Exhibit 2-12.** Residential use comprised 61 percent of consumption with 31 percent of use by non-residential customers.

EXHIBIT 2-10
Number of Meters by Customer Category

	2008	**2009**
Residential	19,318	19,033
Non-residential	3,253	3,211
Total	**22,571**	**22,244**

EXHIBIT 2-11
Annual Consumption by Customer Category

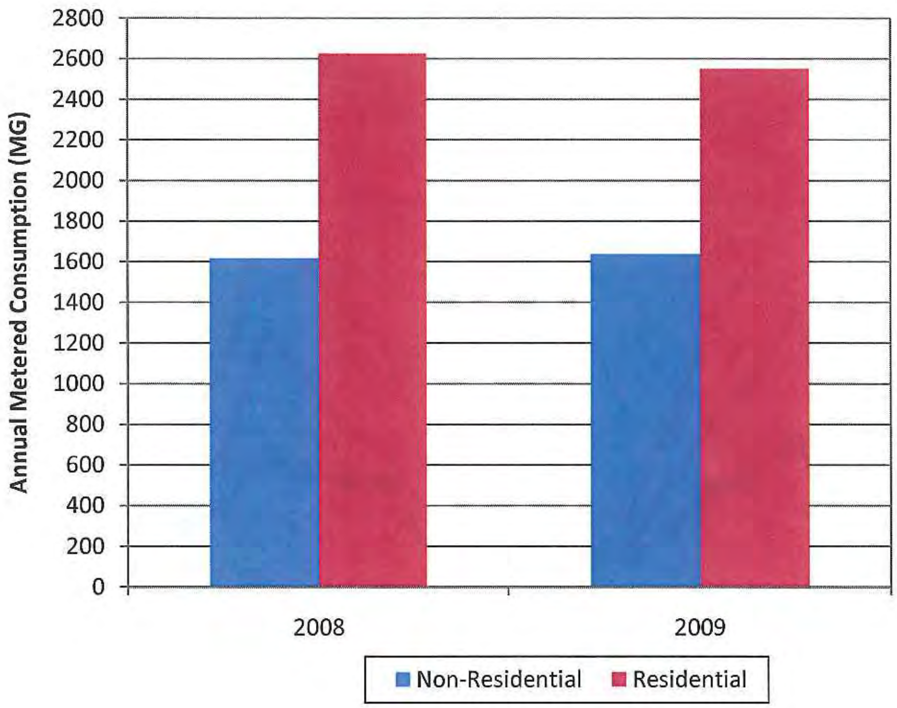
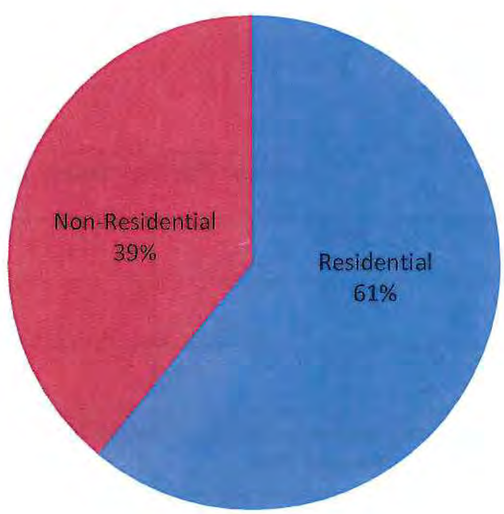


EXHIBIT 2-12
Percent Annual Consumption by Customer Category, 2009



The average monthly consumption by customer category for 2008 and 2009 is shown in **Exhibit 2-13.**

EXHIBIT 2-13
Monthly Water Consumption, 2008-2009

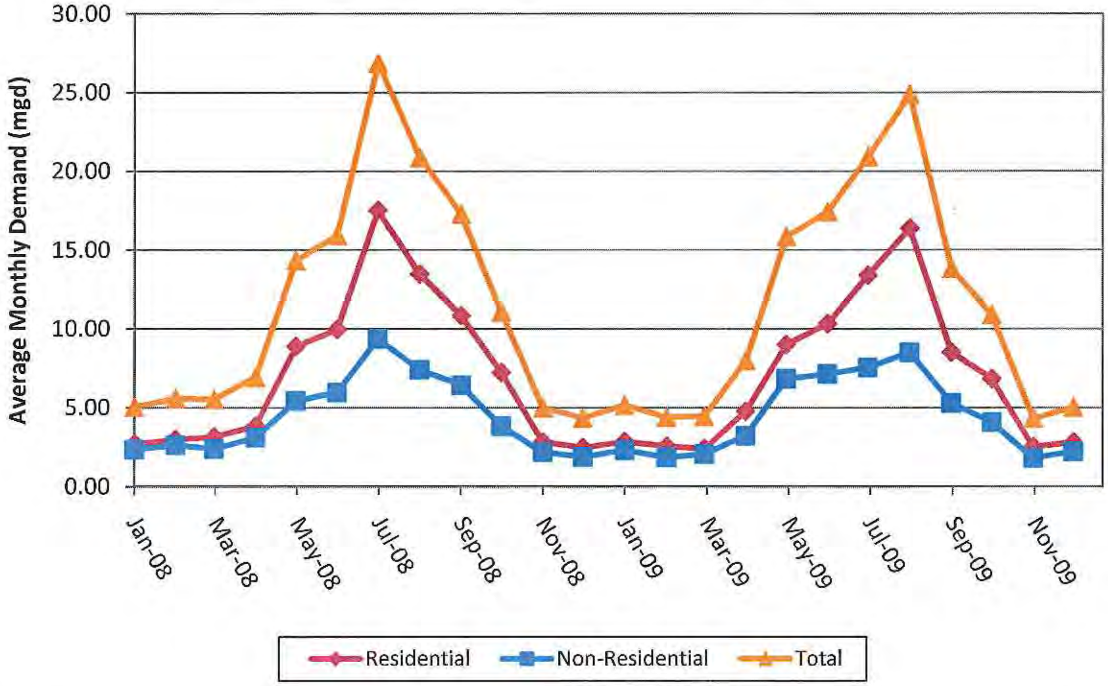


Exhibit 2-14 provides a comparison of the ADD for the residential customer category and for the non-residential customer categories during the last year of the analyzed period for this Plan and the City's previous Plan.

EXHIBIT 2-14
Current and Historic ADD by Customer Category

Customer Category	Average Day Demand (mgd)	
	2003[1]	**2009**
Residential	5.7[2]	7.0
Non-residential	5.7	4.9

[1] As provided in the City's 2004 approved WMCP. Since that time, continual refinements to customer categories have been made. In addition, the City was not fully metered until December 2004.

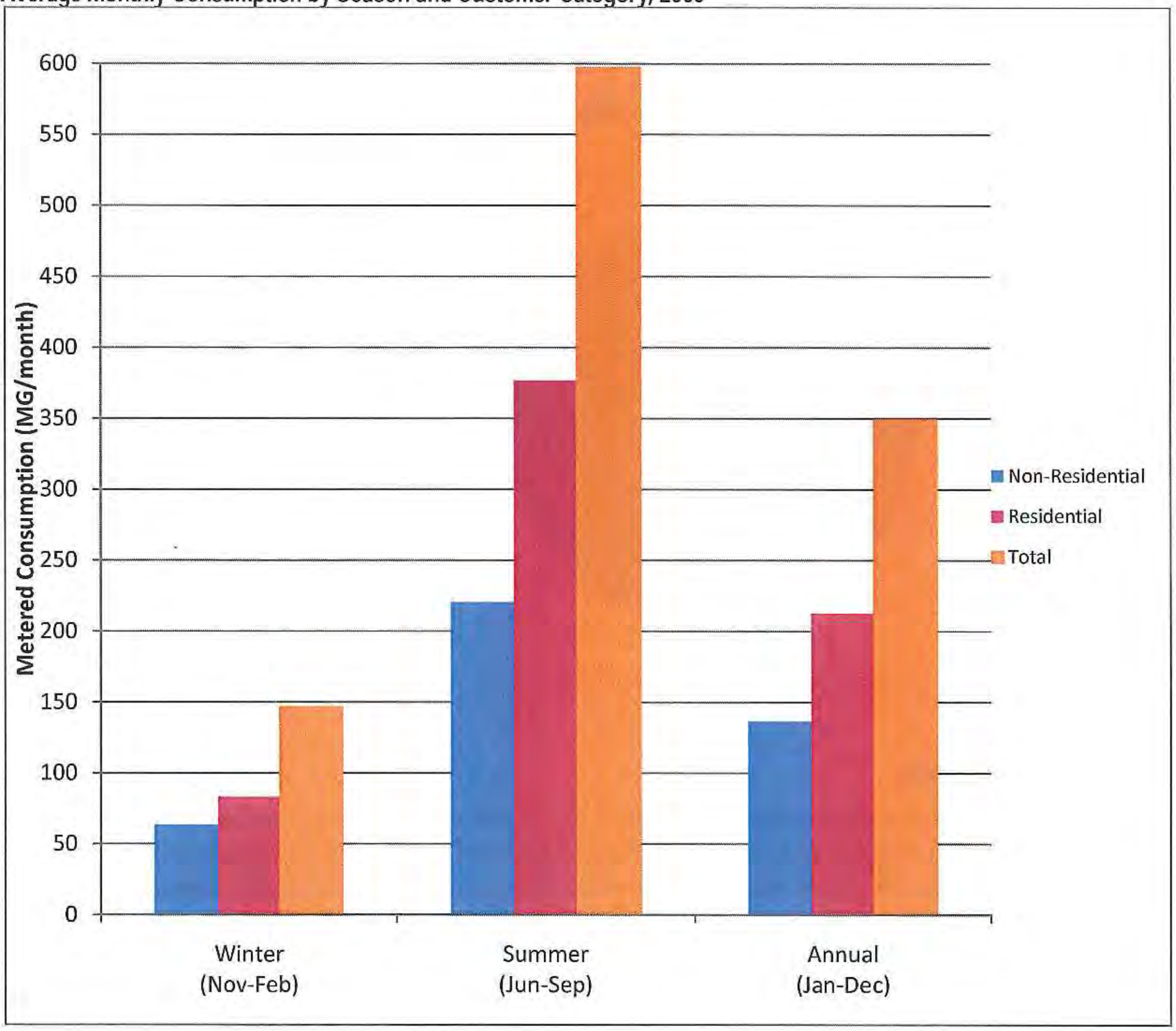
[2] Includes 0.35 mgd that was the estimated demand for non-metered residential use.

mgd = million gallons per day

The ADD for the residential category during 2009 was 12.6 mgd during summer months (June through September) and 2.8 mgd during winter months (November through February.) The ADD for non-residential categories during 2009 was 7.4 mgd during summer months and 2.1 mgd during winter months.

Exhibit 2-15 presents the average monthly consumption for the two major customer categories by season for 2009. For the purposes of this analysis, the summer months are defined as June through September and winter months are defined as November through February. The total average monthly consumption was 597 MG per month for summer months, and 146 MG per month for the winter months. The overall monthly average for the entire year was 349 MG per month. The summer season to winter season use ratio was 4.1.

EXHIBIT 2-15
Average Monthly Consumption by Season and Customer Category, 2009

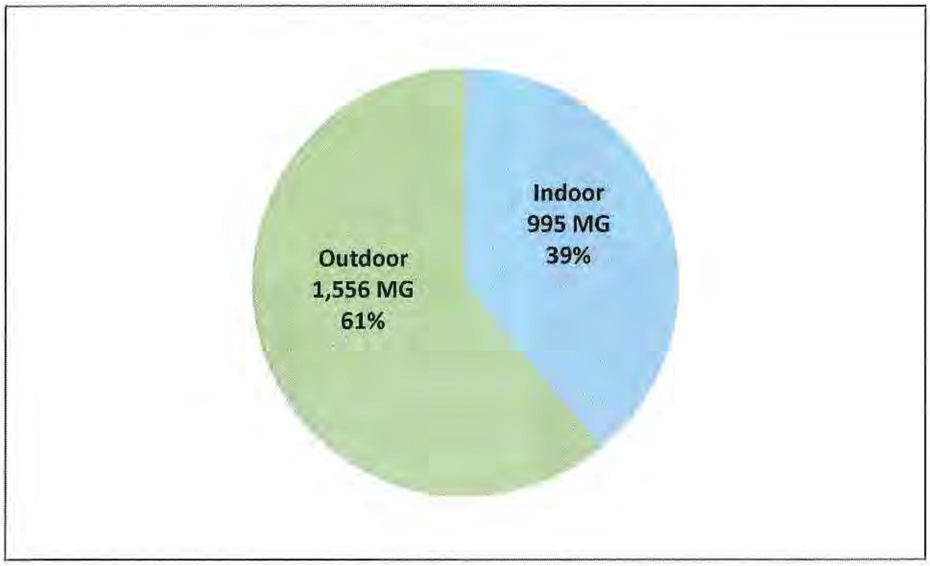


Indoor and Outdoor Water Use

To estimate indoor versus outdoor use, wintertime consumption was assumed to be representative of indoor water use (or at least to exclude outdoor irrigation) for residential customers. Non-residential customers were not included in the analysis because of the variability of types of customers within the non-residential category. The wintertime monthly average of 83 MG for residential users was multiplied by a 12-month period to determine the average annual indoor use of 996 MG. The outdoor use by residential customers was assumed to be the difference between total use and the calculated indoor use, resulting in outdoor annual average use of 1,556 MG. The results appear in **Exhibit 2-16.**

Indoor water use represented approximately 39 percent of annual water use by residential customers. Because outdoor use represents the majority of residential use, conservation measures focused on reducing outdoor use could substantially reduce average demand and peak season demand. Conservation efforts targeting indoor residential water use could have some impact on reducing overall average demands.

EXHIBIT 2-16
Estimated Annual Residential Indoor and Outdoor Use, 2009



Non-Revenue Water

The difference between production and authorized consumption is equivalent to a system's non-revenue water, which includes both apparent and real water losses. Apparent losses result from meter inaccuracies, error introduced by data entry or manipulation, and unauthorized consumption (illegal connection to the system or unauthorized use of a fire hydrant). Positive apparent losses would reduce the volume attributed to real losses. Conversely, because of the nature of these types of errors, apparent losses may have negative values. If apparent losses are negative, real losses are underestimated. Apparent and real water losses often are expressed as a percentage of system production. Non-revenue water is equal to system losses plus any authorized but unbilled water use within a system.

Exhibit 2-17 presents the annual non-revenue water for 2008 and 2009. The exhibit also lists total production and consumption as well as the percent of non-revenue water. These percentages ranged from 4 percent to 10 percent, with an average of 7 percent. A valve maintenance and hydrant flushing program is completed about every 2 years and occurred in 2008, which likely contributed to a higher percentage that year. The City is not aware of any leaks in its system or significant losses of water.

The City currently does not have a systematic leak detection program; however, leakage is not believed to be a significant loss. Authorized unbilled water use for flushing, water quality testing, reservoir cleaning and draining, as well as reservoir leakage is calculated and tracked by the City's Operations staff, but not precisely metered so the exact percent contributed to the overall non-revenue water cannot be determined. This is a benchmark activity the City intends to include in its "water audit" improvements.

EXHIBIT 2-17
Historic Annual Non-revenue Water

Year	Production (MG)	Metered Consumption* (MG)	Water Losses (MG)	Percent
2008	4700	4242	458	10%
2009	4353	4189	164	4%
Average			**311**	**7%**

*Does not include unbilled authorized consumption such as hydrant flushing, water quality testing, etc.
MG = million gallons

City of Bend Water Rights

OAR 690-086-0140(5)

The City holds 12 groundwater rights that authorize the use of groundwater at a rate of up to 68.2 cfs (44.1 mgd) for municipal purposes: 7 certificates and 5 permits. In addition, the City holds six surface water rights that authorize a total use of up to 36.1 cfs (23.3 mgd) from Bridge Creek and Tumalo Creek for municipal purposes. **Exhibit 2-18** summarizes the City's water rights. The exhibit includes the priority date, source, type of use, and maximum instantaneous rate of use to date for each water right. The City provided the total maximum annual volume of use, because the volume of use is recorded by well, not water right, and each well is typically an authorized point of appropriation for multiple water rights. For the same reason, the City has provided the total average daily and monthly quantities of water diverted, rather than providing this information for each water right. However, **Exhibit 2-19** describes the monthly volume of water diverted from each well.

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EXHIBIT 2-18
City of Bend Water Rights

Application Number	Permit Number	Certificate or Transfer Number	Authorized Wells	Priority Date	Authorized Rate (cfs)	Authorized Rate (mgd)	Type of Beneficial Use	Maximum Withdrawal To Date	2009 Average Withdrawal		5-Year Average Withdrawal (2005-2009)		Authorized Date for Completion	Mitigation Credits	Notes
								Instantaneous (cfs)	Daily (MG)	Monthly (MG)	Daily (MG)	Monthly (MG)			
Groundwater															
G-12226	G-11380	85414	Outback Well #1 Outback Well #2 Outback Well #3 Outback Well #4 Bear Creek Well #1 Airport Well #2	9/7/1990	10	6.5	Municipal	10	6.51	198.02	6.91	210.19	N/A - Certificated	N/A	
G-5644	G-4946	68702	River Well #1 River Well #2	10/31/1971[1]	0.9	0.6	Municipal	0.9					N/A - Certificated	N/A	
G-5644	G-4946	85415	River Well #1 River Well #2	10/13/1971	2.7	1.7	Municipal	2.7					N/A - Certificated	N/A	
G-5644	G-4946	85412	River Well #1 River Well #2 Copperstone Pilot Butte Well #1	10/13/1971	7.57	4.9	Municipal	7.57					N/A - Certificated	N/A	
G-5644	G-4946	85413	River Well #1 River Well #2 Pilot Butte Well #1 Bear Creek Well #1 Bear Creek Well #2	10/13/1971	4.87	3.1	Municipal	4.87					N/A - Certificated	N/A	
G-8695	G-8565	85411	A Well (Westwood)	12/22/1978	1.51	1.0	Quasi-Municipal	1.51					N/A - Certificated (Partial perfection of Permit G-8565)	N/A	
G-8695	G-8565		A Well (Westwood) Pilot Butte Well #4 Shiloh Well #3 Hole Ten Well #1 Hole Ten Well #2	12/22/1978	0.94	0.6	Quasi-Municipal						10/1/2020	N/A	Permit Amendment T-10941
G-11942	G-11379	85559	Rock Bluff Well #1 Rock Bluff Well #2 Rock Bluff Well #3	6/30/1989	4.16	2.7	Municipal	4.16					N/A - Certificated (Partial perfection of Permit G-11379)	N/A	
G-11942	G-11379		(Rock Bluff) Well #1 (Rock Bluff) Well #2 (Rock Bluff) Well #3 Pilot Butte Well #3	6/30/1989	3.84	2.5	Municipal						10/1/1998 - extension application pending	N/A	Permit Amendment T-8342
G-13097	G-16177		Bear Creek Well #3 Bear Creek Well #4 Bear Creek Well #5 [2]Outback #7 [2]Shiloh #3 [2]Hole Ten 1 [2]Hole Ten 2	8/27/1992	12	7.8	Municipal	0					4/26/2027	Obligation: 1,611.5; Assigned: 4.9	Limited by Maximum annual volume of 3223 AF and corresponding mitigation provided. Permit Amendment T-11138.
G-13098	G-16178		Pilot Butte Well #3 Pilot Butte Well #4 Pilot Butte Well #5 [2]Outback #7 [2]Shiloh #3 [2]Hole Ten 1 [2]Hole Ten 2	8/27/1992	12	7.8	Municipal	0					3/2/2027	Obligation: 1,611.5; Assigned: 174.05	Limited by Maximum annual volume of 3223 AF and corresponding mitigation provided. Permit Amendment T-11138.
G-4677	G-4435		Lava Island Well #1 Lava Island Well #2 Lava Island Well #3 Lava Island Well #4 Lava Island Well #5 Lava Island Well #6 Lava Island Well #7 Lava Island Well #8 Bear Creek Well #2 Outback Well #3 Outback Well #4 Outback Well #5 Outback Well #6 Pilot Butte Well #4 Shiloh Well #3 Hole Ten Well #1 Hole Ten Well #2	11/8/1968	7.75 cfs total; 0.935 0.98 0.98 0.97 0.97 0.97 0.97 0.975 N/A N/A N/A N/A N/A N/A N/A N/A N/A	5 mgd total; 0.60 0.63 0.63 0.63 0.63 0.63 0.63 0.63 N/A N/A N/A N/A N/A N/A N/A N/A N/A	Municipal						10/1/2020	N/A	Permit Amendments T-8783, T-10351, & T-10941
				Total Authorized	68.2	44.1									
				Total Certificated	31.7	20.5									

[1] Priority date day is likely a typo. Application G-5644 and Permit G-4946 had priority dates of 10/13/1971.
[2] Permit amendment in process.

EXHIBIT 2-18

City of Bend Water Rights Continued

Application Number	Permit Number	Certificate or Transfer Number	Facility/ Location Name	Priority Date	Authorized Rate (cfs)	Authorized Rate (mgd)	Type of Beneficial Use	Maximum Withdrawal To Date Instantaneous (cfs)	2009 Average Withdrawal Daily (MG)	2009 Average Withdrawal Monthly (MG)	5-Year Average Withdrawal (2005-2009) Daily (MG)	5-Year Average Withdrawal (2005-2009) Monthly (MG)	Authorized Date for Completion	Mitigation Credits	Notes
Surface Water															
S-67983	S-49823	85713	Bridge Creek & Unnamed Tributary of Middle Fork Tumalo Creek	12/12/1983	12.2	7.9	Municipal	12.2					N/A - Certificated (Partial perfection of Permit S-49823)	N/A	
S-67983	S-49823		Bridge Creek & Unnamed Tributary of Middle Fork Tumalo Creek	12/12/1983	2.8	1.8	Municipal						10/1/1999 -extension application pending	N/A	
Decree: Vol. 1, Page 153		85526	Tumalo Creek	This right is senior to all other rights on Tumalo Creek	6	3.9	Domestic, Municipal	6					N/A - Certificated	N/A	
Decree: Vol. 1, Page 135		31411	Tumalo Creek	8/5/1900	2	1.29	Municipal	2					N/A - Certificated	N/A	Period of use: 4/15-10/15; Not to exceed 6.52 cfs and 821.7 AF/year
				9/1900	4.5	2.91		4.5	5.42	164.71	5.17	157.27		N/A	
				6/1/1907	0.02	0.01		0.02						N/A	
Decree: Vol. 1, Page 135		31665	Tumalo Creek	9/1900	1.314	0.85	Municipal	1.314					N/A - Certificated	N/A	Period of use: 4/15-10/15; Not to exceed 2.603 cfs and 328.14 AF/year
				4/28/1905	0.186	0.12		0.186						N/A	
				6/1/1907	1.103	0.71		1.103						N/A	
Decree: Vol. 1, Page 135		Transfer B-112	Tumalo Creek	10/29/1913	4/1-5/1: 2.43 cfs 5/1-5/15: 3.23 cfs 5/15-9/15: 5.99 cfs 9/15-10/1: 3.23 cfs 10/1-11/1: 2.43 cfs	4/1-5/1: 1.57 mgd 5/1-5/15: 2.09 mgd 5/15-9/15: 3.87 mgd 9/15-10/1: 2.09 mgd 10/1-11/1: 1.57 mgd	Municipal	0					10/1/2019	N/A	Period of use: 4/1-11/1; Not to exceed 5.99 cfs and 1923.5 AF/year.
				Total Authorized	36.1	23.3									
				Total Certificated	27.3	17.7									

EXHIBIT 2-19
2009 Monthly Water Use by Well

Well	January	February	March	April	May	June	July	August	September	October	November	December
	Volumes in Million Gallons (MG)											
Bear Creek 1	0	0	0	9.93	34.57	34.86	44.29	44.15	43.10	14.54	0	0
Bear Creek 2	0	0	0	0	5.83	7.34	22.34	21.97	15.30	0.55	0	0
Outback 1	0.04	0.01	0	6.88	31.24	20.71	0	0	0.41	8.83	1.18	4.57
Outback 2	10.27	3.04	0	8.47	31.11	23.12	0	0	0.88	13.36	1.19	6.52
Outback 3	12.46	6.11	0	1.22	36.82	16.64	20.77	18.64	14.53	6.25	0	4.72
Outback 4	11.47	2.36	0	3.73	43.66	39.58	50.27	49.88	49.37	23.73	0	3.74
Out back 5	4.74	0.82	0	11.82	44.75	33.59	41.18	40.56	27.02	18.50	2.13	1.95
Outback 6	0.94	0	0	1.81	35.47	6.04	11.21	10.70	4.06	15.00	1.23	1.32
Outback 7	0	0	0	0	0	0	0	0	0	0	0	0
Outback 8	0	0	0	0	0	0	0	0	0	0	0	0
River Well 1	0	0	0	1.61	16.35	39.59	43.10	7.60	2.63	0	0	0
River Well 2	0	0	0	0	77.70	11.21	16.98	0	1.71	0	0	0
Westwood	1.77	0	0.003	0	3.76	7.87	15.90	17.79	9.06	0.15	0	0
Copperstone	0	0	0	0	27.06	43.68	45.34	41.66	44.07	1.46	0	0
Pilot Butte 1	0	0	0	0	0	13.04	37.36	37.95	36.43	8.39	0	0
Pilot Butte 2	0	0	0	0	0	0	0	0	0	0	0	0
Pilot Butte 3	0	0	0	0	23.54	43.76	37.38	37.40	36.37	15.37	0	0
Rock Bluff 1	0.01	0	0	0.41	4.53	6.34	13.90	9.40	8.41	0.31	0	0
Rock Bluff 2	0	0	0	0	0	0	0	0	0	0	0	0
Rock Bluff 3	9.11	0.4	0.50	9.29	45.70	25.24	30.27	31.29	25.25	14.90	0	1.37
Hole 10 North	6.86	7.5	6.21	8.05	6.79	6.52	8.07	10.39	8.94	6.66	4.81	4.39
Hole 10 South	6.41	5.7	6.25	5.77	6.78	6.68	7.49	9.42	8.04	6.26	4.93	4.62
Shilo 1	0	0	0	0	0.02	0	0	0	0	0	0	0
Shilo 2	0	0	0	0	0.02	0	0	0	0	0	0	0
Shilo 3	0	0	0	0	0	0	0	0	0	0	0	0

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Groundwater

The City's seven water right certificates for the use of groundwater authorize the use of up to 31.7 cfs. The City's most senior groundwater right certificates (68702, 85415, 85412, and 85413), have a priority date of October 13, 1971[3] and authorize the use of up to 0.9 cfs, 2.7 cfs, 7.57 cfs, and 4.87 cfs, respectively.

The City also holds water right Certificate 85411, which has a priority date of December 22, 1978, and authorizes the use of up to 1.51 cfs. This certificate was issued as the result of the partial perfection of Permit G-8565, which authorized the use of up to 2.45 cfs. The remaining portion (0.94 cfs) of Permit G-8565 continues to be in the water right development process as a permit. OWRD approved an application for an extension of time that extends the development timeline for Permit G-8565 to October 1, 2020.

In addition, the City holds water right Certificate 85559, which has a priority date of June 30, 1989, and authorizes the use of up to 4.16 cfs. This certificate was issued as the result of the partial perfection of Permit G-11379, which authorized the use of up to 8.0 cfs. The remaining 3.84 cfs portion of Permit G-11379 continues to be in the water right development process as a permit. The City filed an application for an extension of time with OWRD on October 31, 2003. That extension application is pending.

The City's most junior water right certificate is Certificate 85414, which has a priority date of September 7, 1990, and authorizes the use of up to 10 cfs.

Finally, the City holds three additional municipal water use permits that authorize the use of groundwater: Permits G-4435, G-16177, and G-16178. Permit G-4435 authorizes the use of up to 7.75 cfs of groundwater. OWRD extended the development timeline for Permit G-4435 until October 1, 2020. Permits G-16177 and G-16178 each have a priority date of August 27, 1992, and each authorizes water use at a rate of up to 12.0 cfs and volume of up to 3,223 acre-feet. OWRD issued these permits after the inception of the Deschutes Basin Mitigation Program and, accordingly, the City must provide mitigation credits to offset the impacts on surface water from use of groundwater under these permits. OWRD determined that each permit has a total mitigation obligation of 1,611.5 credits based on a consumptive use estimate of 50 percent. To date, 4.9 credits have been assigned to Permit G-16177 and 229.15 credits have been assigned to Permit G-16178.

Surface Water

The City's six surface water rights authorize the use of up to a total of 36.1 cfs (23.3 mgd) from the Bridge Creek and Tumalo Creek watersheds. The City's surface water rights are evidenced by four certificates, one permit, and one transfer.

The City's most senior surface water right is Certificate 85526, which authorizes the use of up to 6.0 cfs from Tumalo Creek. The certificate evidencing this water right does not provide a date of priority, but states instead that the "right is senior to all other rights on Tumalo Creek." The City acquired this water right as the result of a judgment of the Deschutes County Circuit Court in a case between the City of Bend and the Deschutes County Municipal Improvement District.

[3] Certificate 68702 appears to include a scrivener's error stating that its priority date is October 31, 1971, rather than October 13, 1971, as provided in Permit G-4946, from which the certificate was issued.

The City holds two additional surface water right certificates for the use of water from Tumalo Creek: Certificate 31411, which authorizes the use of up to 6.52 cfs; and Certificate 31665, which authorizes the use of up to 2.603 cfs. Both rights originated as multiple decreed rights for irrigation purposes, which were acquired by the City and transferred to municipal purposes. As a result, these certificates each have three different priority dates with a maximum authorized rate associated with each date. These rights also carry an annual volume limitation and a season of use limitation stemming from their origins as irrigation water rights.

The City's most junior municipal water right certificate is Certificate 85713, which authorizes the use of up to 12.2 cfs from Bridge Creek and an unnamed tributary of Middle Fork Tumalo Creek. This certificate was issued as the result of the partial perfection of Permit S-49823, which authorized the use of up to 15.0 cfs. The remaining 2.8 cfs portion of Permit S-49823 continues to be in the water right development process as a permit.

Finally, the City holds a water right evidenced by Transfer B-112. Under this transfer, the maximum authorized rate of diversion from Tumalo Creek varies by season from up to 2.43 cfs to 5.99 cfs. The right also has an annual volume limitation and a season of use because it was originally an irrigation right. Transfer B-112 changed the place of use, point of diversion, and character of use of two certificates for irrigation and domestic use. On May 18, 2009, OWRD approved an extension of time allowing until October 1, 2019 for the City to complete this transfer.

Juniper Utility Water Right

The City has possession of water right application G-13809, which was held by the former Juniper Utility, based on a condemnation proceeding. Title to the application and other Juniper Utility system property will not transfer until the case is complete; the judgment is entered and the City pays the award of just compensation into court. As a result, the Juniper Utility water rights are not considered as part of the discussion of the City's water rights or listed in Exhibit 2-18.

Aquatic Resource Concerns

The City's water supply is from both groundwater and surface water. Groundwater in the Deschutes Basin is not an OWRD-designated Critical Groundwater Area or Groundwater Limited Area. The City's surface water sources are Bridge Creek and Tumalo Creek to the west of Bend. **Exhibit 2-20** shows the listed fish species that occur in Bridge Creek and Tumalo Creek. Tumalo Creek is listed on Oregon Department of Environmental Quality's (DEQ) 303(d) list of impaired water bodies for the following parameters: alkalinity, ammonia, chloride, chlorophyll a, dissolved oxygen, pH, phosphate phosphorous, flow modification, habitat modification and temperature. Bridge Creek is 303(d) listed for temperature.

EXHIBIT 2-20
Native Fish Species that Occur in Bridge Creek and Tumalo Creek that are Listed as Sensitive, Threatened, or Endangered Under the Oregon or Federal Endangered Species Acts

Species	Evolutionarily Significant Unit (ESU)	Federal Listing	State Listing
Inland Columbia Redband Trout (*Oncorhynchus mykiss gairdneri*)	Range-wide	Sensitive	Sensitive – Vulnerable

- Federal ESA listed species (threatened and endangered) were obtained from http://www.nmfs.noaa.gov/pr/species/esa/fish.htm and http://ecos.fws.gov/tess_public/pub/stateListingIndividual.jsp?state=OR&status=listed
- Federal sensitive species were obtained from the Interagency Special Status/Sensitive Species Program (Oregon and Washington) at http://www.fs.fed.us/r6/sfpnw/issssp/agency-policy/
- State ESA listed species (threatened and endangered) were obtained from http://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp
- State sensitive species were found at http://www.dfw.state.or.us/wildlife/diversity/species/docs/SSL_by_taxon.pdf

Evaluation of Water Rights/Supply

OAR 690-086-0140(3)

As previously described, the City's water supply is provided by its surface water and groundwater rights. The City holds water rights authorizing use of up to approximately 68.2 cfs (44.1 mgd) of groundwater from the Deschutes Aquifer and 36.1 cfs (23.3 mgd) of surface water from Bridge Creek and Tumalo Creek. The City's existing water right capacity is sufficient to meet its current peak water demands. The City's current water supply is, however, limited by stream flow, surface water right regulation, surface water quality events, volume limitations on water rights, system capacity, and mitigation requirements in the Deschutes Groundwater Study Area.

Surface Water

The amount of water available to satisfy the City's surface water rights is a function of water right priority date (seniority) and stream flow, as further described below.

A. Watermaster Distribution

Most of the City's surface water rights were originally irrigation water rights that the City acquired for municipal purposes. As a result, these rights have annual volume limitations and limit the use of water to the irrigation season. The City's surface water rights authorize the use of up to 36.1 cfs during the irrigation season and 21.0 cfs during the remainder of the year. Further, because these rights share priority dates with other irrigation water rights held by the Tumalo Irrigation District (TID), streamflows in Tumalo Creek are distributed between the City, TID, and the instream water rights that also originated from a TID irrigation water right during times of low flow.

For demonstration purposes, **Exhibits 2-21 and 2-22** describe the amount of water to which the City is entitled at different streamflows, as well as the amounts to which TID and the instream water rights are entitled.

EXHIBIT 2-21
Tumalo Creek Water Rights Distribution during Irrigation Season

Total stream flow	BEND	TID	INSTREAM
40	11.1	22.3	6.5
60	14.2	38.7	7.0
80	16.3	56.1	7.6
100	17.5	74.7	7.8
120	18.0	94.2	7.8
140	18.6	113.6	7.8
160	19.2	133.0	7.8
180	19.7	152.5	7.8
200	20.3	171.9	7.8
220	20.9	191.3	7.8
240	21.1	206.4	12.4

TID = Tumalo Irrigation District

EXHIBIT 2-22
Tumalo Creek Water Rights Distribution during Irrigation Season

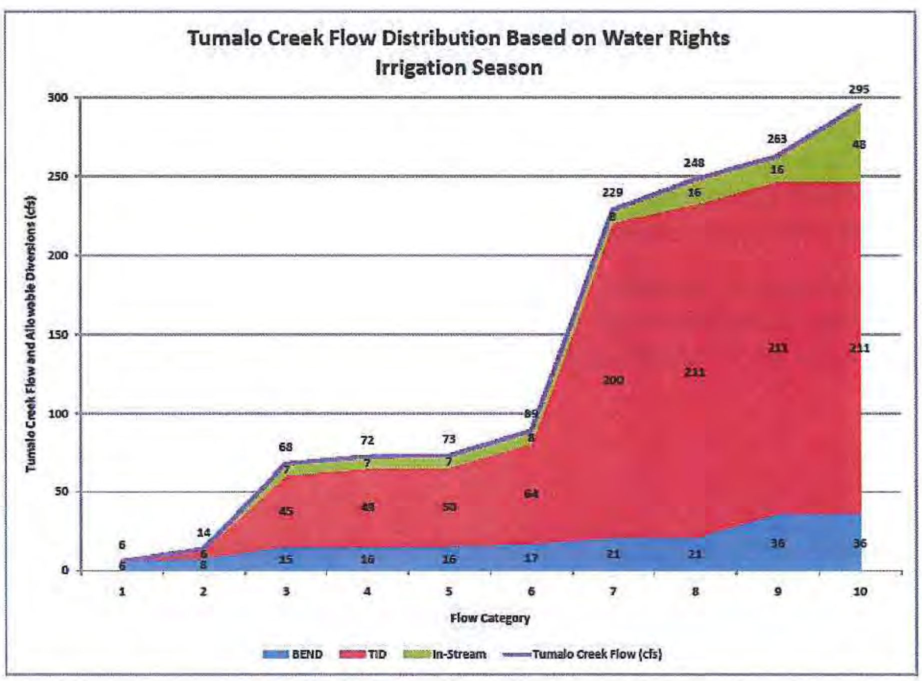

Exhibit 2-23 breaks down the water rights used by the City, TID, and instream water right by rate and priority date.

Exhibit 2-23
Tumalo Creek Water Rights Distribution by Priority Date

PRIORITY	MAX RIGHT IN CFS		
	BEND	TID	Instream
Unrestricted	6.000	0.000	0.000
August 5, 1900	2.000	5.645	0.178
September 1900	7.434	39.593	7.065
April 28, 1905	0.186	4.178	0.131
May 27, 1907	0.000	0.585	0.018
June 1, 1907	1.513	13.750	0.431
October 29, 1913	3.981	136.000	0.000
December 8 1961	0	11.3	7.800
December 12 1983	15.000	0.000	0.000
TOTAL	**36.114**	**211.051**	**15.623**

CFS = cubic feet per second

Flows in Tumalo Creek are influenced by snow melt. The flows typically peak during May and June, and are the lowest during September. Based on historic flow information provided by OWRD, the 80 percent exceedance flows (flows expected to be available 80 percent of the time, or 8 years out of 10) in Tumalo Creek above the Tumalo Feed Canal during September are calculated to be 52 cfs. At this flow, the City would be entitled to up to approximately 13 cfs under the watermaster's distribution schedule, which distributes water according to priority date among the City, TID, and the instream water rights. During July, which is typically the month during which the City has the highest maximum monthly demand, the 80 percent exceedance flows in Tumalo Creek are calculated to be 72 cfs. At this flow, the City would be entitled to up to approximately 15.6 cfs.

Under low-flow conditions in Tumalo Creek, the City's water use would be limited even further. Historic (7-day rolling average) stream flows of 42.5 cfs were observed in September 1945. Under such conditions, the City could expect to be limited to as little as 11.5 cfs (7.4 mgd).

B. Water Quality

Water quality also can affect the reliability of the City's surface water rights. Because the City currently does not filter its surface water, its use of surface water is vulnerable to turbidity events during spring melt and thunderstorms, and to other water quality problems that can result from forest fires or other causes. These events have the potential to degrade water quality to the point where some water quality standards are exceeded, limiting the City's ability to use its surface water source. The City is currently in the process of addressing this problem by planning for installation of surface water treatment facilities.

C. Instream Water Rights

Three instream water rights have been established on Tumalo Creek. The two senior instream rights resulted from TID allocation of conserved water projects. The instream water right evidenced by Certificate 81332 has a priority date of December 8, 1961, and protects flows ranging from 1.7 cfs to 7.8 cfs from April through October at the Tumalo Feed Canal diversion. Because of its priority date, this instream right affects only the reliability of the City's Permit S-49823 and Certificate 85713, which have priority dates of December 12, 1983. The instream water right evidenced by Certificate 84351, however, has multiple priority dates ranging from August 5, 1900 to June 1, 1907. These priority dates are identical to several of the priority dates for the City's surface water rights. This right protects up to 2.0 cfs from April 15 to October 15 from the Tumalo Feed Canal diversion to Lake Billy Chinook. The third instream water right is evidenced by Certificate 73222 and has a priority date of October 11, 1990. This right protects flows year-round from the confluence of South Fork Tumalo Creek to the mouth. Because of its junior priority date, this instream rights does not affect the reliability of the City's water rights.

D. Over-all Reliability

Based on its priority, the City's water right Certificate 85526 is highly reliable. The certificate authorizes the use of up to 6 cfs (3.9 mgd) from Tumalo Creek year-round and is senior to all other water rights on the creek. As a result, this right is not subject to regulation when the streamflow falls below levels necessary to meet the needs of other existing water rights.

The City's water rights evidenced by Certificates 31411 and 31665 and Transfer B-112 have a number of limitations. First, water use under these rights, which originated as irrigation rights, is limited to the irrigation season (April 15 to October 15 for the certificates and April 1 to November 1 for Transfer B-112). Further, these rights have annual volume limitations: 821.7 acre-feet for Certificate 31411; 328.14 acre-feet for Certificate 31665; and 1923.5 acre-feet for Transfer B-112. Finally, as previously described, these rights are subject to regulation according to the watermaster's distribution schedule when streamflows are insufficient to meet the needs of existing water rights with the same or senior priority dates. In a typical year, regulation may occur in late summer (late July into September). As a result, the City is generally unable to divert water at the full rates authorized by these rights during the peak demand time of the year.

The City's Permit S-49823 and Certificate 85713, which resulted from partial perfection of this permit, have a priority date of December 12, 1983. Although these rights do not have a season of use or annual volume limitations, they are not reliable during the irrigation season because of their junior priority date. These rights will be the first to be regulated to meet the needs of senior consumptive water rights and instream water rights evidenced by Certificates 81332 and 84351. Because of the above-described limitations on the City's surface water rights, the City depends on its groundwater rights to help meet peak day demand during the summer and other times when sufficient surface water is not available to meet the City's water needs.

Groundwater

The City holds groundwater rights authorizing use of up to approximately 68.2 cfs (44.1 mgd) of groundwater. According to the City's 2010 Optimatics study (*February 2010 Design Data Summary Report*), the total in-service groundwater well capacity is 41.5 cfs (approximately 26.8 mgd). Consequently, the City's use of its maximum authorized rate is limited by the current capacity of its wells.

The City holds seven certificated groundwater rights: Certificates 85414, 68702, 85415, 85412, 85413, 85411, and 85559. They authorize the use of a combined total of up to 31.71 cfs. These water rights provide the City with a reliable groundwater supply.

In addition, the City holds Permit G-8565, which authorizes the use of up to 0.94 cfs, and Permit G-4435, which authorizes the use of up to 7.75 cfs of groundwater. The City has obtained extensions of time allowing it until October 1, 2020 to complete development of both permits. These permits are expected to provide the City with a reliable water supply.

The City also holds Permit G-11379, which authorizes the use of up to 3.84 cfs. The current development timeline for this permit was October 1, 1998. An extension application for this permit is pending. The reliability of this permit could be reduced as a result of conditions included through the extension process.

Finally, the City holds groundwater Permits G-16177 and G-16178, each of which have a priority date of August 27, 1992 and authorize the use of water at a rate of up to 12.0 cfs and a volume of up to 3,223 acre-feet annually. Permits G-16177 and G-16178 each have a total mitigation obligation of 1,611.5 credits. To date, 234 credits have been assigned to Permits G-16177 and G-16178, which allows the use of up to 468 acre-feet of groundwater. To increase the volume of water appropriated for beneficial use under these permits, the City will need to secure additional mitigation credits. The need to mitigate for the use of water under these permits limits their reliability to some extent. The second increment in the City's incremental mitigation plan calls for the City to obtain an additional 1,126 acre-feet of mitigation. Further, the administrative rules implementing the mitigation program are scheduled to "sunset" on January 2, 2014. The City will be able to maintain the mitigation established before that date, but it is unclear how, or if, mitigation can be established after the program sunsets.

Summary

The City's groundwater rights appear to be reasonably reliable at present. The City's ability to increase its appropriation of groundwater, however, will be limited by its ability to obtain additional mitigation credits and the need for additional groundwater production capacity. The City's surface water Certificate 85526 is the most senior water right on Tumalo Creek and, accordingly, is highly reliable. The City's remaining surface water rights typically are regulated according to the watermaster's distribution schedule and the City is not able to divert the maximum rate authorized by its water rights. Currently, the City's surface water supply is vulnerable to water quality concerns.

System Description

OAR 690-086-0140(8)

The City operates a public drinking water system (Public Water System Identification Number 4100100) that supplies water to its customers from both surface and groundwater sources. **Exhibit 2-24** provides a schematic of the City's existing distribution system. **Exhibit 2-25** provides a schematic of the City's existing surface water diversion and conveyance system in the Tumalo Creek watershed. The surface water supply originates from Tumalo Creek and Bridge Creek, approximately 12 miles west of the City at the Bridge Creek Intake Facility. Tumalo Creek water is conveyed through two parallel transfer pipes to a canal flowing to Bridge Creek. The water is diverted at the Bridge Creek Intake Facility and the raw water is conveyed approximately 11.5 miles via two parallel pipes to the City's Outback site. The water is disinfected at the Outback site with the addition of chlorine and then flows through the CT Basin and Outback Reservoir 1. Four finished water transmission pipes transmit water from the Outback site to the City's distribution system. The groundwater supply originates from 21 existing wells associated with water rights.

The City's distribution system is comprised of 423 miles of pipe, 15 storage reservoirs, and 6 pump stations as well as associated appurtenances such as control valves, pressure reducing valves, isolation valves, meters, and fire hydrants. The system has nine primary pressure zones serving customers ranging in elevation from approximately 3,430 to 4,160 feet above mean sea level. Summaries of the pipelines, reservoirs, wells, and pump stations are presented in **Exhibits 2-26, 2-27, 2-28, and 2-29**, respectively.

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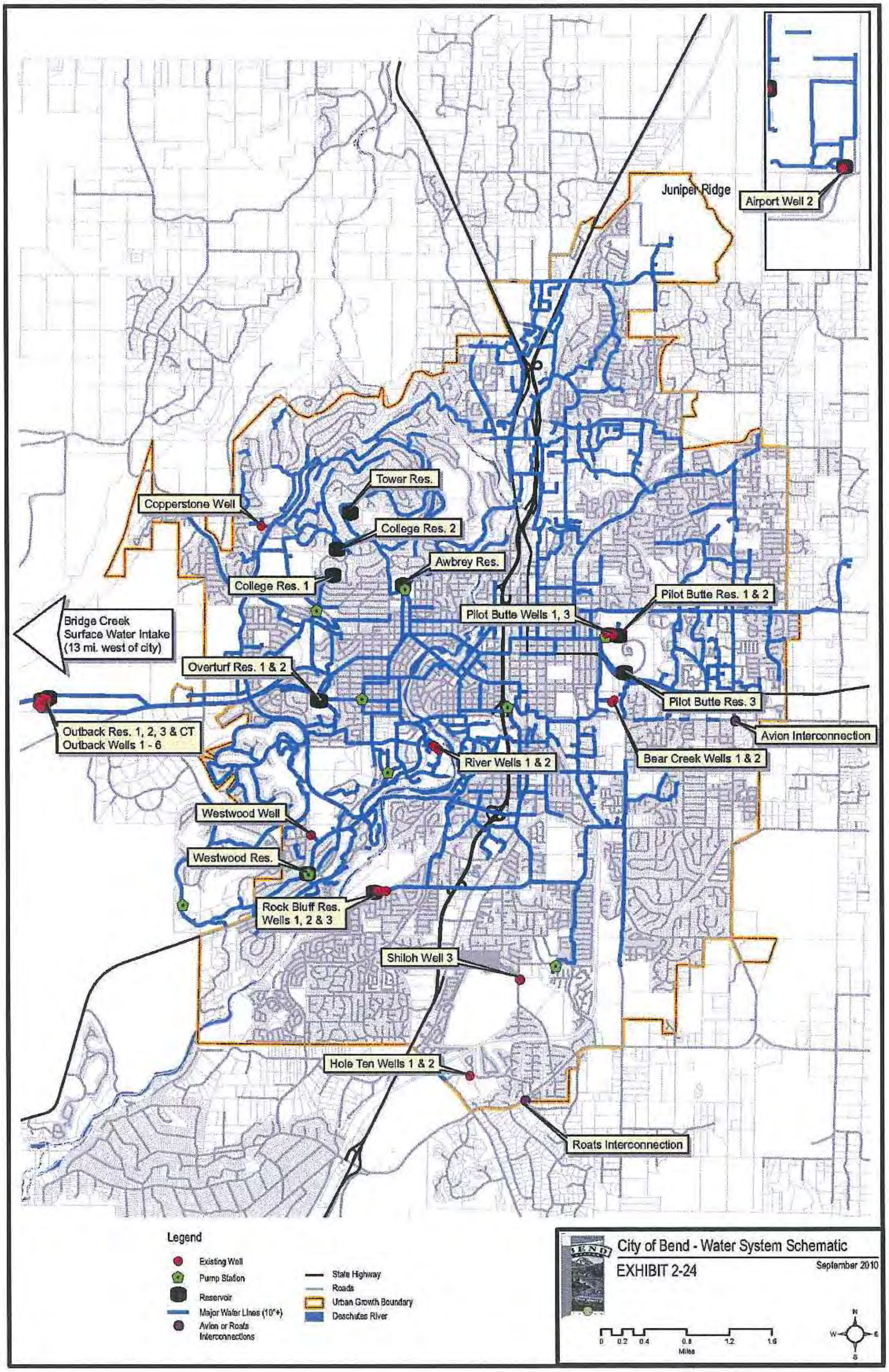
Juniper Ridge
Airport Well 2
Tower Res.
Copperstone Well
College Res. 2
Awbrey Res.
College Res. 1
Pilot Butte Res. 1 & 2
Bridge Creek
Surface Water Intake
(13 mi. west of city)
Pilot Butte Wells 1, 3
Overturf Res. 1 & 2
Pilot Butte Res. 3
Outback Res. 1, 2, 3 & CT
Outback Wells 1 - 6
Avion Interconnection
River Wells 1 & 2
Bear Creek Wells 1 & 2
Westwood Well
Westwood Res.
Rock Bluff Res.
Wells 1, 2 & 3
Shiloh Well 3
Hole Ten Wells 1 & 2
Roats Interconnection
Legend
Existing Well
Pump Station
Reservoir
Major Water Lines (10"+)
Avion or Roats Interconnections
State Highway
Roads
Urban Growth Boundary
Deschutes River
City of Bend - Water System Schematic
EXHIBIT 2-24
September 2010
0 0.2 0.4 0.8 1.2 1.6
Miles
N
W
E
S

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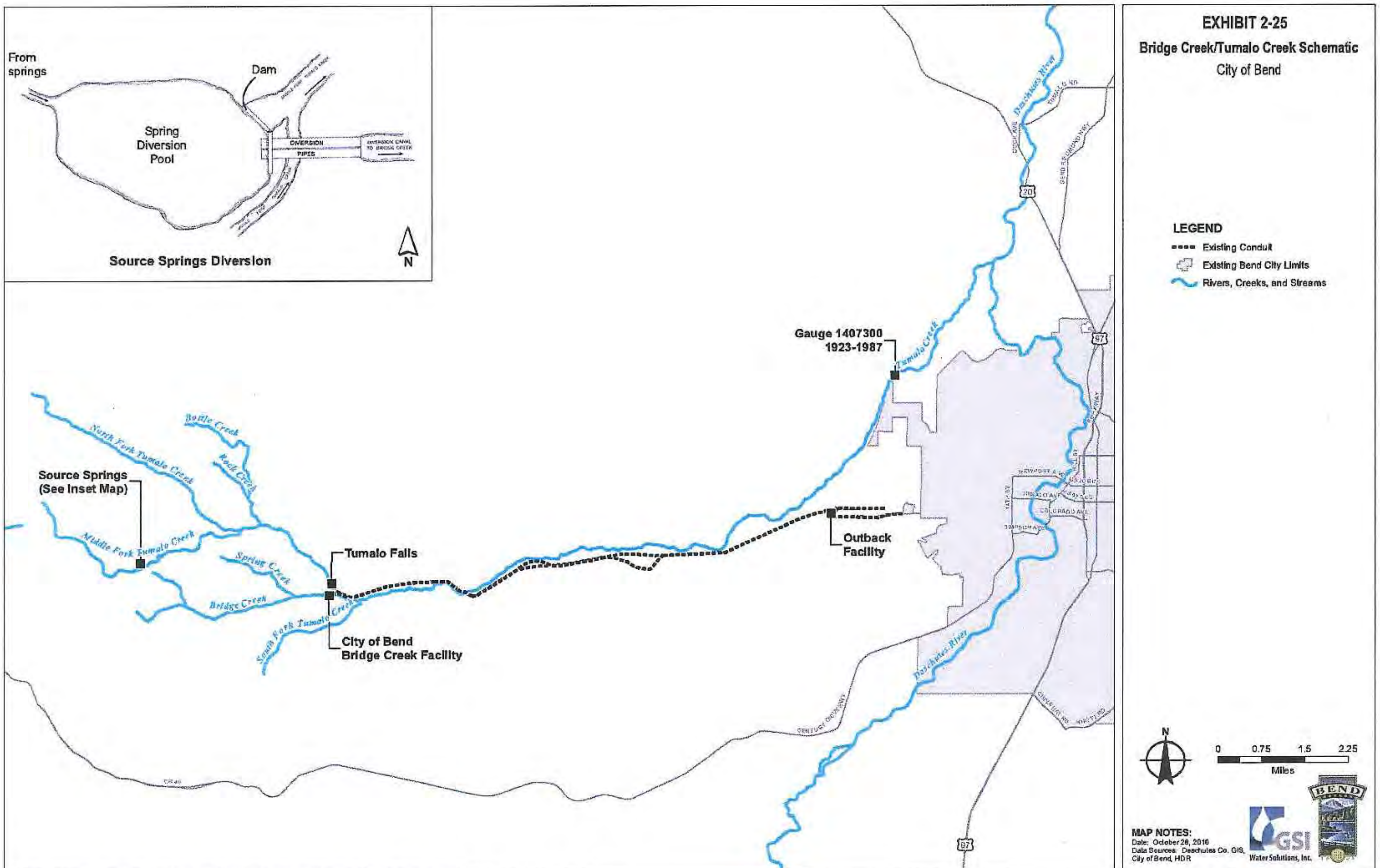

EXHIBIT 2-25
Bridge Creek/Tumalo Creek Schematic
City of Bend
LEGEND
Existing Conduit
Existing Bend City Limits
Rivers, Creeks, and Streams
From springs
Dam
Spring Diversion Pool
DIVERSION PIPES
Source Springs Diversion
N
Gauge 1407300 1923-1987
Tumalo Creek
Deschutes River
Outback Facility
Tumalo Falls
City of Bend Bridge Creek Facility
Source Springs (See Inset Map)
North Fork Tumalo Creek
Middle Fork Tumalo Creek
Bottle Creek
Rock Creek
Spring Creek
Bridge Creek
South Fork Tumalo Creek
COLORADO AVE
20
97
0 0.75 1.5 2.25
Miles
MAP NOTES:
Date: October 28, 2010
Data Sources: Deschutes Co. GIS, City of Bend, HDR
GSI Water Solutions, Inc.
BEND

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EXHIBIT 2-26
Summary of Pipeline Sizes

Pipe Diameter (in)	Total Length (mi)	Percent of Total Pipeline
2	6	1.4%
4	5	1.1%
6	68	16.0%
8	188	44.3%
10	32	7.6%
12	79	18.7%
14	2	0.4%
16	34	8.1%
18	3	0.6%
24	3	0.7%
30	2	0.6%
36	3	0.6%
Total	**423**	**100%**

EXHIBIT 2-27
Summary of Reservoirs

Name	Volume (MG)	Elevation (ft)	Max Height (ft)
Awbrey	5.0	3,775	20.5
College 1	0.5	4,095.8	23.3
College 2	1.0	4,087.9	31.5
Outback 1	2.0	3,976	40.1
Outback 2	3.0	3,976	35.4
Outback 3	3.6	3,982	29.4
Outback Contact Basin	1.5	3,980	31
Overturf East	1.5	3,844	28
Overturf West	1.5	3,844	28
Pilot Butte 1	1.5	3,750	31.5
Pilot Butte 2	1.0	3,840.5	39.5
Pilot Butte 3	5.0	3,757.3	24.3
Rock Bluff 1	1.5	3,840	39
Tower Rock	1.0	4,213	31
Westwood	0.5	3,842	28

EXHIBIT 2-28
Summary of Existing Wells Associated with Water Rights for Bend's Municipal System

Well Description	Current Operational Capacity (gpm)
Bear Creek Well 1	1,050
Bear Creek Well 2	1,150
Copperstone Well	1,050
Hole Ten 1	800
Hole Ten 2	800
Outback Well 1	650
Outback Well 2	650
Outback Well 3	1,200
Outback Well 4	1,300
Outback Well 5	1,000
Outback Well 6	1,250
Pilot Butte Well 1	900
Pilot Butte Well 3	900
River Well 1	1,900
River Well 2	2,200
Shiloh Well 3	1,300
Airport Well 2[1]	285
Rock Bluff Well 1	750
Rock Bluff Well 2	700
Rock Bluff Well 3	900
Westwood Well	600

[1] Although Airport Well 2 is included in Certificate 85414 and this exhibit, this well is now used exclusively for fire flow events only as a backup to the wholesale water supply from Avion Water Company. The well does not provide water to the City's municipal water supply system.

EXHIBIT 2-29
Summary of Existing Pump Stations

Pump Description	Flow Rate* (gpm)	Total Capacity (gpm)	Firm Capacity (gpm)**
Awbrey Pump 1	950	3,490	2,150
Awbrey Pump 2	1,340		
Awbrey Pump 3	1,200		
College Pump 1	1,050	1,950	900
College Pump 2	900		
Murphy Road Pump 1	300	1,500	1,200
Murphy Road Pump 2	300		
Murphy Road Pump 3	300		
Murphy Road Pump 4	300		
Murphy Road Pump 5	300		
Scott Street Booster Pump 1	530	1,590	1,060
Scott Street Booster Pump 2	530		
Scott Street Booster Pump 3	530		
Tetherow Pump 1	150	3,650	2,950
Tetherow Pump 2	700		
Tetherow Pump 3	700		
Tetherow Pump 4	700		
Tetherow Pump 5	700		
Tetherow Pump 6	700		
Westwood Pump 1	390	2,390	1,490
Westwood Pump 2***	550		
Westwood Pump 3	900		
Westwood Pump 4	550		

* Flow rates indicate typical flow rates based on available SCADA data and model results if available to the nearest 50 gallons otherwise they are based on pump curves which may or may not be accurate.

** Firm capacity is defined as the total installed capacity remaining with the largest pump at a facility out of service.

*** Flow includes some recirculation through the Westwood Reservoir and pump station.

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3. Municipal Water Conservation Element

This section addresses the requirements of OAR 690-086-0150(1) – (6).

This rule requires a progress report on conservation measures in the City's existing Plan, and a description of any additional conservation measures. The rule also requires descriptions of specific required conservation measures and benchmarks.

Current Conservation Measures

OAR 690-086-0150(1) and (3)

The City submitted a WMCP in 2004 that was approved by the OWRD on February 28, 2005 (Special Order Vol. 63, Pg. 279). **Exhibit 3-1** shows the required and additional conservation measured required by OAR 690-086-0150(4)-(6) that were included in the previously approved WMCP. Exhibit 3-1 also provides a progress report for each conservation measure.

EXHIBIT 3-1
City of Bend Previously Approved 5-year Benchmarks

Conservation Measure	2004 5-year Benchmark	Progress Report
System metering	• Fully meter Juniper Utility customers.	• System is fully metered. • All hydrant use within the Bend service area requires metering.
	• Install permanent metered fill stations and develop portable metered hydrant program.	• Permanent water fill stations and portable "card lock," accessed units attached to fire hydrant ports for use by contractors, were installed for construction and water hauling use.
Meter testing and maintenance	• Periodic verification of all commercial meters exceeding 3-inch size.	• The City is testing and rebuilding all meters that exceed 2 inches. Each of these meters is checked and calibrated every 2 years or checked through computer analysis of customer usage each month.
	• Replace all small meters on a rolling 15- to 20-year cycle, or as needed based on billing data indicating inaccuracies.	• Small meters are replaced on a 15- to 20- year cycle, or as needed.
	• Periodic verification of all source meters.	• Several source meters have been replaced or upgraded.
Annual water audit	• Perform water audit accounting for uses and potential losses of water.	• The City approximated water produced vs. water sold in the recent Optimatics study (2010).

Conservation Measure	2004 5-year Benchmark	Progress Report
Leak detection and pipeline repair or replacement	• Periodic leak detection surveys—at least 10 miles of water mains. • Provide brochure to customers on using meters for leak detection; and distribute toilet tank leak detection dye tablets. • Perform flow audit calculations to verify inflows match outflow, for each Bridge Creek transmission line.	• Leak detection surveys have occurred for 45-50 miles of water mains since 2004. • The City distributed toilet leak tablets to more than 2,500 customers per year during the past few years. • A flow audit on Bridge Creek transmission lines occurred in 2009 and the City installed a new master meter at the end of the line.
Rate structure and billing practices	• Continue to expand and refine water use data collection and analysis, and expand breakdown of customer classes. • City Council to decide on whether/how to modify rate structure. • Continue to utilize customer bills to communicate water conservation messages and incentive programs.	• Customer classes and service coding remain to be reorganized and updated pending a software analysis and establishment of a process to replace antiquated utility billing software and related accounting modules. • At the beginning 2008, the City Council decided to reduce the quantity allowance for metered customers from 6 ccf to 4 ccf. Customers pay a volume-based rate for monthly water use exceeding the allowance. • The City continues to provide information to the public with bill stuffers and new e-mail alerts. WaterWise is mentioned in almost every bill stuffer (monthly) and alert with at least one key message about water efficiency and conservation.
Public education	• Upgrade the website to more fully convey the City's WaterWise Program • Continue sponsorship and participation in approximately 3 to 5 annual events attended by the public • School tours and speakers bureau • Print and radio advertising with focus on the irrigation season • Periodically review and upgrade printed handouts and related materials	• The City is updating its entire website, as well as the WaterWise website (www.waterwisetips.org). • The City sponsored or participated in at least 4 events per year. • Public speaking events requests vary each year. The City has sponsored or participated in school events and tours. • The City continues to provide information to the public using fact sheets, publications, its website, bill stuffers, City Edition Videos, and related outreach in partnership with the City Communications Manager. The "Signs You Might Be Wasting Water" campaign, included radio, print, and video messages. • The City continues to review and upgrade outreach materials.

Conservation Measure	2004 5-year Benchmark	Progress Report
	• Continue funding Customer Field Representative position, to provide customer outreach and enforce irrigation restrictions	• The City discontinued the Customer Field Representative position in 2005 due to budget and management decisions.
Technical and financial assistance programs	• Review even-odd day irrigation restrictions.	• Even-odd irrigation restrictions and time of day water restrictions are still in place awaiting optimization and engineering analysis to better understand potential peak day effects.
	• City-managed Greenwood Cemetery: install a Maxicom irrigation control system.	• The City completed a total retrofit of Greenwood and Pilot Butte Cemeteries. It installed smart irrigation controller timers, replaced sprinkler heads, and updated system piping.
	• City Landscape Retrofit Project: Budget for replacement of the landscape irrigation system at one site per year.	• The City Landscape Retrofit Project resulted in completion of at least 14 retrofits. A total of 66 City landscape sites are now retrofitted with smart irrigation controllers.
	• City Landscape sites: Complete maintenance and management plan.	• The City completed 136 maintenance and management plans for City landscape sites.
	• Bend-La Pine School District Irrigation Agreement: Partner with school districts to provide technical assistance to implement weather-based watering control at all new and existing sites.	• The City is providing technical assistance to the Bend-La Pine School District to fully meter sites, move off of irrigation district water, and upgrade and retrofit its irrigation systems.
	• Oregon State Parks Irrigation Agreement: At Pilot Butte State Park, City to provide technical assistance to implement weather-based watering control and operation of irrigation system.	• The Oregon State Parks Irrigation Agreement recently expired, but the State is still using the smart irrigation controller system at the park and incorporating native landscape design to decrease irrigation demand.
	• Water audits for selected large customers. Audits of turf fields will be completed as part of partnership described above.	• Water audits of large use customers were discontinued because of staffing, budget, coordination, and prioritization issues. However, the City still funded the Irrigation Association to provide training for Certified Landscape Irrigation Auditors and audited two schools in the Bend-La Pine School District.
	• Irrigation audits will also become part of standard contracts for City-funded irrigation improvement projects. Contracts will include performance standards and correction actions.	• Water auditing of City contracts decreased because of staffing, budget, coordination, and prioritization issues. The City's specifications and standards currently are being upgraded, and they still need to be included in City contracts.

Conservation Measure	2004 5-year Benchmark	Progress Report
	• Continue to expand water partnerships using weather-based irrigation technology including new large landscape partners.	• The City created WaterWise partnerships to install smart irrigation controllers with large use customers, but drastically scaled back the program in 2005 to address only a few cases.
Retrofit /replacement assistance	• Toilet retrofit program feasibility survey.	• The City decided not to conduct the survey because of staffing and budget limitations.
Water reuse, recycling, and non-potable water opportunities	• Perform a feasibility study of delivery of Level 4 effluent to irrigation canal system, with attendant exchange of water rights. Will be done in conjunction with ongoing discussion of water supply options between City and regional irrigation districts.	• The City completed a scope of work for the feasibility study in July 2010.

Additional Conservation Measures

OAR 690-086-0150(3)

In addition to the above-described conservation measures, the City has implemented the following conservation measures.

- The City's water utility and related "WaterWise" programs have become more integrated with other water-related utilities, such as stormwater and water reclamation.
- Significant efforts have been made to increase regional recognition that conservation is ongoing and important through participation in the Central Oregon Cities Organization, Bend 2030 process, and the Deschutes Water Alliance and its related work plans.
- The City maintains a display in the main lobby area at City Hall related to water use during the irrigation season.
- Since 2006, the City has distributed an estimated 1,500 shower timers to save water and energy.

Use and Reporting Program

OAR 690-086-0150(2)

The City has a water use measurement and reporting program that complies with the measurement standards in OAR Chapter 690, Division 85. The City's water use records can be found on the OWRD Web site (http://apps.wrd.state.or.us/apps/wr/wateruse.) The City currently measures surface water entering the distribution system at its Outback facility, and records surface water use daily. The City measures groundwater entering the distribution system at its pumps using meters and the SCADA system, and records groundwater use monthly.

Required Conservation Programs

OAR 690-086-0150(4)

OAR 690-086-0150(4) requires that all water suppliers establish 5-year benchmarks for implementing the following required conservation measures:

- Annual water audit
- System-wide metering
- Meter testing and maintenance
- Unit-based billing program
- Leak detection and repair (if system leakage exceeds 10 percent)
- Public education

5-year Benchmarks for Required Existing or Expanded Conservation Measures

The City currently addresses all of the required conservation measures. A summary of the 5-year benchmarks for required and additional conservation measures is provided below. During the next 5 years, the City plans to implement the following conservation measures required of all municipalities:

1. **Annual water audits.** A water audit involves an accounting of all water entering and leaving the water distribution system to identify system leakage, as well as authorized or unauthorized water uses. The City conducted basic water audits in the past, but these audits were difficult because the City was not fully metered, it did not closely track non-revenue water, and its customer classes and service codes needed to be revised because of inaccuracies. The City is working to remove these obstacles to its ability to conduct meaningful water audits. For example, the City does not have a system to track unbilled authorized consumption and its billing by customer class is unreliable. To address these issues, the City has established the following benchmarks.

   5-year Benchmarks:

   - The City will develop and implement an annual water audit program within the next 5 years. As part of this effort, the City will develop a method to calculate and track unbilled authorized consumption, which may include development of additional measurement methodology, to more accurately determine revenue and non-revenue water.
   - The City also will reorganize and update customer classes and service codes, as well as work toward equipping all water meters with automated metering infrastructure (AMI) meters.

2. **System-wide metering.** The City's water system became fully metered in December 2004. In addition, all hydrant use within the Bend service area now requires metering, resulting in better tracking of non-fire-related hydrant water use.

5-year Benchmark:

- The City will continue to install meters at all new service connections.

3. **Meter testing and maintenance.** The City is testing and rebuilding all meters that exceed 2 inches. Each of these meters is checked and calibrated every 2 years or checked through computer analysis of customer usage each month. The City tests meters if requested by customers, and if the tested meter is found to be 3 percent above or below the proper reading, the meter is repaired or replaced.

   Most residential meters are relatively new because of recent efforts to meter all residences. The City is also working to update its meters and expects to install 12,500 AMI meters by December 2010. Residential meters typically are replaced on a 15- to 20-year basis in accordance with AWWA guidelines. The City is eliminating the 5/8 x ¾ inch meter so that base meters for residential units will be ¾ inch.

   In 2008, the City installed a new master meter at the end of the Bridge Creek transmission line to measure the amount of surface water that it conveys into the distribution system.

   Source meters are verified when reservoirs are drained and filled each year, and their accuracy is verified using flow rates, pump curve data, and fill rates. Another verification of source meter accuracy occurs indirectly with daily chlorine testing throughout the system. Chlorine disinfection calculations rely on source meter accuracy; chlorination can stop or be reduced if a source meter fails or reads incorrectly. Inlet chlorine analyzer alarms are triggered by reduced chlorination levels, which notify on-call staff to address the problem. Several source meters have been replaced or upgraded within the past 5 years, but these new meters did not include the most advanced technology. However, the City now has a better understanding of the new technology available for metering, accordingly as certain wellfields are upgraded and refined, replacement meters will use improved technology and measure water use more accurately.

   5-year Benchmarks:

   - The City will continue to replace all existing meters with the new AMI standard within the next 5 years.
   - The City will use improved technology when upgrading or replacing existing source meters during the next 5 years.

4. **Unit-based billing program.** The City's customers are billed on the basis of the quantity of water use metered and a base fee. Customers pay a base fee according to meter size, which includes a quantity allowance of up to 4 ccf (ccf = 100 cubic feet). Customers also pay a per ccf unit rate for their monthly water use exceeding 4 ccf.

   In July 2008, the City Council decided to reduce the base quantity allowance for metered customers from 6 ccf to 4 ccf. At the same meeting, City staff also proposed a tiered rate structure, based on recommendations from the City's Water Rate Community Advisory

Committee. The City Council decided not to adopt this rate structure because of numerous concerns.

5-year Benchmarks:

- The City will continue to bill customers based, in part, on the quantity of water metered.
- The City intends to reduce the base quantity allowance from 4 ccf to zero ccf within the next 5 years.

5. **Leak detection and repair.** The City's average non-revenue water in 2008-2009 was 7 percent. Therefore, system leakage did not exceed 7 percent. Although the OWRD requires a leak detection and repair program only when leakage exceeds 10 percent, the City has a program to repair and replace water mains that leak.

Most of the distribution system water mains are relatively new ductile iron pipe with low potential for excessive leakage that were put in place during the City's recent period of rapid growth. Since 2004, City staff and contractors have conducted leak detection surveys of 45 to 50 miles of water mains. During 2005-2006, contractors conducting leak detection surveys found no sizable leaks, but did discover and repair two meters with small leaks. City staff have conducted leak detection using in-house electronic equipment and tested for leaks during valve and hydrant maintenance activities. In February 2009, the City tested the Bridge Creek transmission line for leakage. The City also works cooperatively with customers when leaks are discovered on the customer side of the meter, typically in the older galvanized service lines.

5-year Benchmarks:

- The City will continue to conduct leak detection surveys to monitor changes in pipe integrity over time.
- The City will continue to monitor customer consumption records for evidence of leaks and to work cooperatively with customers when leaks are discovered.
- The City will install AMI data technology at all of its meters, which will record hourly consumption and radio transmit that information to the City. This "real-time" information will help the City find and address leaks in the system on the customer side of the meter.

6. **Public education.** The City provides water conservation information through numerous media and programs.

__Web site.__ The City as a whole has been working to upgrade its Web site and to continuously update the online information. The Water Division Web site includes information on billing, lawn and garden irrigation regulations, water service and billing, water meters, forms and documents related to water use, water system master plans, and links to the WaterWise Web site that addresses water conservation. The same upgrading and updating work has been occurring with the City's WaterWise Web site (www.waterwisetips.org), which focuses on water conservation. The WaterWise Web site includes information on indoor water use, xeriscaping, rain gardens, and landscape watering. Publications have been continuously added to the Web sites and links have been changed regularly, added, or dropped as part of Web site management.

Public Outreach Through Events. The City sponsored or participated in at least four events per year during the last 5 years. Staffed events included: school events, various summer fairs, and outdoor events throughout the spring summer and fall. Water conservation materials provided to the public at these events have included publications, shower timers, and toilet leak detection tablets. Public speaking event requests vary each year. In addition, the City has sponsored or participated in school events and tours, but classroom visits and outreach at other events have been reduced because of staffing issues. Total contacts are estimated at 1,500 customers per year, based on literature taken by customers.

Furthermore, the City is increasing regional recognition that conservation is a priority by participating in the Central Oregon Cities Organization, Bend 2030 process, and the Deschutes Water Alliance.

Public Outreach Publications and Media. The City continues to provide information to the public using fact sheets, publications, its Web site, bill stuffers, City Edition Videos, and related outreach in partnership with the City Communications Manager. However, the creation of new or updated outreach materials has been significantly downscaled because of budget, staffing, and project priority changes.

The City continues to focus its water conservation outreach efforts on outdoor uses. The City maintains a display in the main lobby area at City Hall related to water use during the irrigation season. The City also developed an outdoor-oriented packet for its customers that includes WaterWise program handouts and rain gauges.

WaterWise Program. The City had to significantly reduce the WaterWise Program in 2005. This resulted in cuts in program staffing. The 2010 fiscal year budget re-established a new position at the program manager level to manage the City's water conservation benchmarks and to help develop, implement, and track related projects.

Customer Field Representative. The City discontinued the Customer Field Representative position in 2005 because of budget and management decisions. This position enforced the even-odd day watering restrictions and time-of-day watering restrictions, as well as addressed violations for wasting water. This work was based on drive-by monitoring and complaints to the City.

5-year Benchmarks:

- The City will continue to provide water efficiency and conservation outreach information to the public using print materials, radio, and video.
- The City will continue to update its Web site and outreach materials as needed.
- The City will explore the potential for development of cost-share partnerships between the City's three water utilities: water, stormwater, and wastewater. The

water and stormwater utilities have the potential to jointly hire an employee that can serve both programs.

Expanded Use under Extended Permits

OAR 690-086-0150(5)

This rule applies to municipal water suppliers that propose to expand or initiate diversion of water under an extended permit with a resource issue. The City has an extended permit (Permit G-8565), but this permit does not have resource issues as defined under 690-086-0140(5)(i). Furthermore, the City's average non-revenue water in 2008-2009 was 7 percent, and consequently, its system leakage is less than the 15 percent target specified by this rule. Nonetheless, the City has a leak detection and repair program under which City staff and contractors have conducted leak detection surveys of 45 to 50 miles of water mains since 2004.

Expanded Use under Extended Permits

OAR 690-086-0150(6)

Under OAR 690-086-0150(6), a water provider that serves a population greater than 7,500 must establish 5-year benchmarks for implementing a number of listed conservation measures or document that the measures are neither feasible nor appropriate. A summary of the 5-year benchmarks for additional conservation measures is provided in this section.

5-Year Benchmarks for Additional Conservation Measures

1. **Leak detection and pipeline repair and replacement.** The City's average non-revenue water in 2008-2009 was 7 percent. Therefore, system leakage does not exceed 10 percent. Although the OWRD only requires a leak detection and repair program to reduce leakage to 15 percent, or if feasible to 10 percent, the City has a program to repair and replace water mains that leak. The City's program is detailed in Leak Detection and Repair under OAR 690-086-0150(4).

   5-year Benchmark: As stated in Leak Detection and Repair under OAR 690-086-0150(4), the City will continue to conduct leak detection surveys to monitor changes in pipe integrity over time. The City will continue to monitor customer consumption records for evidence of leaks.

2. **Technical and financial** assistance. The City's technical and financial assistance program has had three components: large landscape program partnerships, large customer water audits, and indoor water use, which includes toilet tank leak detection and shower timers. Each of these previously used components and their related activities and accomplishments during the previous planning period is described in detail below.

City of Bend Large Landscape Program Partnerships
The City has developed partnerships with customers that have large landscapes requiring irrigation to help them improve their water conservation. The City helps these partners by providing technical and financial assistance in a variety of formats.

Bend Metro Parks & Recreation District
The City partnered with the Bend Metro Parks & Recreation District on various water conservation efforts. The City provided support to the district and included the district in its efforts to continue to move toward full use of new smart irrigation technologies.

Bend-La Pine School District
The City provided technical assistance to the Bend-La Pine School District to help fully upgrade and retrofit the district's irrigation systems after completion of a partial system audit. The City also provided technical assistance with development of new landscape standards and practices that the district recently adopted. When the district passed a recent bond levy, it used the new information to retrofit all major landscapes within the district.

Northwest Crossing Development, Palmer Homes
Like the Bend-La Pine School District, the Northwest Crossing development and Palmer Homes have adopted irrigation efficiency standards, such as the installation of smart irrigation controllers, use of pressure compensating irrigation sprinkler heads, and proper design and layout. These entities also advertised the use of smart irrigation controllers and efficient landscapes in their marketing materials. This included education efforts with preferred contractors and licensed landscapers doing work for their projects.

Oregon State Parks: Pilot Butte State Park
Through a now-expired agreement to deliver water to a large turf area at Pilot Butte State Park, the City was able to educate state staff and complete the first installation of a smart irrigation controller. The City provided Pilot Butte State Park with technical assistance and the required design standard information to implement use of the smart irrigation controller system at the park.

Water Audits for Large Use Customers
Water audits analyze a customer's water use and identify ways to make water use more efficient. The City funded the Irrigation Association to provide training for Certified Landscape Irrigation Auditors and more than 30 landscape professionals participated. The City invested approximately $5,000 on audit of sites at two schools in the Bend-La Pine School District. The district adopted some of the recommendations, including the use of smart irrigation controllers, proper nozzles, and head-to-head coverage. In addition, the schools now consider system zoning and pressure, have improved soil preparation, and use different turf varieties.

However, the City and water conservation studies[4] have found that audits generally were not cost-effective because customers are reluctant to pay for the audits or recommended improvements. As a result, the expense did not materialize into actual water savings.

Indoor Water Use

The Indoor Water Use component of the City's technical and financial assistance program has two components: toilet tank leak detection dye tablets and shower timers.

Toilet Tank Leak Detection Dye Tablets

To decrease leaks that occur on customer premises, the City distributes toilet tank leak detection dye tablets. The City has distributed toilet leak tablets to more than 2,500 customers per year during the past few years.

Shower Timers

Shower timers are small plastic devices that have a 5-minute sand-filled timer mounted to a rotating base. They are designed to adhere to the wall inside a shower using the attached suction cup and are rotated to start and restart the timer. The goal is to reduce both water and energy use by making shower users aware of their time in the shower. The City distributed more than 1,500 timers at schools and public events, and in the display booth set up in City Hall. Timers are also available by phone and e-mail request.

5-year Benchmarks:

- The City will continue efforts to develop and maintain WaterWise partnerships with large use customers during the next 5 years.
- The City will continue to distribute toilet tank leak detection dye tablets, shower timers, and related information to customers during the next 5 years.
- The City will conduct cost analysis aimed at the creation of cost-effective rebate programs within the next 5 years.
- The City will develop a pilot program for creation of water budgets for targeted customer groups, based on evapotranspiration data.
- The City will continue to fund and promote the use by all customers of the Agrimet weather station and its Web site, including a pilot project to place real time evapotranspiration data on the City Web site for use in creation of outdoor water use budgets.

3. Retrofit/replacement of inefficient fixtures.

City of Bend Landscapes

The City manages and maintains 136 landscape sites covering 439 acres, many of which require irrigation, and maintenance and management plans have been completed for all of

[4] HDR Technical Memorandum, *Conservation Program for Water Management and Conservation Plan,* December 8, 2010.

these landscape sites. Of these 136 landscape sites, 66 sites have been retrofitted with smart irrigation controllers. The City recently retrofitted 14 of those 66 sites as part of the City Landscape Retrofit Project. The sites of the 14 retrofits had their irrigation systems and/or landscapes altered or completely rebuilt to decrease maintenance and meet irrigation water savings goals, which often included reducing the area irrigated and xeriscaping. The City also completed a total retrofit of two cemeteries, including Greenwood and Pilot Butte Cemeteries. It replaced the original irrigation system with smart irrigation controlled timers and replacing sprinkler heads and related piping.

Toilet Efficiency
Many homes and business in the City were built before the federal high efficiency toilet (HET) standard of 1.6 gallons per flush was put in place in 1994. As a result, the need for a special program addressing toilet efficiency is reduced. The City considered conducting a retrofit program feasibility survey, but this did not occur because of staffing and budget limitations.

5-year Benchmarks:

- The City will continue to pursue greater irrigation efficiency of its existing City-owned landscapes and all new landscapes so they will meet the latest specification and standards, which includes the use of smart irrigation controller technology, xeriscaping principles, and other sustainable landscape practices.
- The City will study the cost effectiveness of implementing a toilet rebate replacement or incentive program based on the new voluntary federal HET standard.
- The City will become an EPA Water Sense Program partner and make related information available through its Web links, bill stuffers, and other methods.
- The City will provide a list of qualifying toilets that meet the various flush standards along with the creation of a toilet efficiency fact sheet.

4. **Water rate structure and billing schedule.** The City's water rate structure is related in part to its customers' water use. Customers pay a monthly base charge, which currently is based on meter size and includes a quantity allowance of 4 ccf before the quantity rate applies. Customers also pay a per unit rate for monthly water use exceeding 4 ccf.

   The City sends monthly bills to customers and supports water conservation by providing customers timely information about their water consumption. The City also includes water efficiency and conservation information with the bills. WaterWise is mentioned in almost every bill stuffer and content emphasizes at least one key message about water efficiency and conservation.

   5-year Benchmarks:

   - As stated in Unit-based Billing Program under OAR 690-086-0150(4), the City will continue to bill customers based, in part, on the quantity of water metered.
   - The City intends to reduce the base quantity allowance from 4 ccf to zero ccf within the next 5 years.

- The City also will continue to send monthly bills and to provide water efficiency and conservation information to the public with periodic bill stuffers and electronic messaging with related conservation information and links to the City's conservation Web site.

5. **Reuse, recycling, and non-potable water opportunities.** The Resort at Pronghorn, located down-gradient of the wastewater treatment plant, obtains recycled water from the City. Level 4 treated effluent from the wastewater treatment plant enters infiltration ponds and a spray irrigation system that waters two golf courses during the irrigation season. The City recently renewed its Water Pollution Control Facility permit with the DEQ that allows recycling of that City water. Pronghorn is not within the City's existing drinking water service area.

   In July 2010, the City completed a scope of work for a full-scale feasibility study that will investigate increasing the use of recycled water both inside and outside the City's service area.

   5-year Benchmark: During the next 5 years, the City will continue to look for opportunities to increase the use of recycled water.

6. **Other measures.**

   Irrigation Restrictions
   The City currently has even-odd irrigation restrictions and time of day water restrictions in place. Even house numbers water on even-numbered days and odd house numbers water on odd-numbered days. Irrigation hours are 5 a.m. to 10 a.m. and 4 p.m. to 10 p.m. No watering is allowed on the 31st day of the month. For a period of time, these policies were waived if someone installed an approved smart irrigation controller. These policies were put in place many years ago when the City used a flat rate water billing system and were designed to keep reservoirs from being drained by unlimited water use.

   Code changes are now under consideration in the next fiscal year and may include a recommendation to move away from the even-odd day irrigation restriction system, which is not currently enforced. The City would like to move exclusively to a time-of-day restriction that aims to provide an enforceable program that incentivizes smart water use, as well as off-peak irrigation time periods, to prevent or reduce the need for costly engineering improvements necessary to meet maximum demands in the morning and evening peaking periods.

   5-year Benchmark: Within the next 5 years, the City will evaluate adoption of modified irrigation restrictions based on time of day (hours that promote efficient water use).

   City Standards and Specifications
   The City recognizes that conservation and water efficiency standards need to be included in City contracts with landscaping and irrigation work, so the City currently is upgrading its related standards and specifications. The City also created a landscape standard, which is explained in an article in Water Efficiency Magazine called "There is no Silver Bullet" (available on the City's Web site).

5-year Benchmark: The City will continue to implement current landscape standards through related approval processes during the next 5 years.

Other WaterWise Partnerships

The City has also partnered on water conservation-related efforts with: Oregon Department of Energy, Local Area Water Network, Palmer Homes, Earth Advantage, High Desert Green Industry Conference, Upper Deschutes Watershed Council, AWWA, Building Green Council and 3E Strategies, Central Oregon Builders Association, ReSource, Rebuild America, Oregon State University (OSU) Extension, Central Oregon Community College (COCC), Bend Garbage and Deschutes County, Oregon Landscape Contractors Association, irrigation districts, Central Oregon Cities Organization, Deschutes Coordination Group, Deschutes River Conservancy, Oregon Association of Water Utilities, and Oregon Water Utility Council. While the City has created successful partnerships, the City's WaterWise program was drastically scaled back in 2005 to address only a few cases, such that an emphasis on building partnerships needs to be re-incorporated into the WaterWise campaign efforts.

5-year Benchmark: The City will continue to seek appropriate partnership opportunities based on current project priorities, budget, and staff time.

Collaboration Among the City's Water Utility Programs

The City has three water-related utilities (water utility, water reclamation, and stormwater programs) and several areas of regulatory responsibilities that are related to more efficient use of water and the benefits of conservation. The City has implemented a communication effort encompassing all of these areas and has promoted it as "WaterWise" programs. Collaborations include exploring how to combine funds from different programs to hire staff and present information on stormwater, safe drinking water, water conservation, and industrial pretreatment programs within the homepage of the City's WaterWise Web site and related efforts.

5-year Benchmark: The City will continue to look for coordination opportunities to more efficiently communicate and implement related programs.

Hydrant Meter Program for Temporary and Permanent Water Uses

Use of drinking water through typical unmetered locations, such as fire hydrants, for construction and other public uses, now comes under the authority of the Hydrant Meter Program. Use of hydrants now requires a permit and use of a temporary metered fill station that also includes backflow protection. All water is measured and billed. In addition, the City has installed one permanent fill station that has the added feature of a card-lock billing system to address the use of multiple users at one location. Contractors have the option of bringing their own water trucks to the fill stations to fill up with water as needed, or using the hydrant meter boxes.

5-year Benchmark: The City will continue to implement the hydrant meter program and related fill station.

Review and Implementation of Water Conservation Analysis Project
In December 2010, HDR Engineering (HDR) completed a water conservation analysis project for the City to examine opportunities to enhance its existing water conservation program. HDR is a national architectural, engineering, and consulting firm with strong expertise in water utility planning, including water conservation planning, and has performed water conservation work for numerous Pacific Northwest utilities. HDR used its proprietary Water Conservation Measure Analysis Model to analyze conservation opportunities for the City. The model is an Excel-based tool that estimates water savings and costs for various pre-loaded conservation measures based on specific information about the municipality. HDR's Water Conservation Opportunities memorandum, which is provided in **Appendix B**, presents more detailed information about HDR's modeling process and results.

HDR compiled demographic information for the City's service area, applied assumptions for customer participation rates for each conservation measure, calculated the savings achieved by shifting to more efficient hardware or behavior, and calculated the direct costs for those shifts. HDR established customer participation rates using professional judgment based on its experience with other communities.

HDR developed four "conservation packages." These packages included: (1) a conservation potential assessment of 37 of the 49 analyzed measures that were not mutually exclusive, which included both behavioral and "hardware" based measures; (2) hardware measures for both indoor and outdoor water conservation; (3) hardware measures for outdoor water conservation only; and (4) hardware measures for indoor conservation only.

5-year Benchmark: During the next 5 years, the City will work with the City Council and the City's Engineering Department to develop capital improvement and conservation budgets to identify which conservation measures to fund and implement.

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4. Municipal Water Curtailment Element

This section satisfies the requirements of OAR 690-086-0160.

This rule requires a description of past supply deficiencies and current capacity limitation. It also requires inclusion of stages of alert and the associated triggers and curtailment actions for each stage.

Introduction

Curtailment planning is the development of proactive measures to reduce demand during supply shortages as the result of prolonged drought or system failure from unanticipated events including catastrophic events (flooding, landslides, earthquakes, and contamination), mechanical or electrical equipment failure, or events not under control of the City (for example, localized or area-wide power outages and intentional malevolent acts).

History of System Curtailment Episodes

OAR 690-086-0160(1)

Within the last decade, the City has not experienced water shortages resulting from system failure related to catastrophic events or mechanical or electric equipment failure. The City, however, routinely has experienced a reduction in its access to surface water during the peak-demand season because of reduced stream flows. As described in Section 2, most of the City's surface water rights share priority dates with water rights held by TID and instream water rights established by TID in the allocation of conserved water process, and OWRD regulates these rights according to its distribution schedule when flows in the Tumalo Creek Basin are insufficient to meet all of the existing water demand. In these circumstances, the City has increased its reliance on its groundwater sources. Consequently, the City has not been required to implement curtailment measures.

The City is currently able to use its groundwater rights as needed to meet its water demands. Future groundwater use may be limited by system (well) capacities and groundwater restrictions in the Deschutes Study Area.

The City also has experienced occasional short-duration interruptions to normal service delivery as a result of pipe or water main breaking, lightening striking wells, and other mechanical or electrical malfunctions of its water supply and delivery system. In these events, the City has relied on its unaffected water sources, either surface water or groundwater, during the service interruption.

Curtailment Stages and Event Triggers

OAR 690-086-0160(2) and (3)

Depending on the nature of the event that results in a water supply shortage and considering predecessor and successor conditions, this curtailment plan for the City is designed to be initiated and implemented in progressive stages.

Events causing this curtailment plan to be activated would include, but not be limited to, the following:

- Abnormal weather conditions preceding the peak summer supply season that present a high likelihood for below normal summer streamflows in Bridge and Tumalo Creeks
- Declaration of a drought for Deschutes County by the Governor pursuant to ORS 536.720
- Catastrophic natural disaster that damages individual critical facilities or extensive portions of the City's distribution system
- Mechanical or electrical malfunction of critical pumping facilities at the City's surface water intake or wells
- Interruption of local utility electrical service
- Terrorist act perpetrated on any of the City's critical facilities or storage reservoirs, or contamination of source water

The current major risk to the City's surface water supply is fire within the Tumalo Creek watershed. A fire would elevate turbidity levels in the creek above applicable water quality standards, and preclude the City from using its surface water supply until the water quality improved. The City currently is working to mitigate this risk by developing a water treatment plant which, depending on the design of the system, may enable the City to continue to use surface water during high-turbidity events.

The City's curtailment plan has four distinct stages, each of which is triggered by one or more of the events listed above and is grouped as shown in **Exhibit 4-1**.

EXHIBIT 4-1
Curtailment Stages 1 through 4

Curtailment Stages	Initiating Conditions
Stage 1: **Water Shortage Alert**	• Forecasts of below normal summer streamflows • Forecasts of above normal temperatures • Minor damage to transmission mains or distribution system • Minor mechanical or electrical malfunction at one to three wells
Stage 2: **Mild Water Shortage** **Demand Reduction Target:** **10 percent of MDD**	• Supply capacity is 91 to 100 percent of demand • Mechanical or electrical malfunction at four to seven wells • Extended periods of above normal temperatures or below normal streamflows • Declaration of drought by Governor pursuant to ORS 536.720 • Extensive damage to water supply infrastructure
Stage 3: **Serious Water Shortage** **Demand Reduction Target:** **20 percent of MDD**	• Supply capacity is 81 to 90 percent of demand • Mechanical or electrical malfunction at 8 to 12 wells • Imminent terrorist threat against supply system • Multiple failures to transmission mains or distribution system
Stage 4: **Severe Water Shortage** **Demand Reduction Target:** **40 percent of MDD**	• Supply capacity is less than 81 percent of demand • Loss of utility electrical service to wells • Fire in Bridge Creek watershed or near wells • Contamination of source of supply • Extensive damage to transmission, pumping, or treatment processes caused by natural disaster or any other event • Intentional acts or fire, contamination of source, or any other event resulting in an immediate, sustained deprivation of water supply

Authority

The City Manager is authorized to determine the need for water curtailment and to declare a water curtailment stage. Plan provisions will remain in effect until the City Manager terminates the curtailment requirement. Actions may be applied to the entire system, or only to those water use sectors, or in those geographic areas that are directly affected by any water supply shortage. The City Manager is responsible for execution of the curtailment plan provisions after a water curtailment stage is declared.

Curtailment Plan Implementation and Enforcement

OAR 690-086-0160(4)

Stage 1: Water Shortage Alert

Triggers for Stage 1 include minor damage to the City's distribution system, and minor malfunctions at one to three wells. Stage 1 will activate a program to inform customers of the potential for drought or the need for temporary reductions in consumption because of reasons other than drought. The City Manager will issue a general request for voluntary reductions in water use by all water users. The request will include a summary of the current water situation, the reasons for the requested reductions, and a warning that mandatory cutbacks will be required if voluntary measures do not sufficiently reduce water usage. Stage 1 public information program elements would include the following:

- Contact local media outlets and request that the public be informed about the potential for summer water shortages or temporary interruptions to normal service delivery.
- Post prepared public service announcements, including conservation tips, on the City's Web page.
- Provide notices on water bills or through utility bill inserts.

Stage 2: Mild Water Shortage

Triggers for Stage 2 include supply capacity of 91 to 100 percent of demand, and extensive damage to water supply infrastructure. Stage 2 status will activate a program to reduce nonessential water use. In addition to Stage 1 voluntary measures, Stage 2 elements would include the following:

- Prohibit filling swimming pools and ponds.
- Prohibit washing sidewalks, driveways, and patios.
- Prohibit pressure washing roofs, decks, or home siding unless such uses were contracted before implementation of this curtailment action and are demonstrated to the City Manager's satisfaction to be necessary for painting, repair, remodeling, or reconstruction.
- Prohibit using water for dust control unless it is shown to the City Manager's satisfaction that water used for dust control is needed to meet public health or safety requirements including, but not limited to, abatement of fire or sanitation hazards, or to meet air quality standards mandated by DEQ.
- Encourage customers to refrain from washing cars except at commercial washing establishments that recycle or reuse water.

Stage 3: Moderate Water Shortage

Triggers for Stage 3 include supply capacity of 81 to 90 percent of demand, and multiple failures in the joints of the City's transmission mains. The voluntary measures in Stage 2 become mandatory in Stage 3. In addition to Stage 2 measures, Stage 3 elements would include the following:

- Prohibit washing vehicles except by commercial establishments or fleet washing facilities that recycle the water in their washing process, except where health, safety, and welfare of the public are contingent on frequent vehicle cleaning, such as for garbage trucks, and vehicles that transport food, or otherwise required by law.
- Prohibit water line testing and flushing in connection with construction projects, except for critical water facilities.

Stage 4: Severe Water Shortage

Triggers for Stage 4 include supply capacity of less than 81 percent of demand, and extensive damage to transmission, pumping or treatment processes. In addition to the elements included in Stage 3, the City Manager may impose any other restrictions on water use or activities that may require the need for water supplies. Under Stage 4, all water use, except uses necessary for human consumption and sanitation needs, may be prohibited if necessary.

If the event renders water in the system unsafe to drink, the City will activate appropriate response protocols, notify the local news media to solicit their assistance in notifying customers, and contact law enforcement officials, as appropriate.

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5. Municipal Water Supply Element

This section satisfies the requirements of OAR 690-086-0170.

This rule requires descriptions of the City's current and future service area and population projections, demand projections for 10 and 20 years, and the schedule for when the City expects to fully exercise its water rights. The rule also requires comparison of the City's projected water needs and the available sources of supply, an analysis of alternative sources of water, and a description of required mitigation actions.

Delineation of Service Areas

OAR 690-086-0170(1)

The City's existing water system serves the current UGB and the Tetherow Development, excluding those areas served by Avion and Roats. The areas currently served within the UGB and Tetherow Development, including 294 acres in the Juniper Ridge planned area, were used in calculating the 10-year demand projection for this Plan. The same area, in addition to the remaining 221 acres of the Juniper Ridge planned area, was used to develop the 20-year demand projection for this Plan. The current and future service areas are shown in **Exhibit 5-1.**

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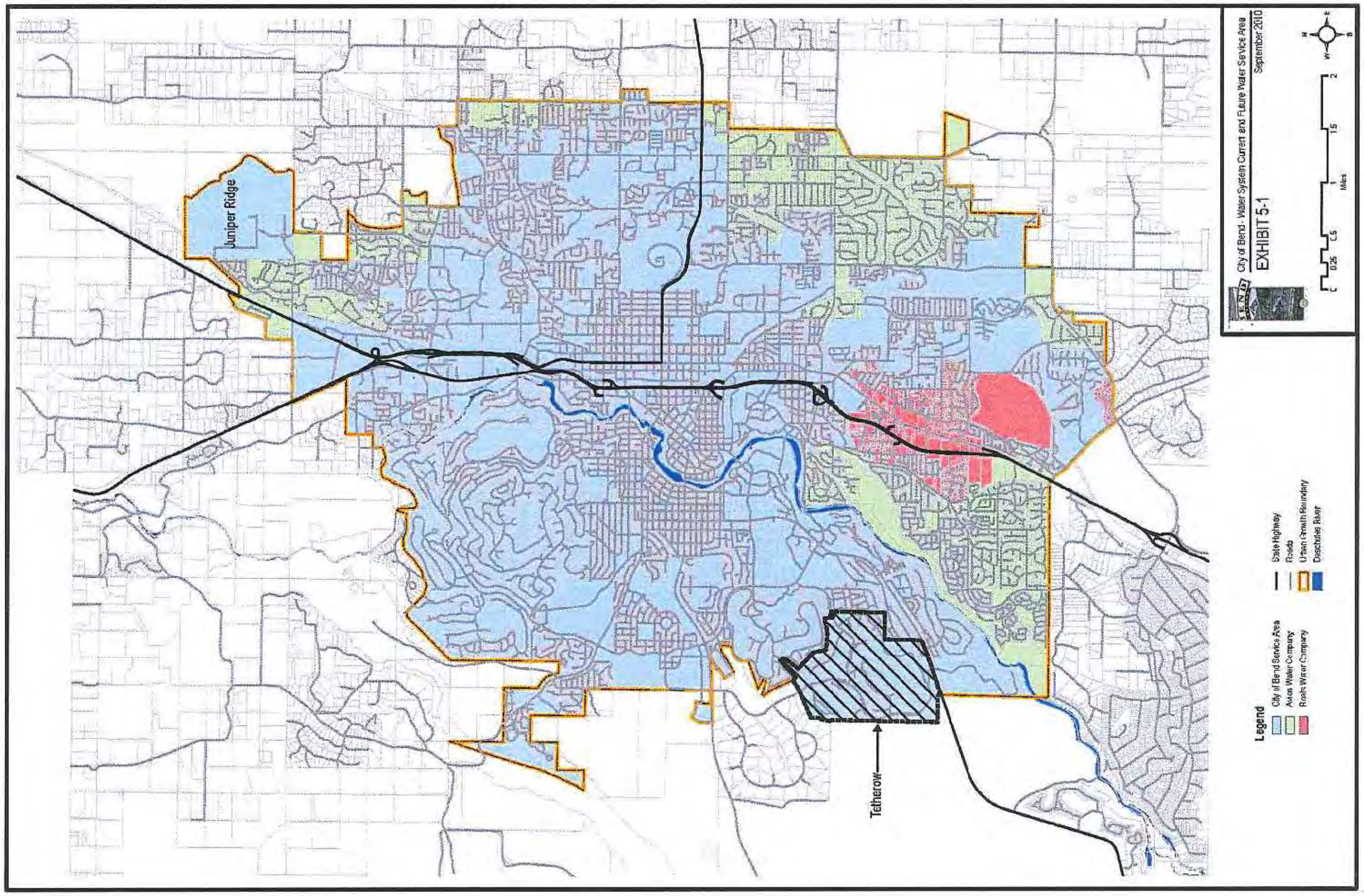
EXHIBIT 5-1
CITY OF BEND CURRENT AND FUTURE SERVICE AREA



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Population Projections

OAR 690-086-0170(1)

The 2004 to 2009 population for the City's water service area was estimated using the method described in Section 2. Future populations (2010 to 2030) within the City's service area were developed by increasing the service area population according to the annual growth rate for the City population as a whole. The annual growth rates for the City were those the City adopted from the Office of Economic Analysis' (OEA) April 2004 average annual growth rates for Deschutes County for 2000 to 2040. OEA bases its population forecast on demographic data, and assumptions about projected age-specific birth and age and sex-specific death rates for the existing population and in-migrants to the state and counties. (These growth rates were included in the *Deschutes County Coordinated Population Forecast 2000-2025*.)

Exhibit 5-2 summarizes the projected populations for 2020 and 2030.

EXHIBIT 5-2
Population Projections for the City of Bend and Bend Water Service Area

	2020	2030
City of Bend	104,501	123,567
Bend Water Service Area	79,748	94,298

These population projections were not used to develop the City's water demand forecasts. As described in detail below, demand forecasts were developed on the basis of projected land use development.

Demand Forecast

OAR 690-086-0170(3)

Future growth and water demand projections were calculated for the 2020 and 2030 planning horizons using growth rates from historical average water production records, as described in more detail below.

The specific spatial and water use data sets used in the development of demand projections for the City include:

- The Buildable Lands Inventory (BLI) database
- Planning and Land Use Information for the Tetherow Development
- Planning and Land Use Information for the Juniper Ridge Development
- 2008 water billing records for the City
- 1998-2008 production data for the City
- 2004 Deschutes County Coordinated Population Forecast

The City's BLI database indicates the total potential for, and spatial distribution of, residential growth based on low, medium, and high development densities; however, it does not indicate when it will occur. It also does not provide information on the density or rate of development for non-residential lands.

Build-out projections were generated for sizing ultimate water system infrastructure requirements as part of the City's Water System Master Plan Update Optimization Study; however, the date at which build-out occurs was not identified. Ten-year projections also were created as part of that project to assist in prioritizing the near-term improvements. To initially generate the 10-year projections, the following assumptions were made:

- Growth would be limited to the current urban growth boundary and Tetherow Development between 2010 and 2020.
- There would be a linear growth rate between 2010 and 2020.
- The BLI data would be used to spatially allocate demand.
- The ratio of residential to non-residential demand would remain constant through 2020.

The annual historic growth rate between 1998 and 2008 was calculated as shown in **Exhibit 5-3,** which illustrates that the City's growth in water demand has been highly variable during the past 10 years. At times, the City experienced rapid growth while at other times, a decline in water demand occurred. Overall, an average growth rate between 1998 and 2008 of more than 4 percent was measured.

EXHIBIT 5-3
Historical ADD and Percent Growth

Year	Historical ADD (mgd)	Annual % Growth
1998	8.6	
1999	10.2	18.60%
2000	10.7	4.90%
2001	10.6	-0.93%
2002	11.5	8.49%
2003	11.4	-0.87%
2004	11.5	0.88%
2005	11.3	-1.74%
2006	11.55	2.21%
2007	12.7	9.96%
2008	12.84	1.10%
Average		**4.3%**

ADD = average day demand

One of the primary challenges that the City faces in projecting future water demand is the lack of a precise service area population. An overall City population number is available; however, as previously described, the City does not serve water to the entire population. Therefore a per capita water usage number is difficult to calculate with certainty.

To calculate future demands using dwelling units identified in the BLI data, a gallons per capita per day per capita (gpcd) number was required. For planning purposes, the City assumes 2.4 people per household. A current per capita water usage was estimated by multiplying the number of active residential meters within the City's service area by 2.4 people per residential household and dividing by current water use for those meters. The per capita usage was calculated to be 172 gpcd, which includes a 10 percent peaking factor for non-revenue water (based on non-revenue water for 2008).

As described in the assumptions above, future non-residential water demand growth also was required. The basic assumption was made that the ratio of residential to non-residential water usage would remain constant through 2020. In 2008, non-residential demand accounted for 4.6 mgd of the 12.84 mgd overall demand in the City's service area, or 36 percent, based on customer billing records. Future non-residential water use rates were calculated at 4,000 gallons per acre per day, by using the existing calculated future non-residential demand divided by the non-residential acres to be developed. The one exception to this is the Juniper Ridge Development, where higher per acre water usage rates (4,500 gallons per acre per day) were used to accommodate the potential opportunity for water-intensive industry to develop there. While it is difficult to predict the water needs of future customers, the City has a duty to serve water within its service area. As a result, the City must be prepared to serve water to large industrial users with high water use needs should such water users locate within its service area.

To calculate the 2020 projections, the historical water demand growth rate of 4.3 percent was used as an overall 10-year target. To identify where the growth in the City is going to occur, the City's BLI data was used. The key was to identify a BLI-based development density that provided a 2020 demand similar to the 4.3 percent system-wide growth rate. For 2020 calculations, 2.4 people times 172 gpcd was multiplied by the number of parcels within the current UGB at medium density. Then the demand for the non-residential areas along with Tetherow Development and Phase 1 of the Juniper Ridge Development were included. The midpoint of demand between the median density developments value and existing demand yielded a spatial distribution of 2020 demand within the service area that was close to the total water demand target based on historical growth. The resulting demand is 21.7 mgd, compared to the 21.3 mgd generated by using a 4.3 percent per year growth rate. This yields a yearly increase in ADD of 0.74 mgd between 2010 and 2020.

Through discussions with City staff, it was determined that projecting the 4.3 percent per year growth through 2030 would generate demand numbers that were too aggressive. Lacking other information on when growth would occur, the 0.74 mgd per year growth through 2030 was determined to be the best available projection. This yields a 2030 ADD of 29.1 mgd, or 3.1 percent growth per year between 2010 and 2030.

Demand Projection Summary

Historical MDD factors also were developed for use in projecting future peak demands. The City's water system is designed so that the sources of supply equal or exceed MDD. Demands in excess of MDD are provided by storage tanks. Factors of 2.25 (MDD/ADD) for MDD were determined from historical data. The 2010, 2020, and 2030 ADD values and peaking factors were used to determine the future MDD projections.

See **Exhibits 5-4 and 5-5** for future ADD and MDD.

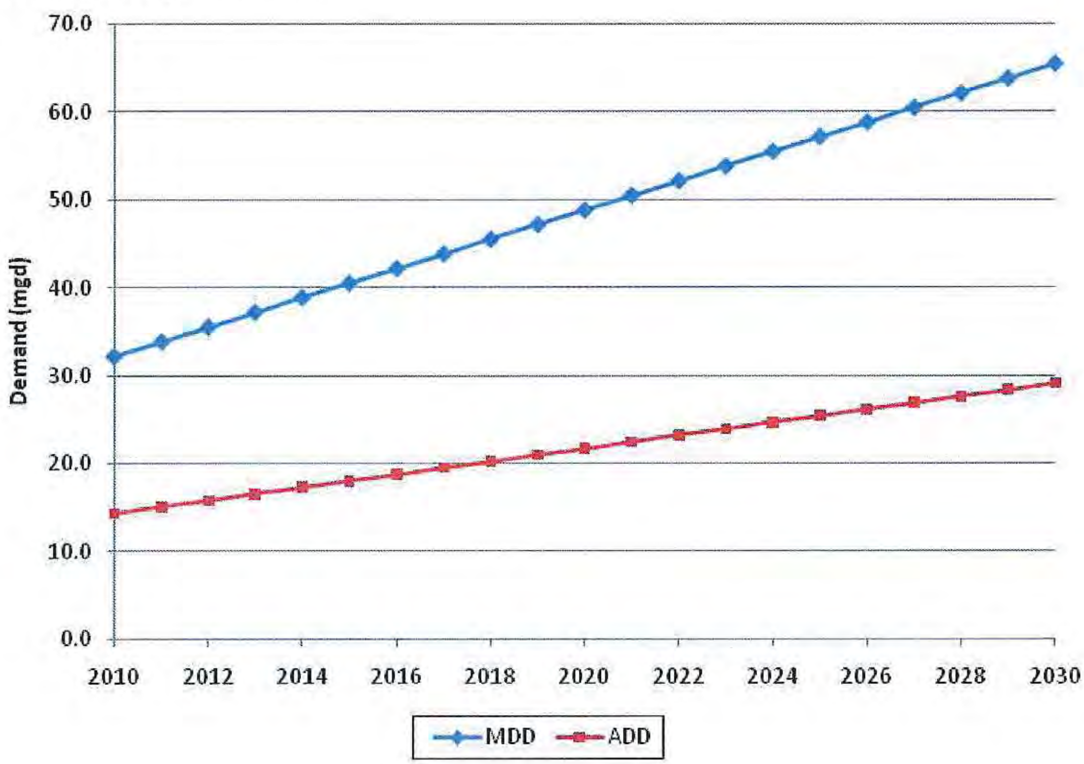
EXHIBIT 5-4
Future Demands for the City's Water Service Area (mgd)

Year	ADD	MDD
2010	14.3	32.2[1]
2020	21.7	48.8
2030	29.1	65.5

[1] The City's actual 2010 MDD was approximately 20 percent less than the projected MDD for that year. The reduced demand compared to the projections is likely due to the cool, wet weather during the spring and summer of 2010, the City's recent efforts to optimize system operations, as well as less demand due to the current economic downturn.

Using this annual growth rate of 0.74 mgd per year, the ADD values for each year from 2010 through 2030 were calculated and the peaking factors for MDD were used to obtain the values in **Exhibit 5-5.**

EXHIBIT 5-5
2010 to 2030 Projected Demands



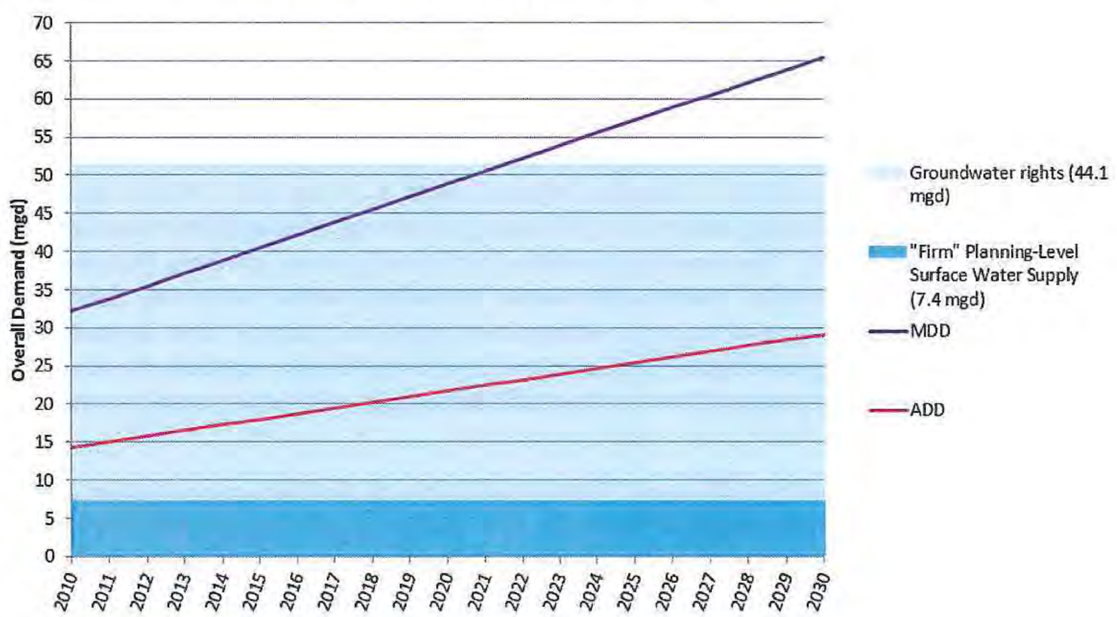
Schedule to Exercise Permits and Comparison of Projected Need to Available Sources

OAR 690-086-0170(2) and (4)

The City holds surface water rights that authorize the use of up to 36.1 cfs (23.3 mgd). As described in Section 2, the amount of surface water available to the City is directly related to the amount of flow in Tumalo Creek and the proportional distribution of that water between TID, instream water rights established as part of TID's conserved water projects, and the City. For the purposes of planning for the amount of surface water available to meet peak needs, the City evaluated historic stream flows in Tumalo Creek to establish a likely low-flow scenario. Under that evaluation it was determined that a stream flow of 42.5 cfs and a proportional share for the City of 11.5 cfs (7.4 mgd) should be the "firm" planning-level peak demand surface water supply. The City also holds groundwater rights authorizing use of 68.2 cfs (44.1 mgd). The City's surface water and groundwater rights combined provide a planning-level reliable water supply of 79.7 cfs (51.5 mgd).

Exhibit 5-6 shows the City's "firm" surface water and groundwater rights superimposed on the City's projected ADD and MDD. As shown in Exhibit 5-6, the City may need up to approximately 65.5 mgd to meet its MDD by 2030. The water supply provided by the City's existing water rights, however, currently can be relied on in a low-streamflow, high demand scenario to provide approximately 51.8 mgd of supply. Consequently, the City will need to fully exercise its existing water rights and may need additional water supply to meet its projected 2030 MDD.

EXHIBIT 5-6
Projected Demands and Reliable Supply under the City's Existing Water Rights



Based on projected water demand growth, the City anticipates fully exercising all of its existing surface water and groundwater rights during the next 20-year planning period.

As part of its effort to meet projected demand, the City will need access to the full amount of its Permit G-8565. Therefore, the City is requesting access to the 0.72 cfs of "green light water" under "extended permit" G-8565.

Alternative Sources

OAR 690-086-170(5)

OAR 690-086-0170(5) requires an analysis of alternative sources of water if any expansion or initial diversion of water allocated under existing permits is necessary to meet future water demand. During the next 20-year planning period, the City intends to expand or initiate diversion of water under existing Permits G-8565, G-11379, G-16177, and G-16178 to meet future water demands described above. (Groundwater permit G-4435 is fully developed and will be certificated in the near future.)

During the past several years, the City has spent significant resources evaluating its water supply needs and supply alternatives. Through a series of extensive water supply planning efforts, associated with the City's Watershed Source Water Improvements project, the City has affirmed its commitment to a dual source supply: gravity-fed surface water from Bridge and Tumalo Creeks under its existing water rights to meet base demands; and groundwater to meet current and future peak needs. As part of this process, the City has evaluated these supply sources in terms of cost, availability, reliability, feasibility, and likely environmental impacts.

Meeting future demand during the 20-year planning period from "new" surface water rights is not feasible. Surface water in the Deschutes Basin is fully appropriated and not available.

With respect to groundwater, obtaining a "new" groundwater right currently appears unlikely for the following reasons. In 2001, the U.S. Geological Survey (USGS) published a hydrologic study for the Deschutes Basin[5] and concluded that virtually all groundwater not consumptively used in the Upper Deschutes Basin discharges to surface water near Pelton Dam. Further, much of the Deschutes River is protected under the Oregon Scenic Waterways Act, which requires maintenance of the "free-flowing character of the scenic waterway in quantities necessary for recreation, fish and wildlife." The conclusions of the USGS study raised concern that new groundwater withdrawals could "measurably reduce" mandated scenic waterway flows. Therefore, OWRD adopted special rules providing for mitigation of stream flow impacts as a condition of granting new groundwater rights in the Deschutes Basin to address the scenic waterway concerns and the potential for substantial interference with other surface water rights.

OWRD's rules close the Deschutes Ground Water Study Area to further appropriation except for a cumulative total of 200 cfs maximum rate for final orders approving groundwater permit

[5] Gannett, M.W., Lite, Jr., K.E., Morgan, D.S., and Collins, C.A., 2001, Ground-water hydrology of the upper Deschutes Basin, Oregon: U.S. Geological Survey Water-Resources Investigations Report 00-4162 ("USGS Study"): http://pubs.usgs.gov/wri/wri004162/.

applications issued after the effective date of the rules. OWRD estimates that all 200 cfs of the "cap" have been claimed, meaning that other than applications already in the queue and under the 200 cfs cap, no new groundwater permits will be issued in the Deschutes Basin Ground Water Study Area. It is unclear whether this cap will be modified.

Further, OWRD's mitigation program rules are set to expire on January 2, 2014. It is difficult to predict whether legislation to extend the program (and perhaps to increase the cap) would be enacted. Without the legislation, and without an administrative program, it is unclear how OWRD would evaluate new groundwater permit applications in the Deschutes Basin.

Therefore, the full exercise of the City's existing permits is the most feasible and reliable alternative in the near term. Additionally, because the City must provide mitigation to offset the impacts of this groundwater use on surface water for its two newest and biggest permits, the likely environmental impacts of this water use are limited.

The following discussions analyze the extent to which the City can meet its projected water need through other alternatives.

Conservation Measures

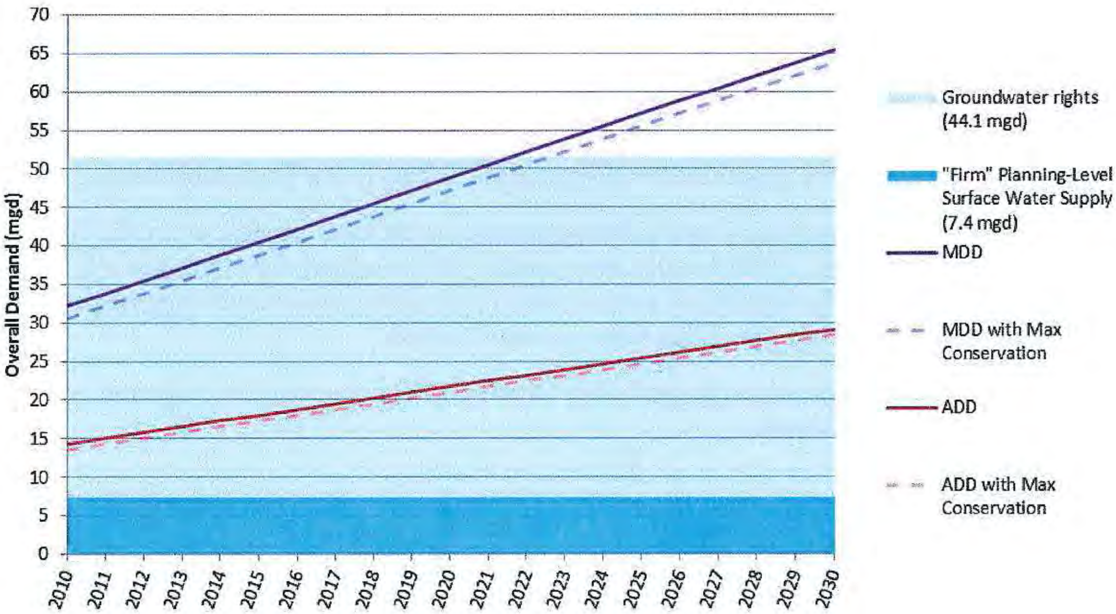
OAR 690-086-170(5)(a)

As described in Section 3, HDR developed a water conservation analysis evaluating 49 conservation measures to determine costs, predict participation rates, and evaluate water savings. HDR's analysis projected that if the City implemented the 37 conservation measures analyzed that were not mutually exclusive, the City could save 740,000 gallons per day (gpd) on an annual average basis, and 980,000 gpd on a peak season (April through October) basis. (Appendix B contains HDR's conservation analysis report.)

Exhibit 5-7 presents the total projected ADD and MDD compared to the City's reliable water rights, as well as the ADD and MDD considering implementation of all of these conservation measures. The latter demand projections were developed on the basis of HDR's conservation analysis. The ADD with conservation was estimated by reducing the projected ADD by 740,000 gpd. The projected MDD with conservation was estimated by multiplying the projected ADD with conservation values by the MDD/ADD peaking factor of 2.25. Although HDR projected these water use reductions to be the maximum savings during the course of a 10-year planning period, for the purposes of Exhibit 5-7, these savings rates were continued throughout the 20-year planning period for this WMCP to represent the maximum savings potential likely to be available through conservation.

HDR estimated the total direct cost for implementing all of these conservation measures to be approximately $3 million. This figure does not include staff and related overhead costs to implement the conservation measures. Because this cost exceeds its current conservation budget, the City will be working with the City Council during the next 5 years to develop capital improvement and conservation budgets and to determine which conservation measures to implement, as further described in Section 3.

EXHIBIT 5-7
Projected ADD and MDD and City of Bend Water Rights, Including Conservation



As shown in Exhibit 5-7, implementing all of the analyzed conservation measures that were not mutually exclusive would provide a slight reduction in the City's MDD. However, this reduction is not sufficient to alleviate the City's need to fully exercise its existing permits within the 20-year planning period.

Interconnections

OAR 690-086-170(5)(b)

The City currently has interconnections with Avion and Roats, as described in Section 2. The interconnections with Avion and Roats are considered only for emergency water supply conditions, so these interconnections are not being included as part of the City's water supply portfolio, and will not alleviate the City's need to fully exercise its existing water use permits described above within the 20-year planning period.

Cost Effectiveness

OAR 690-086-170(5)(c)

OAR 690-086-170(5)(c) requires an assessment of whether the projected water needs can be satisfied through other conservation measures that would provide water at a cost that is equal to or less than the cost of other identified sources. However, as described above, even if the

City implemented all of the non-mutually exclusive conservation measures considered by HDR as part of its Water Conservation Analysis Project (without regard to cost), the conservation savings would be insufficient to alleviate the City's need to fully exercise its existing water use permits during the 20-year planning period.

Quantification of Maximum Rate and Monthly Volume

OAR 690-086-0170(6)

OAR 690-086-0170(6) requires a quantification of the maximum rate of withdrawal and maximum monthly use if expansion or initial diversion of water allocated under an existing permit is necessary to meet demands in the 20-year planning horizon. The City anticipates expanding its use of the following permits: G-8565, G-11379, G-16177, and G-16178 to meet peak demands. As previously noted, groundwater permit G-4435 is fully developed and will be certificated in the near future. When calculating the maximum rate and monthly volume for each permit, the entire portion of the right in permit status was considered, rather than only the currently undeveloped portion of the right.

The City is projected to require the maximum authorized rate of 0.94 cfs for the portion of Permit G-8565 still in permit status within the next 20 years to meet the City's projected water demands. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-8565 would be approximately 18.2 MG.

The City also anticipates requiring the full 3.84 cfs maximum authorized rate for Permit G-11379 within the next 20 years. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-11379 would be approximately 74.4 MG.

In addition, the City anticipates requiring the full 12 cfs maximum authorized rate for Permit G-16177 within the next 20 years. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-16177 would be approximately 232.7 MG. The volume of water appropriated under Permit G-16177 must be accompanied by the required corresponding mitigation.

Finally, the City anticipates requiring the full 12 cfs maximum authorized rate for Permit G-16178 within the next 20 years. Assuming that this permit is used at the maximum rate 24 hours per day for 30 days during the maximum month, the maximum monthly volume for Permit G-16178 would be approximately 232.7 MG. The volume of water appropriated under Permit G-16178 must be accompanied by the required corresponding mitigation.

Mitigation Actions under State and Federal Law

OAR 690-086-0170(7)

Under OAR 690-086-0170(7), for expanded or initial diversion of water under an existing permit, the water supplier is to describe mitigation actions it is taking to comply with legal requirements of the Endangered Species Act, Clean Water Act, and other applicable state or federal environmental regulations. The City currently is not required to take any mitigation actions under federal law. The City must provide mitigation credits as part of the Deschutes Basin Mitigation Program to offset the impacts to surface water of the consumptive portion of its use of groundwater under Permit G-16177 and Permit G-16178. The City has an approved incremental mitigation plan and will continue to use water under these two permits in compliance with the mitigation plan.

Alternative Sources

OAR 690-086-170(8)

OAR 690-086-0170(8) requires an analysis of alternative sources of additional water if acquisition of new water rights will be necessary within the next 20 years to meet the projected water demands. At this time, the City does not have any new water right applications pending. The City is currently engaged in two major projects that could have significant impacts on how the City provides water to meet projected demands. These studies are: (1) the Watershed Source Water Improvements and (2) Water System Master Plan Update Optimization Study – Final Report, Draft December 2010. In addition, the Deschutes Basin mitigation program "cap" of 200 cfs has been met and the program rules are scheduled to sunset January 2, 2014. Whether this program is extended will significantly affect how the City meets its future water demands. Moreover, during the next 5 years, the City will be developing capital improvement and conservation budgets and will be selecting and implementing additional conservation measures. Based on the results of these efforts, the City will reevaluate the supply necessary to meet projected demands, and reassess future water source alternatives. The City anticipates providing an updated water demand and source availability comparison that includes the City's long-term water supply source(s) with its 5-year update to this Plan.

Appendix A

Local Government Letter

GSI
Water Solutions, Inc.

December 1, 2010

Paul Blikstad, Senior Planner
Deschutes County - Planning Division
117 NW Lafayette Avenue
Bend, OR 97701

Subject: Water Management and Conservation Plan for the City of Bend

Dear Mr. Blikstad:

The City of Bend has developed a Draft Water Management and Conservation Plan (WMCP). The City has prepared this plan to fulfill the requirements of Oregon Administrative Rule Chapter 690, Division 86 of the Oregon Water Resources Department (OWRD).

Under these rules, a water supplier is required to make its draft plan available for review by each affected local government and seek comments relating to consistency with the local governments' comprehensive land use plans. Please find enclosed a copy of the City's Draft WMCP. Although we expect to make minor revisions to this document prior to submission to OWRD, any changes will not affect the plan's consistency with Deschutes County's comprehensive land use plan.

Please provide comments to me by no later than December 31, 2010. If the plan appears consistent with your agency's Comprehensive Land Use Plan, a letter response to that effect would be appreciated. You may send your comment to me at the address on this letterhead or e-mail them to me directly at: asussman@gsiwatersolutions.com.

If you have any questions, please feel free to contact me. My telephone number is 541-753-0745, extension 201. Thank you for your interest.

Sincerely,

Adam Sussman
Senior Water Resources Consultant

Enclosure

Appendix B

HDR Water Conservation Opportunities Memorandum

Technical Memorandum

HDR

To:	**Patrick Griffiths and Ric Olson; City of Bend**
From:	**Kelly O'Rourke and Joe Miller; HDR, Inc.**
CC:	**Ronan Igloria; HDR, Inc.**
	Adam Sussman and Suzanne Moellendorf; GSI, Inc
Date:	**December 8, 2010 - FINAL**
Subject:	**Conservation Program for Water Management and Conservation Plan HDR Project #139138**

HDR performed a water conservation analysis project for the City of Bend. The purpose of the project was to examine opportunities to enhance Bend's existing water conservation program. The information will be used to potentially refine the City's program and to update portions of its *Water Management and Conservation Plan*. The work was done as a sub-consultant to GSI Water Solutions, Inc. (GSI). The scope of HDR's work focused on demand-side conservation measures.

This technical memorandum includes the following three sections:

1. **Conservation Background:** This section provides an overview regarding water conservation, which provides context for the analysis performed for this specific project. This section also summarizes Bend's current water conservation efforts.

2. **Analysis Methodology:** This section describes the methodology used to analyze the conservation measures, describes the conservation measures analyzed, documents key assumptions, and documents demographic and consumption data inputs.

3. **Results and Conclusions:** This section provides results of the initial analysis for each individual conservation measure, provides results of conservation "packages", and provides conclusions regarding the analysis. ***(Section 3.6 contains the conclusions; for readers interested primarily in the conclusions please refer to that section, which begins on page 25.)***

1 Conservation Background

1.1 Conservation Overview

Water conservation is defined as the management of water resources so as to eliminate waste and maximize efficient use of the resource. Conservation can be divided into many categories, as shown in Table 1. It is important to understand these categories since the cost structure, longevity of savings, certainty of savings, and social impacts vary across the categories.

Table 1 Conservation Categories

Measures (Saves water)		Incentives (Motivates Customers to save water)		
Hardware	**Behavior**	**Educational**	**Financial**	**Regulatory**
More efficient equipment. *Example: Install high efficiency toilets.*	More efficient behaviors. *Example: Take shorter showers.*	Explain why and how to save water. *Example: Conservation tips brochure.*	Make saving water financially attractive. *Example: Use inverted block rate structure.*	Require conservation actions. *Example: Require retrofit to code upon resale.*

Conservation is first divided into two categories: measures and incentives. Measures save water in and of themselves, while incentives motivate customers to save water. Measures are divided into hardware and behavior. Hardware measures entail using more efficient equipment, while behavioral measures entail promoting behavior changes toward more efficient practices. Hardware measures tend to be more expensive, but have longer lasting savings and a higher certainty of savings, compared to behavioral measures. Incentives can be divided into three categories: educational, financial, and regulatory. Educational incentives explain why and how to save water. Financial incentives make saving water financially attractive. Regulatory incentives are mandatory requirements for conservation actions. Examples for each type of measure and incentive are provided in Table 1.

Conservation can be achieved on both the supply-side and demand-side. Supply-side conservation is associated with a utility's conveyance and distribution infrastructure such as leak detection and repair. Demand-side conservation is associated with the water user such as homeowners installing high efficiency toilets.

A utility's conservation program should reflect the reasons why the utility is implementing conservation and the utility's water use patterns. Typical conservation drivers include: 1) meeting regulatory requirements, 2) demonstrating stewardship, 3) decreasing operating costs, 4) deferring/avoiding capital costs, and 5) extending available supplies. The utility's conservation drivers and water use patterns shape which measures and incentives to implement, the saving goal, the appropriate budget, and whether to focus on supply-side or demand-side efforts.

Table 2 shows how a utility's conservation driver determines the strategy for its conservation program.

Table 2 Conservation Driver Determines Conservation Strategy

Conservation Driver	Conservation Program Strategy
Meet Regulatory Requirement	Implement the required level of conservation.
Demonstrate Stewardship	Implement more than the required level of conservation.
Decrease Operating Costs	Implement conservation that is more cost-effective than the variable cost of supplying water.
Defer/Avoid Capital Costs	Implement the amount of conservation necessary to obtain the savings required to defer/avoid capital costs.
Extend Available Supplies	Implement conservation that is more cost-effective than the cost of developing new traditional supply.

1.2 Bend's Current Conservation Program

Most of the conservation drivers discussed above applies to Bend. The City is committed to meeting all regulatory requirements related to conservation. The City understands the environmental benefit of leaving water instream and in the aquifer and is interested in going beyond regulatory commitments to demonstrate strong stewardship of the resource. Bend is also interested in conservation as a mechanism to defer or avoid capital costs and to extend available supplies.

Bend's current conservation program features both supply-side and demand-side efforts and includes both measures and incentives. A summary of the major elements of the program are listed in Table 3. A more detailed summary of Bend's conservation program will be provided in the *Water Management and Conservation Plan* being prepared by GSI.

Table 3 Major Elements of Conservation Program

Supply-Side Elements	Demand-Side Elements
• Source and customer metering • Meter calibration and replacement • Annual system water audits • Pipeline leak detection	• Public education and outreach • Irrigation programs to promote and/or fund controllers, rain sensors, native plants, and audits • Toilet leak detection tablets

The materials and services budget for the City's conservation program is approximately $50,000 annually for communication and outreach. This does not include staffing costs. The City does not currently have budget allocated for direct costs such as rebates or hardware purchases.

2 Analysis Methodology

2.1 Basic Method

The methodology for determining water savings and costs for Bend is generally the same for all conservation measures. The basic method is to compile demographic information for Bend's service area, apply assumptions for customer participation rates for each conservation measure, calculate the savings achieved by shifting to more efficient hardware or behavior, and calculate the costs for those shifts.

HDR's proprietary Water Conservation Measure Analysis Model was used for this analysis. The model is an Excel-based tool that estimates the water savings and costs for various demand-side water conservation measures. The spreadsheet is pre-loaded with a set of commonly analyzed conservation measures. The spreadsheet is customized for clients by entering client-specific data (e.g., planning period, demographics, and water consumption) and selecting which of the pre-loaded measures should be analyzed. The spreadsheet analyzes the measures and provides summary tables and graphs. Various program "packages" can also be created based on the analyzed measures to represent potential conservation scenarios.

The costs for a conservation program can be divided into the three categories shown below. The HDR model only incorporates the direct costs incurred by the utility.

- **Direct Costs:** This includes rebates paid to customers (e.g., clotheswasher rebates), purchasing fixtures to give to customers (e.g., efficient showerheads), and paying for professional audits (e.g., outdoor irrigation audits).

- **Indirect Costs:** This includes marketing and distribution costs that necessary to implement the measures, such as graphic design, printing, postage, and advertising. The exact nature of the marketing and distribution techniques that will eventually be implemented is often unknown during the measure analysis work. Therefore, the indirect costs are not included in HDR's model. However, Bend should plan to budget for indirect costs, which, as a general rule, can be 10-20% of the direct costs.

- **Staff Costs:** This includes the salary and benefits for City staff assigned to plan, manage, and implement the conservation program. Some water utilities include staff costs in their official conservation budget, while others do not. Regardless of whether staff costs appear in the official conservation budget, the "opportunity cost" should be recognized in that staff time allocated to a conservation program is not available for other utility functions.

The initial results from the model are simply the outcomes of the analysis for every conservation measure, considered independently of the other measures. Those results, by themselves, do not indicate which measures should be implemented. The initial results must be coupled with Bend's conservation driver and screened through various criteria in order to determine which measures and/or groups of measures ("packages") are most appropriate.

2.2 Measures Analyzed

The measures analyzed for this project are described below.

- **Clotheswashers - Efficient Residential Capacity (In Unit):** Provide partial rebates to replace less efficient residential-capacity clotheswashers (located in housing units) with more efficient models. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per clotheswasher. The model assumes one rebate per participating household.

- **Clotheswashers - Efficient Residential Capacity (Common Area):** Provide partial rebates to replace less efficient residential-capacity clotheswashers (in common laundry areas) with more efficient models. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per clotheswasher. The model assumes one rebate for every five multifamily households for participating multifamily accounts.

- **Clotheswashers - Efficient Commercial Capacity:** Provide partial rebates to replace less efficient commercial-capacity clotheswashers with more efficient models. The participation rate for this measure was set at 25%. The direct cost is a $250 rebate per clotheswasher. The model assumes 12 rebates per participating non-residential account.

- **Clotheswashers - Decrease Partial Loads:** Encourage customers to reduce partial loads of laundry, thereby reducing the number of loads by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.

- **Faucets - 0.5 gpm Bathroom Aerators (Residential):** Provide free 0.5 gpm bathroom faucet aerators, which for the residential customer category is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 10%. The direct cost is $1 per aerator. The model assumes 2.5 aerators per participating single family household and 1.5 aerators per participating multifamily household.

- **Faucets - 0.5 gpm Bathroom Aerators (Non-Residential):** Provide free 0.5 gpm bathroom faucet aerators, which for the non-residential customer category is the maximum allowed under the plumbing code. Brings non-code customers up to code. The participation rate for this measure was set at 30%. The direct cost is $1 per aerator. The model assumes 2.1 aerators per participating non-residential account.

- **Faucets - 1.0 gpm Bathroom Aerators:** Provide free 1.0 gpm bathroom faucet aerators, which for the residential customer category is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $1 per aerator. The model assumes 2.5 aerators per participating single family household and 1.5 aerators per participating multifamily household.

- **Faucets - 1.5 gpm Bathroom Aerators:** Provide free 1.5 gpm bathroom faucet aerators, which for the residential customer category is more efficient than the maximum of 2.5

gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $1 per aerator. The model assumes 2.5 aerators per participating single family household and 1.5 aerators per participating multifamily household.

- **Faucets - Decrease Use:** Encourage customers to reduce unnecessary faucet use, such as running the water while brushing teeth, thereby reducing combined bathroom and kitchen faucet use by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.

- **Showerhead 1.5 gpm:** Provide free 1.5 gpm showerheads, which is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $3 per showerhead. The model assumes 2.0 showerheads per participating single family household, 1.5 showerheads per participating multifamily household, and 10 showerheads per participating non-residential account.

- **Showerhead 2.0 gpm:** Provide free 2.0 gpm showerheads, which is more efficient than the maximum of 2.5 gpm allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is $3 per showerhead. The model assumes 2.0 showerheads per participating single family household, 1.5 showerheads aerators per participating multifamily household, and 10 showerheads per participating non-residential account.

- **Showerheads - Decrease Use:** Encourage customers to reduce showering time by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.

- **Spray Valves - 1.25 gpm Pre-Rinse Spray Valve:** Provide free, direct installation of 1.25 gpm pre-rinse spray valves, which is more efficient than the maximum of 1.6 gpm allowed under the plumbing code. Pre-rinse spray valves are used in commercial kitchens to rinse dishes prior to loading into dishwashers. The participation rate for this measure was set at 95%. The cost is $130 per spray valve. Due to the direct install nature of this measure, that cost includes both direct and indirect costs. The model assumes 1.5 spray valves per participating non-residential account.

- **Toilets - 1.28 gpf High Efficiency Toilets (HET):** Provide partial rebates to install High Efficiency Toilets (HETs), which is better than the maximum of 1.6 gpf allowed under the plumbing code. HETs are defined as toilets flushing at a maximum of 1.28 gpf. HETs include both dual flush toilets and pressure-assist tank style toilets. The participation rate for this measure was set at 10%. The direct cost is a $100 rebate per residential toilet and a $150 rebate per non-residential toilet. The model assumes 2.3 rebates per participating single family household, 1.8 rebates per participating multifamily household, and 4.2 rebates per participating non-residential account.

- **Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT):** Provide partial rebates to replace less efficient toilets with 1.6 gpf Ultra Low Flow Toilets (ULFT), which is the maximum allowed under the plumbing code. Brings non-code customers up to code. The participation rate for this measure was set at 30%. The direct cost is a $75 rebate per toilet. The model assumes 2.3 rebates per participating single family household, 1.8 rebates per participating multifamily household, and 4.2 rebates per participating non-residential account.

- **Toilets - Decrease Flushes:** Encourage customers to reduce unnecessary toilet flushing, such as flushing trash, thereby reducing toilet flushes by 10%. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.

- **Toilets - Leak Detection:** Provide free toilet leak detection dye tablets to determine if toilets leak and provide information on how to fix leaks. The participation rate for this measure was set at 25%. The direct cost is $0.10 per packet of dye tablets. The model assumes 2.3 dye tablet packets per participating single family household and 1.8 dye tablet packets per participating multifamily household. Toilet leak detection dye tablets can be considered both a behavioral and a hardware measure. It fits the definition of a behavioral measure in that customers must take action to repair a found leak; it fits the definition of a hardware measure in that the fix to a leaky toilet is a piece of hardware. Bend staff classify it as a hardware measure and therefore it appears in the "hardware" packages.

- **Urinals - Waterless Models:** Provide partial rebates to install waterless urinals, which is better than the maximum of 1.0 gpf allowed under the plumbing code. The participation rate for this measure was set at 5%. The direct cost is a $150 rebate per urinal. The model assumes 2.1 rebates per participating non-residential account.

- **Urinals - 0.5 gpf Models:** Provide partial rebates to install 0.5 gpf urinals, which is better than the maximum of 1.0 gpf allowed under the plumbing code. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per urinal. The model assumes 2.1 rebates per participating non-residential account.

- **Urinals - 1.0 gpf Models:** Provide partial rebates to replace less efficient urinals with 1.0 gpf urinals, which is the maximum allowed under the plumbing code. Brings non-code customers up to code. The participation rate for this measure was set at 30%. The direct cost is a $100 rebate per urinal. The model assumes 2.1 rebates per participating non-residential account.

- **Irrigation Controllers - ET Model:** Provide partial rebates for evapotranspiration (ET) based irrigation controllers, which link irrigation to weather conditions. The participation rate for this measure was set at 25%. The direct cost is a $250 rebate per controller for single family customers and a $500 rebate per controller for multifamily and non-residential customers. The model assumes one rebate per participating single family household, multifamily account, and non-residential account.

- **Irrigation Controllers - Rain Sensors:** Provide free rain sensors, which turn off automatic irrigation systems when it is raining. This is only applicable to irrigation systems that can use rain sensors. The participation rate for this measure was set at 25%. The direct cost is a $100 rebate per rain sensor. The model assumes one rebate per participating single family household, multifamily account, and non-residential account.

- **Lawn Dormant:** Encourage customers to let their lawn go dormant in the summer. It should be noted that allowing lawns to go dormant during the summer does not eliminate lawn watering completely. Dormant lawns still require some water to stay alive. The participation rate for this measure was set at 10%. There are no direct costs associated with this measure since most behavior measures do not have direct costs. However, this should not be viewed as a "no-cost" measure since the indirect costs for behavior measures can be significant.
- **Outdoor Audit:** Provide free irrigation audits to improve the efficiency of irrigation systems. Efficiencies can be achieved through hardware improvements or operational changes. The audits are performed by a contracted professional landscape irrigation auditor. The participation rate for this measure was set at 25%. The direct cost is $250 per audit for residential properties and $1,000 per audit for non-residential properties. The model assumes one audit per participating single family household, multifamily account, and non-residential account.
- **Outdoor Irrigation Kits:** Provide free outdoor irrigation kits with devices and information to improve the irrigation efficiency of manual irrigation techniques. Kits typically include items such as a watering timer and shut-off device, a spring-loaded hose nozzle, a rain gauge, hose washers, and a conservation brochure. The participation rate for this measure was set at 25%. The direct cost is $15 per kit. The model assumes one kit per participating single family household.

2.3 Key Assumptions

There are several key assumptions that are fundamental to the analysis. Those assumptions are explained below.

- **Planning Period:** A planning period of 2011 to 2020 (ten years) was used. The planning period is the period of interest for analyzing water conservation savings and costs. The planning period is different than the initial implementation period (see below). For example, Bend may distribute showerheads for five years (the initial implementation period), but may be interested in seeing how the savings and costs associated with those showerheads play out over 10 years (the planning period).

- **Initial Implementation Period:** An initial implementation period of 2011 to 2015 (five years) was used. The initial implementation period is the period when the conservation program will be implemented (aside from any renewals, see below). The initial implementation period is for the entire conservation program (i.e., all measures), rather than for any individual measure (e.g, just high-efficiency showerheads). Therefore, the last year of the initial implementation period is the last year that any one measure is initially implemented. A multi-year implementation period reflects the budgetary and administrative reality that Bend would most likely not implement all measures immediately.

- **Implementation Schedule:** After a one-year "ramp-up" period, an even-paced implementation schedule was assumed for all measures. The implementation schedule is the rate at which the measures are implemented during the initial implementation period. The measures were implemented to 8% of the potential customers in the first year and to 23% of the potential customers each of the remaining years. Therefore, the program reaches full implementation in the fifth year. This means that the gallons per day savings increase over the first five years, then remain constant. After the first year ramp-up period, an even implementation provides a consistent program budget for each year in the initial implementation period.

- **Renew Measure:** Measures are renewed if necessary to maintain savings over the planning period. Measure renewal is necessary if the measure lifespan is shorter than the planning period and if Bend wants to maintain the savings during the planning period. For example, the outdoor audit measure has a lifespan of five years, which means that since Bend's planning period is 10 years, the savings from the outdoor audits will disappear after five years unless Bend renews the measure and gives customers another outdoor audit in five years. Measure renewal has the benefit of maintaining savings, however it means that Bend pays to implement a measure more than once to the same customer.

- **Participation Rates:** Participation rates were selected to represent moderate program implementation levels. In the modeling analysis, participation rates represent the percent of target customers (those with the applicable hardware or behavior that have not already implemented the measure) that participate in the program. For example, for the HET toilet measure, the participation rate is the percent of customers that do not already have a HET toilet that are assumed to participate in Bend's HET toilet program. Participation rates are dependent on many factors including marketing and distribution techniques. Moderate level marketing and distribution techniques were assumed for the analysis.

  The participation rates are a subjective assessment of the relative attractiveness of the measures to customers. The rates were established using professional judgment based on HDR's experience with other communities. The following participation rates were used for the analysis:
  - 5% = unattractive to customers
  - 10% = not very attractive to customers
  - 25% = fairly attractive to customers
  - 30% = very attractive to customers

- **Free Riders:** The concept of free ridership was addressed in the analysis. Free riders are customers that participate in Bend's conservation program, even though they would have implemented the measure anyway. For example, a free rider is a customer who takes a rebate for an efficient clotheswasher, but who was going to buy that clotheswasher regardless of whether Bend offered a rebate program.

When free ridership is addressed in the analysis, the savings associated with free riders are excluded from the cost-effectiveness calculations, which provide a more accurate representation of the true cost-effectiveness of the conservation program. This impacts two values in the model: 1) "Savings for All Customers Over Measure Life (ccf)" and 2) "Cost per ccf Saved Over Measures Life." Those two numbers do not include water savings from free riders. Aside from those two numbers, all other numbers in the model include effects from free riders.

The free ridership percentages are a subjective assessment of the relative level of free ridership for measures. The percentages were established using professional judgment based on HDR's experience with other communities. The following free ridership percentages were used for the analysis:

- 5% = no reason to assume much free ridership
- 15% = higher level of free ridership is expected
- 25% = measures bringing customers up to current plumbing code

2.4 Demographic and Consumption Data Inputs

Demographic Data

The demographic data required for the model are provided in Table 4. The demographic data did not initially distinguish between single family and multifamily, but rather grouped those categories together as "residential." The model is not structured to accommodate a grouped "residential" category and therefore that category was split into single family and multifamily. As documented in footnote "b" to Table 4, that split was based on the 2005 *Housing Needs Analysis; City of Bend Residential Lands Study* which indicates that 72% of households in Bend are single family. This disaggregation is an approximation, but it is considered the best available data to complete the analysis.

Table 4 Demographics

Demographic Unit	First Initial Implementation Year ("Existing" Demographics)		Last Initial Implementation Year		Change Between First and Last Year ("Future" Demographics)	
Year	2011	a	2015	a	5	g
Single Family Households (SF HH) and Accounts	18,953	b	20,290	b	1,336	g
Persons Per SF HH	2.42	c	2.42	c	0.00	g
Multifamily Households (MF HH)	7,371	b	7,890	b	520	g
Multifamily Accounts	737	h	789	h	52	g
Persons Per MF HH	2.42	c	2.42	c	0.00	g
Non-Residential (NR) Accounts	3,217	d	3,444	d	227	g

Demographic Unit	First Initial Implementation Year ("Existing" Demographics)		Last Initial Implementation Year		Change Between First and Last Year ("Future" Demographics)	
Employees	45,362	e	48,560	e	3,198	g
Employees Per NR Account	14	f	14	f	0	g

a. Provided by client via Measure Selection worksheet.

b. Original numbers from GSI/MSA/City grouped SF and MF together. HDR split HHs between SF and MF based on Table 33 in 2005 *Housing Needs Analysis City of Bend Residential Lands Study,* which indicated 72% of HH are SF. Original footnote from GSI/MSA/City as follows: The City used the buildable lands/parcel inventory clipped to the COB water service area to estimate the number of residential households in 2010 (25,860). The inventory includes building permit applications that were received and approved (not constructed) as of Feb 1, 2008 and the City assumes that these units were built by 2010, thereby provide a good estimate for the 2010 number of residential households. Forecasted units were estimated by first summarizing the average annual number of permits issued over the reporting period for the City of Bend. The yearly average was then multiplied by 0.75 since only 75% of the City of Bend is within the City's water service area. Finally, this number (464 for all residential unit) was added each year to estimate the total number of dwelling units by type for the next 5 years, 2011 to 2015. The percent growth rates were: 1.79% from 2010 to 2011 and 7.05% total from 2011 to 2015.

c. Based on the US Census 2000.

d. Based on data from the utility billing system, MSA determined that the number of Non-residential Accounts in 2009 was 3,211. GSI then applied the residential households percent growth rates of 1.79% from 2010 to 2011 and 7.05% total from 2011 to 2015 (Footnote b) to the number of Non-residential Accounts in 2009 for the 2011 and 2015 projections.

e. Based on employment data from Oregon Employment Department, grown by factors consistent with the City of Bend's Economic Opportunities Analysis, the City estimated that the number of employee in 2008 was 44,564. GSI applied the residential households percent growth rates of 1.79% from 2010 to 2011 and 7.05% total from 2011 to 2015 (Footnote b) to the 2008 employment estimate for the 2011 and 2015 projections.

f. Calculation. Employees/NR Accounts

g. Calculation.

h. Professional judgment assuming 10 MF HH per MF account.

Consumption Data

The water consumption data required for the model are provided in Table 5. Water consumption data are used to calculate the Peak Season Increased Use (PSIU), which is the annual amount of water used in the summer months above the base use (i.e., winter water average use). The PSIU is used in the savings formulas for outdoor measures. Two years of water consumption data (2008-2009) for Bend are provided in Table 5. A graphical representation of that data, including the distinction between base use and the PSIU, is provided in Figure 1, Figure 2, and Figure 3.

Similar to the demographic data, the consumption data did not initially distinguish between single family and multifamily, but rather grouped those categories together as "residential." The consumption data was disaggregated using two main pieces of information: 1) the newly disaggregated Bend demographics separating single family and multifamily households, and 2) professional knowledge that a multifamily household typically uses approximately 85% of the consumption of a single family household. This disaggregation is an approximation and the confidence level of the results is reduced somewhat due to this data limitation. This issue only impacts measures with a "peak only" seasonality, since the consumption data is only used to estimate savings for "peak only" measures.

Table 5 Bend Water Consumption (gallons)

Month	Single Family		Multifamily		Non-Residential	
	2008	2009	2008	2009	2008	2009
Jan	63,061,419	66,253,728	20,845,302	21,900,538	72,549,267	71,806,549
Feb	62,456,394	59,312,417	20,645,308	19,606,049	73,693,802	57,261,091
Mar	73,536,334	55,809,549	24,307,844	18,448,157	73,794,355	64,263,994
Apr	86,620,499	111,083,908	28,632,887	36,719,403	93,245,306	99,878,693
May	207,036,509	209,789,572	68,437,068	69,347,109	168,454,780	211,931,167
June	224,516,421	240,333,592	74,215,150	79,443,604	179,263,127	220,964,837
July	407,803,042	311,850,603	134,801,561	103,083,949	290,600,681	233,671,889
Aug	313,766,104	381,582,191	103,717,129	126,134,113	229,720,447	263,698,319
Sep	244,361,307	198,182,035	80,774,987	65,510,173	193,055,297	164,186,426
Oct	168,694,298	159,110,827	55,762,837	52,594,968	118,701,616	126,121,857
Nov	63,803,523	58,413,802	21,090,609	19,309,007	65,212,374	56,025,527
Dec	57,366,708	65,333,699	18,962,884	21,596,417	58,401,851	68,732,407
Total	**1,973,022,559**	**1,917,055,923**	**652,193,568**	**633,693,486**	**1,616,692,904**	**1,638,542,756**

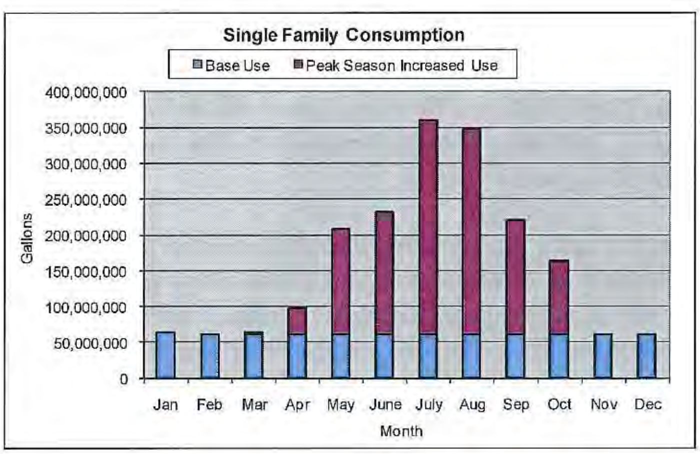


Figure 1 **Single Family Consumption (2008-2009)**

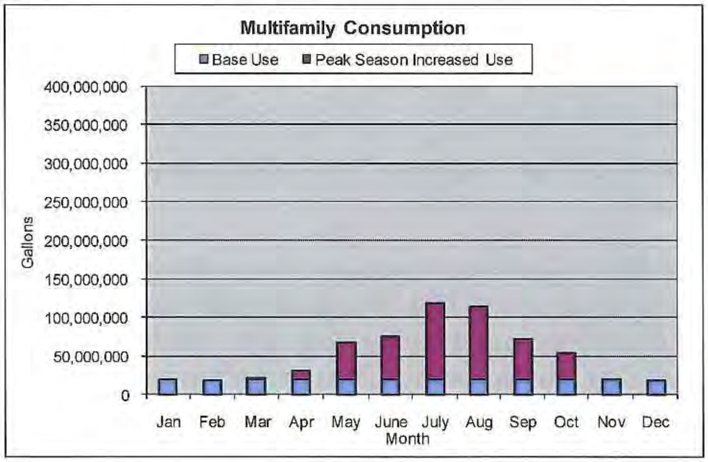


Figure 2 **Multifamily Consumption (2008-2009)**

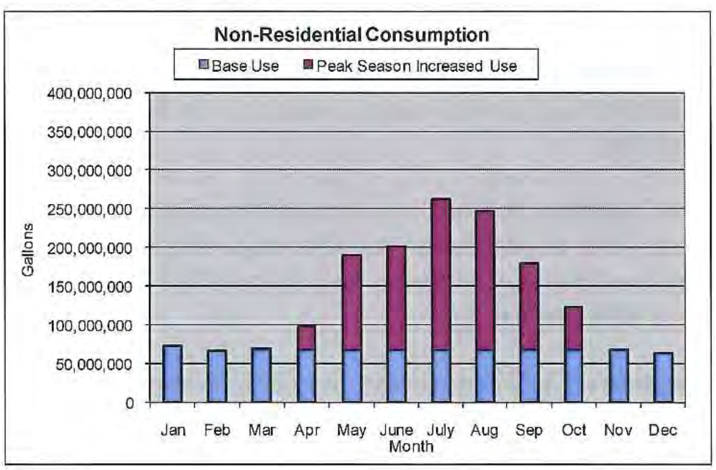


Figure 3 **Non-Residential Consumption (2008-2009)**

2.5 Developing Packages

The model's "package tool" was used to group subsets of measures that represent potential conservation scenarios for Bend. The decision of which packages to create, and which measures to include in each package, is dependent on many factors including the following screening criteria:

- **Available Program Budget:** The conservation program budget impacts program choices. Bend has a current conservation budget of approximately $50,000 annually for communication and outreach and no budget for direct costs such as rebates or hardware purchases.

- **Magnitude of Annual Water Savings:** This is the annual savings in gallons per day at full implementation.

- **Magnitude of Peak Season Water Savings:** This is the peak season savings in gallons per day at full implementation. Note that peak season savings are obtained from both measures that obtain year-round savings (e.g. toilet rebates) and measures that only obtain savings during the peak season (e.g., irrigation system controllers).

- **Cost Effectiveness:** The cost-effectiveness of measures can range widely. For Bend, it ranges from $0.01 to $51.63 per ccf of saved water. Typically, indoor measures are more cost-effective than outdoor measures.

- **Customer Categories:** It may or may not be preferable to provide programs for each customer category (i.e., single family, multifamily, non-residential).

- **Certainty of Savings:** Measures that focus on hardware have a higher certainty of savings compared to measures that focus on behavior. Once a customer installs a piece of hardware (e.g., high-efficiency showerhead), the savings are generally assured for the lifespan of that hardware. However, if a customer enacts a water saving behavior (e.g., taking shorter showers), it is easy for the customer to convert back to their non-conserving behavior.

- **Administrative Complexity:** The impact on staff workload should be considered. Measures that could be implemented together (e.g., single family showerheads and single family bathroom faucet aerators) may have added value in workload efficiencies (as well as in cost efficiencies).

- **Customer Acceptance:** Certain measures may have higher customer acceptance. For example, when measures with different flow rates are analyzed, typically the models with higher flow rates have higher customer acceptance.

Examples of conservation packages that are frequently developed for utilities to consider include the following:

- **Savings Package:** Designed to meet a specific saving goal (e.g., saves X gpd).

- **Cost Package:** Designed to meet a specific budgetary constraint (e.g., costs $X per year).

- **Cost-Effectiveness Package:** Designed to include all measures that meet a certain cost-effectiveness threshold (e.g., measures that cost less than $X per ccf of saved water.

The packages developed for Bend are described below.

- **Package #1 – Conservation Potential Assessment:** This package was designed to show the maximum water savings available, given certain assumptions such as participation rates. This package is intended to provide a "high end" of potential savings. This package was assembled by including all of the analyzed measures, except that certain mutually exclusive measures have been omitted.

- **Package #2 – Hardware Measures – Indoor and Outdoor:** This package was designed to show the maximum water savings from hardware measures that the City is most interested in. The City has less interest in behavioral measures since their savings are less certain. This package was assembled by starting with Package #1 and omitting the behavioral measures and a few hardware measures.

- **Package #3 – Hardware Measures – Outdoor Only:** This package was designed to show the maximum water savings from outdoor hardware measures that the City is most interested in. This package was assembled by starting with Package #2 and omitting all indoor measures, which results in a package that contains only ET Controllers.

- **Package #4 – Hardware Measures – Indoor Only:** This package was designed to show the maximum water savings from indoor hardware measures that the City is most interested in. This package was assembled by starting with Package #2 and omitting all outdoor measures.

3 Results and Conclusions

3.1 Initial Results for Individual Measures

The results of the initial analysis for each individual measure are provided in Table 6. (The table is located at the end of this Tech Memo since it is 11 x 17 in size.) The results represent the highest level of water savings (and associated costs) that can be expected from each analyzed measure, given certain assumptions such as participation rates. It should be noted that additional savings might be obtainable from measures not included in the model, such as supply-side measures (e.g., leak detection) or more aggressive demand-side measures, however that would require continued spending.

The savings and costs in Table 6 are not totaled since there is some overlap due to mutually exclusive measures. For example, the analysis includes 0.5, 1.0, and 1.5 gpm faucet aerator measures. Those measures were analyzed independently of each other. Bend would most likely choose to implement only one of those measures, therefore the savings and costs from the non-selected measures need to be disregarded. If Bend implemented all three measures, the participation rates (and thus savings and costs) for all three measures would need to be reduced. (See Section 3.2 for a package that omits overlapping measures.)

There are four sets of mutually exclusive measures, as described below:

- **Mutually Exclusive Set #1 – Residential Bathroom Faucet Aerators:** Three versions of residential bathroom faucet aerators were analyzed: 0.5 gpm, 1.0 gpm, and 1.5 gpm. All three versions are more efficient than the plumbing code of 2.5 gpm.

- **Mutually Exclusive Set #2 - Showerheads:** Two versions of showerheads were analyzed: 1.5 gpm and 2.0 gpm. Both versions are more efficient than the plumbing code of 2.5 gpm.

- **Mutually Exclusive Set #3 – Toilets:** Two versions of toilets were analyzed: 1.28 gpf and 1.6 gpf. The 1.6 gpf version brings customers up to the plumbing code and the 1.28 gpf version goes beyond code.

- **Mutually Exclusive Set #4 - Urinals:** Three versions of urinals were analyzed: waterless, 0.5 gpf, and 1.0 gpf. The 1.0 gpf version brings customers up to the plumbing code, while the other two versions go beyond code.

Key definitions related to Table 6 (as well as the similar tables for packages) are provided below:

- **Participating Customers:** The number of customers with the applicable fixture or behavior that have not already implemented the measure and that participate in the program. For example, the number of single family households with showers that do not already have an efficient model that participate in the utility's showerhead program. Note that the number of "potential" customers is the number of single family households; multifamily households or accounts; or non-residential accounts (as applicable for each measure), which is provided in Table 4 Demographics.

- **Savings Generating Customers:** The number of customers that generate savings. For measures that only require one step to achieve savings (e.g., toilet rebates), this is the same as the number of participating customers. For measures that require two steps to achieve savings, this is the number of customers that perform both steps and therefore achieve the savings. For example, the number of single family households that take the utility's showerhead and follow through and install it.

- **Devices / Rebates / Audits:** The number of devices, rebates, or audits that will be distributed or performed. For example, the number of toilet rebates. This number can be higher than the number of participating customers since often there are multiple fixtures per customer and due to renewals.

- **Savings for All Customers at Full Implementation (gpd):** This is the gallons per day savings for all customers once the program has been fully implemented. This value is presented for both the average annual and peak season time periods.

- **Savings for All Customers Over Measure Life (ccf):** This is the total savings, in 100s of cubic feet, that are obtained by the measure over the measure lifespan (or multiple lifespans if the measure is renewed). This is the savings number that is used to calculate the cost-effectiveness of the measure.

- **Total Direct Cost Over Planning Period:** This is the total direct cost for a measure over the planning period including the impacts of renewals if applicable. This number is a key input to the measure cost effectiveness calculation.

- **Direct Cost per CCF Saved Over Measure Life:** This is the cost effectiveness of the measure. It is calculated by dividing the "Savings For All Customers Over Measure Life (ccf)" into the "Total Direct Cost Over Planning Period." This number can be used to compare measures to one another, or to compare conservation to other sources of supply.

3.2 Package #1 – Conservation Potential Assessment

As described previously, this package was designed to show the maximum water savings available, given certain assumptions such as participation rates. This package is intended to provide a bookend of the high end of potential savings. As described previously, this package omits certain mutually exclusive measures. This allows the results to be summed for all the remaining measures. The decisions for which measures within a mutually exclusive set were included are explained below:

- **Mutually Exclusive Set #1 – Residential Bathroom Faucet Aerators:** The 1.0 gpm versions were included since they are more cost effective and save a larger volume of water, compared to the 1.5 and 0.5 gpm versions.

- **Mutually Exclusive Set #2 - Showerheads:** The 1.5 gpm versions were included since they are more cost effective and save a larger volume of water, compared to the 2.0 gpm version.

- **Mutually Exclusive Set #3 – Toilets:** The 1.28 gpf versions were included since they are more cost effective, compared to the 1.6 gpf version.

- **Mutually Exclusive Set #4 - Urinals:** The 0.5 gpf versions were included since they are more cost effective and save a larger volume of water, compared to the 1.0 gpf version. The waterless versions were excluded since they are often less acceptable to customers.

The results for Package #1 are shown in Table 7. (The table is located at the end of this Tech Memo since it is 11 x 17 in size.) The analysis estimates the package would save approximately 740,000 gallons per day (gpd) on an annual average basis and 980,000 gpd on a peak season basis. The annual average savings number represents 6.2% of Bend's 2004-2009 average day demand. (The 2004 to 2009 average day demand is 12 mgd per Exhibit 2-3 in Bend's draft *Water Management and Conservation Plan*). The total direct cost of achieving those savings is estimated at approximately $3 million over the course of the ten-year planning period. Those total costs average to approximately $300,000 a year. However, as discussed below, the estimated annual costs vary throughout the planning period with higher annual costs toward the beginning and lower annual costs toward the end.

Several pie charts are provided to convey more information regarding the nature of the savings from this package. Figure 4 shows that nearly two-thirds of the savings are from the single-family customer category, with the remaining savings attributed to the multifamily and non-residential customer categories. Figure 5 shows that approximately two-thirds of the savings are associated with measures focused only on the peak season and one-third of the savings is associated with measures with year-round savings. Figure 6 shows that approximately half of the savings are associated with hardware measures and half with behavioral measures.

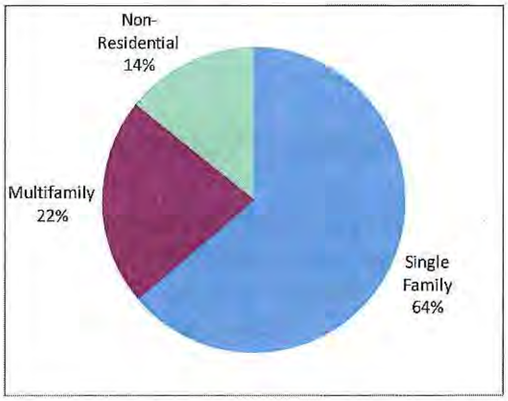


Figure 4 Savings by Customer Category (Package #1)

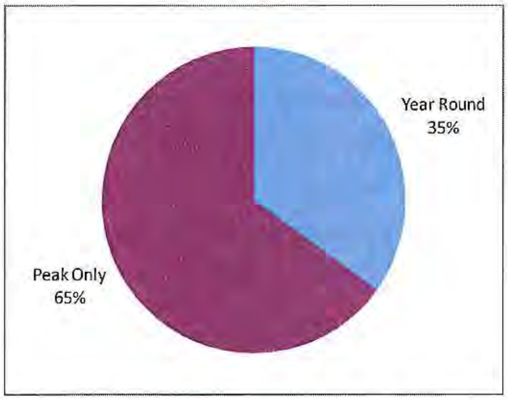


Figure 5 Savings by Seasonality (Package #1)

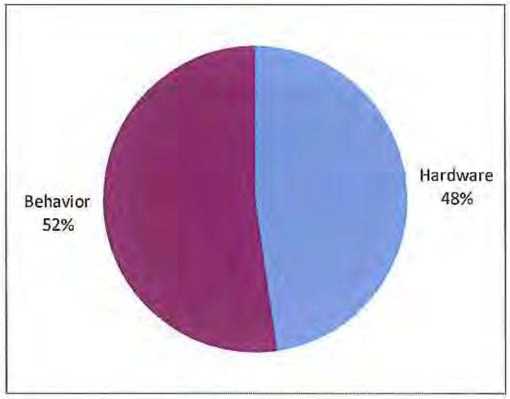


Figure 6 Savings by Hardware vs. Behavior (Package #1)

Figure 7 shows the gallons per day savings for each year. The figure shows how the gallons per day savings: 1) increase during the initial implementation period of 2011-2015, 2) reach their highest level by the last year of the initial implementation period, 3) stay at that level throughout the planning period until 2020, and 4) decline after the end of the planning period as the measures' lifespans expire and the measures are no longer renewed. Note that the savings could be preserved beyond the planning period, however that would require continued spending.

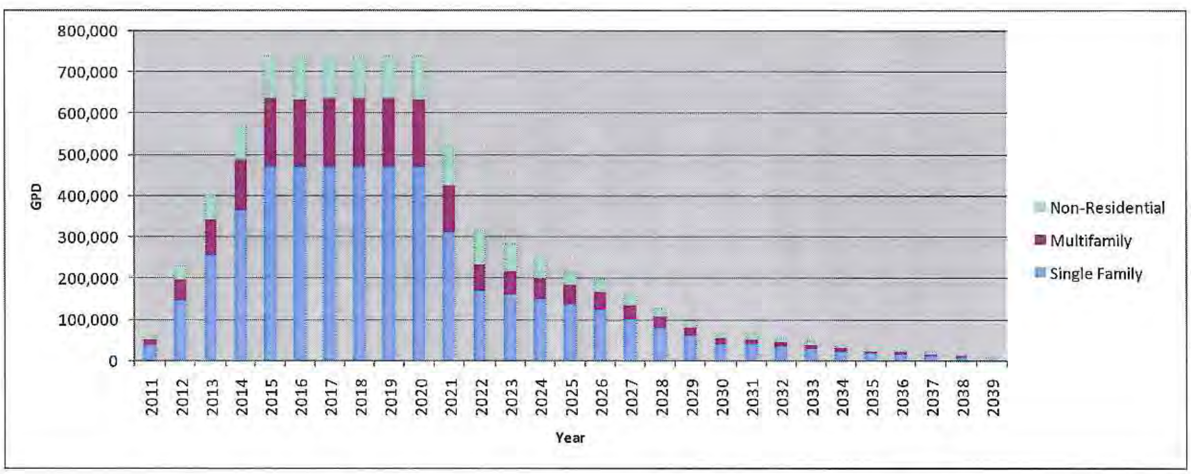


Figure 7 Total Savings Each Year (Package #1)

Figure 8 shows the total direct costs for each year during the planning period for each customer category. The figure shows how the costs: 1) are highest during the initial implementation period, 2) continue at a reduced level during the rest of the planning period due to measure renewal, and 3) end after the planning period. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule.

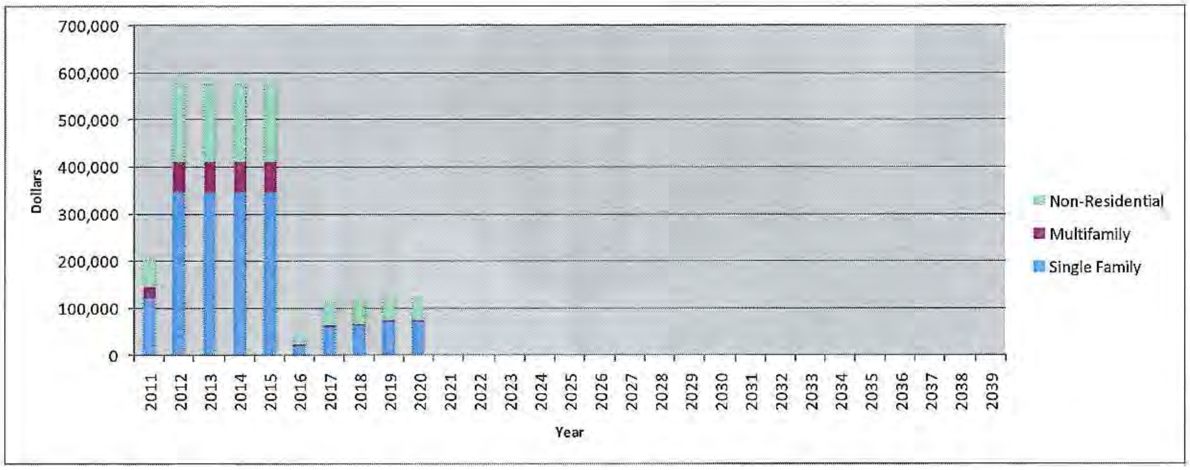


Figure 8 Total Direct Costs Each Year (Package #1)

3.3 Package #2 – Hardware Measures – Indoor and Outdoor

As discussed in Section 2.5, this package was designed to show the maximum water savings from hardware measures that are of most interest to the City. Note that this package includes toilet leak detection dye tablets which, as explained earlier, is considered a hardware measure by the City even though the HDR model technically classifies it as a behavioral measure

The results for Package #2 are shown in Table 8 (the table is located at the end of this Tech Memo since it is 11 x 17 in size). The analysis estimates the package would save approximately 296,000 gpd on an annual average basis and 337,000 gpd on a peak season basis. The total direct cost of achieving those savings is estimated at $1.9 million over the ten-year planning period.

Two pie charts convey information regarding the nature of the savings from this package. Figure 9 shows that the majority of the savings are from the single family category, with the remaining savings split between the multifamily and the non-residential sectors. Figure 10 shows the majority of savings are associated with measures with year-round savings, compared to measures with only peak season savings. By definition of the package, all of the savings are from hardware measures.

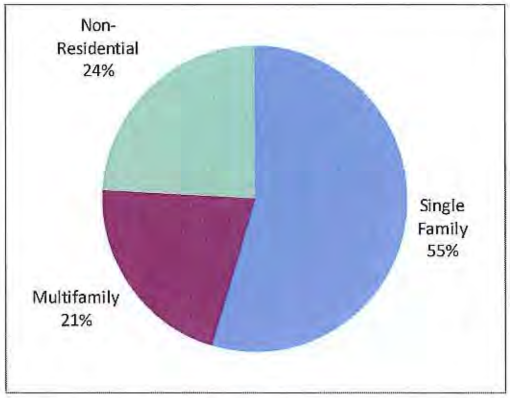


Figure 9 Savings by Customer Category (Package #2)

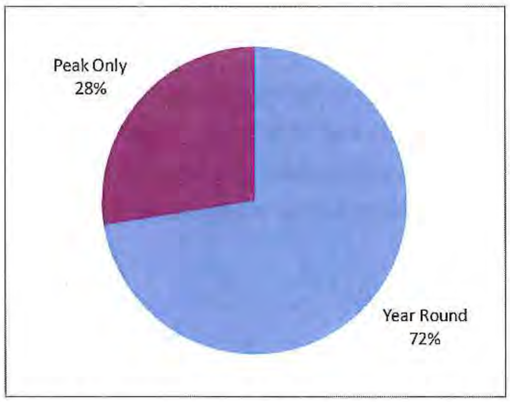


Figure 10 Savings by Seasonality (Package #2)

Figure 11 shows the gallons per day savings for each year, on an average annual basis. The pattern in the figure is similar to the pattern discussed under Package#1 - Conservation Potential Assessment.

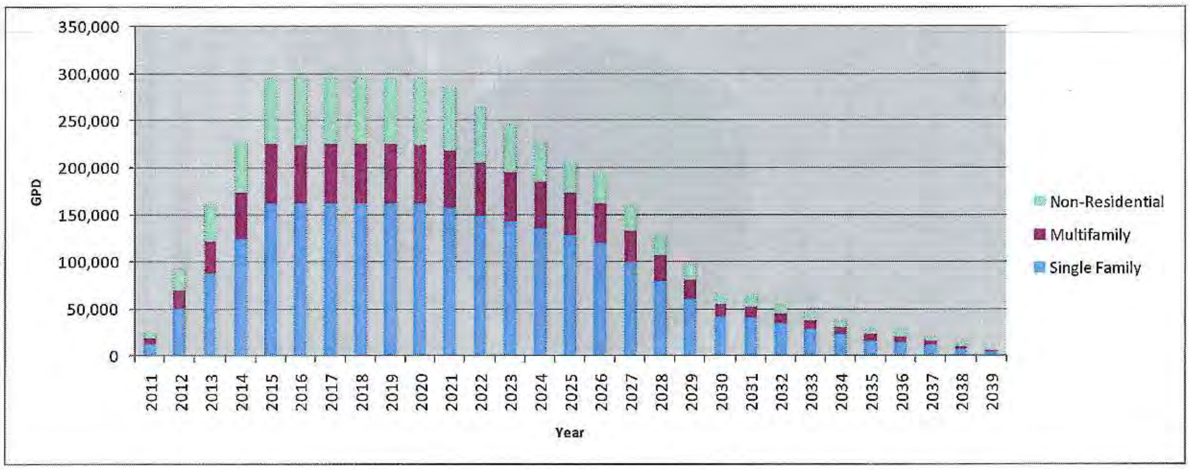


Figure 11 Total Savings Each Year (Package #2)

Figure 12 shows the direct costs for each year during the planning period for each customer category. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule. Although it is not clearly shown in Figure 12, there are minor costs in years 2018 through 2020 due to measure renewal during the planning period.

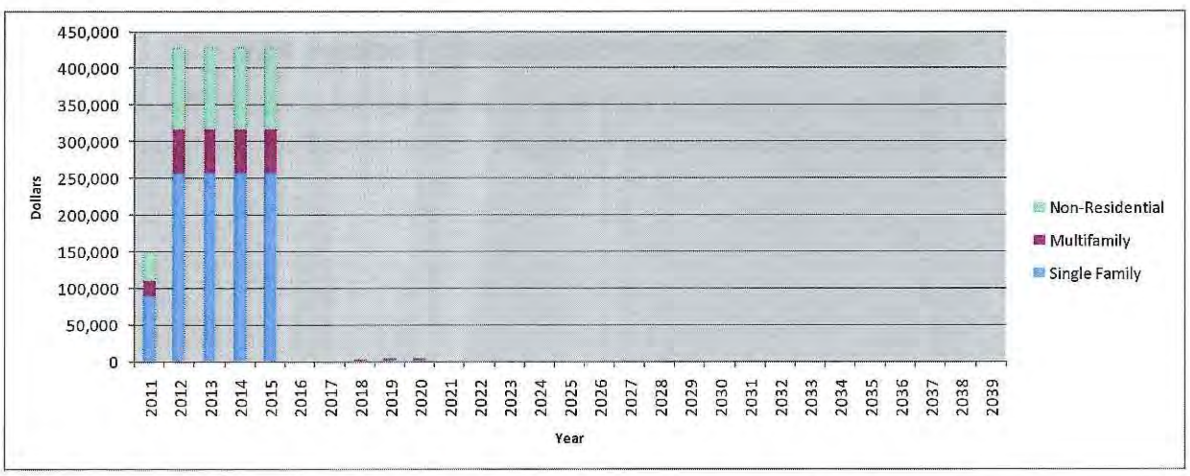


Figure 12 Total Direct Costs Each Year (Package #2)

3.4 Package #3 – Hardware Measures – Outdoor Only

This package was designed to show the maximum water savings from outdoor hardware measures that are of most interest to the City, which is limited to ET Controllers.

The results for Package #3 are shown in Table 9 (the table is located at the end of this Tech Memo since it is 11 x 17 in size). The analysis estimates the package would save approximately 81,000 gpd on an average annual basis and 122,000 gpd on a peak season basis. The total direct cost of achieving those savings is estimated at approximately $380,000 over the ten-year planning period.

Figure 13 shows that nearly half (46%) of the savings are attributed to the non-residential sector, while the single family sector accounts for 34% of the savings, and the remaining 20% of savings are attributed to the multifamily sector. By definition of the package, all of the savings are from hardware measures and are associated with measures focused only on the peak season.

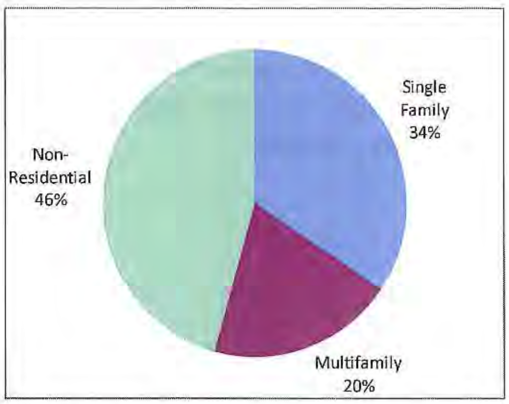


Figure 13 Savings by Customer Category (Package #3)

Figure 14 shows the gallons per day savings for each year, on an average annual basis. The pattern in the figure is similar to the pattern discussed under Package#1 - Conservation Potential Assessment. However, the savings decline more quickly after the end of the planning period since it was not necessary to renew measures during the planning period due to the interaction between the life span of ET controllers, the planning period, and the initial implementation period.

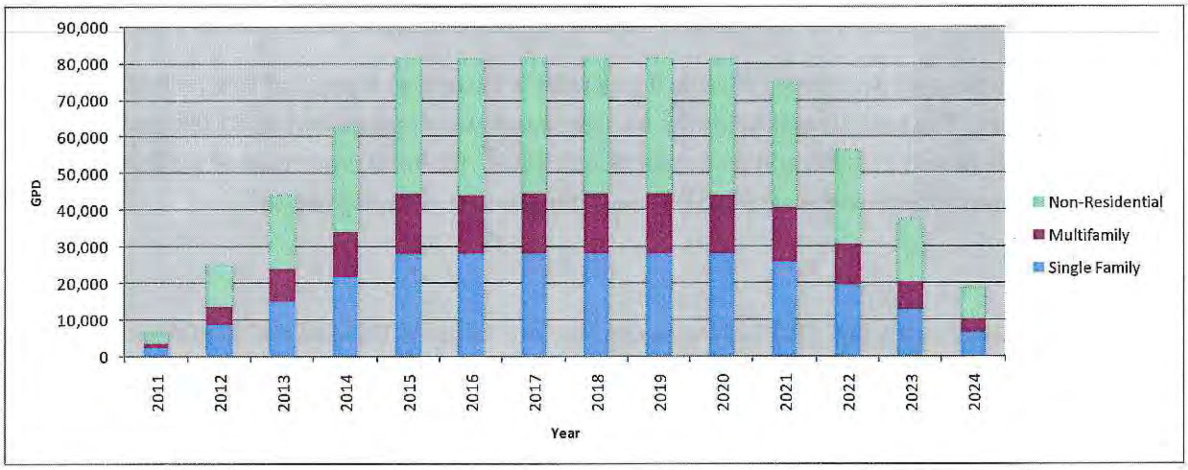


Figure 14 Total Savings Each Year (Package #3)

Figure 15 show the direct costs for each year during the planning period for each customer category. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule.

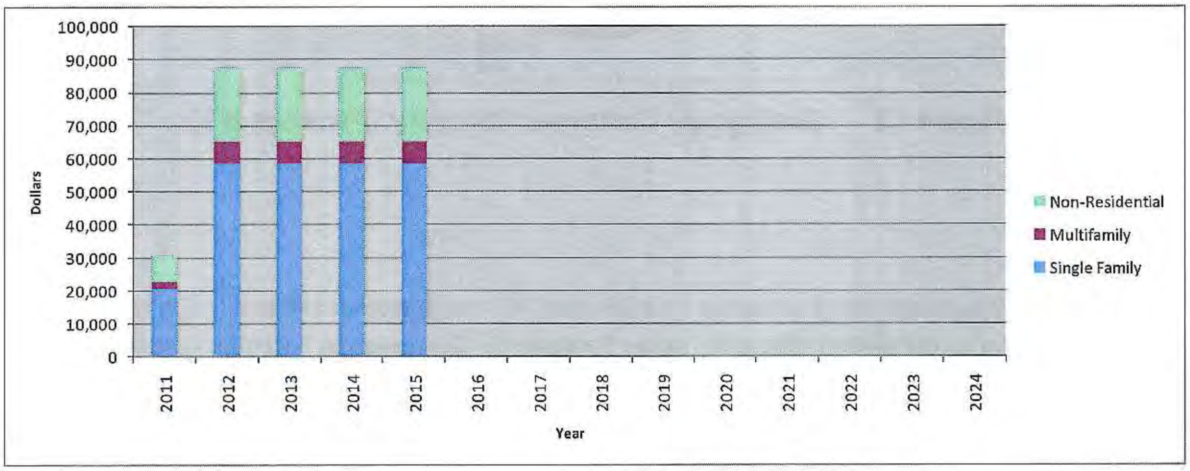


Figure 15 Total Direct Costs Each Year (Package #3)

3.5 Package #4 – Hardware Measures – Indoor Only

This package was designed to show maximum water savings for indoor hardware measures that are of most interest to the City.

The results for Package #4 are shown in Table 10 (the table is located at the end of this Tech Memo since it is 11 x 17 in size). The analysis estimates the package would save approximately 215,000 gpd on both an average annual and peak season basis. The saving are the same since the package only includes indoor measures. The total direct cost of achieving those savings is estimated at approximately $1.5 million over the ten-year planning period.

Figure 16 shows that 62% of the savings are from the single-family category, 22% from multifamily and the remaining 16% from the non-residential category. By definition of the package, all of the savings are from hardware measures and have year round savings.

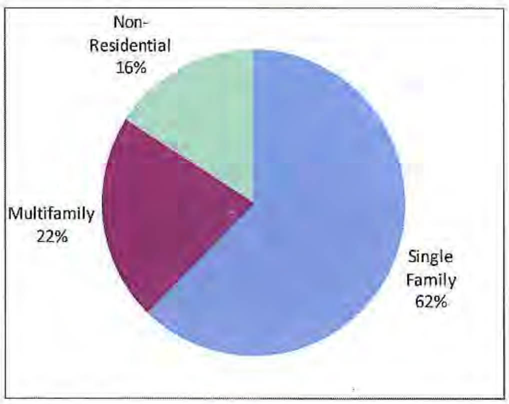


Figure 16 Savings by Customer Category (Package #4)

Figure 17 shows the gallons per day savings for each year, on an average annual basis. The pattern in the figure is similar to the pattern discussed under Package#1 - Conservation Potential Assessment.

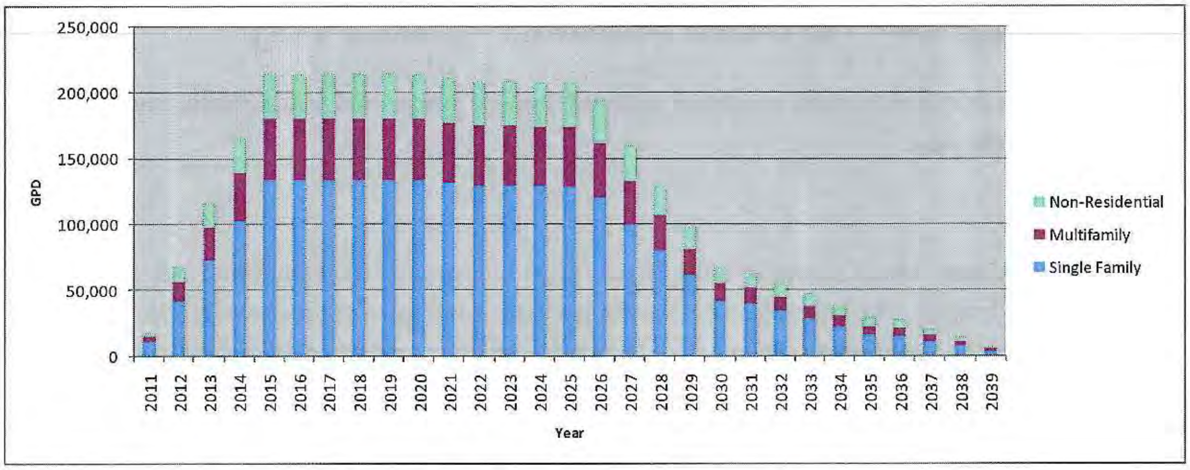


Figure 17 Total Savings Each Year (Package #4)

Figure 18 shows the direct costs for each year during the planning period for each customer category. Note that the lower cost in the first year is due to the one-year "ramp-up" period, as described in Section 2.3 related to the implementation schedule. Although it is not clearly shown in Figure 18, there are minor costs in years 2018 through 2020 due to measure renewal during the planning period.

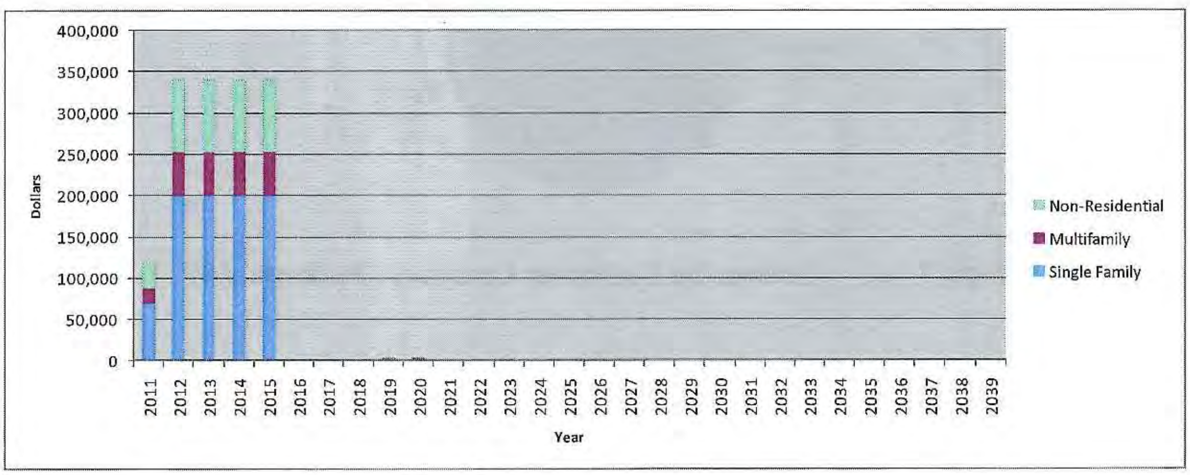


Figure 18 Total Direct Costs Each Year (Package #4)

3.6 Conclusions

A summary of the results from the conservation packages is provided in Table 11. A scatter plot of the average annual savings and the total direct cost over the planning period for each package is provided in Figure 19.

Table 11 Summary of Conservation Package Results

Package	Average Annual Savings (gpd)	Average Annual Savings: % of Average 2004-2009 Average Day Demand	Peak Season Savings (gpd)	Total Direct Cost Over Planning Period	Direct Cost per CCF Saved Over Measure Life
Package #1 - Conservation Potential Assessment	740,000	6.2%	980,000	$3,025,000	$0.80
Package #2 – Hardware Measures – Indoor and Outdoor	296,000	2.5%	337,000	$1,866,000	$0.93
Package #3 – Hardware Measures – Outdoor Only	81,000	0.7%	122,000	$381,000	$1.01
Package #4 – Hardware Measures – Indoor Only	215,000	1.8%	215,000	$1,485,000	$0.91

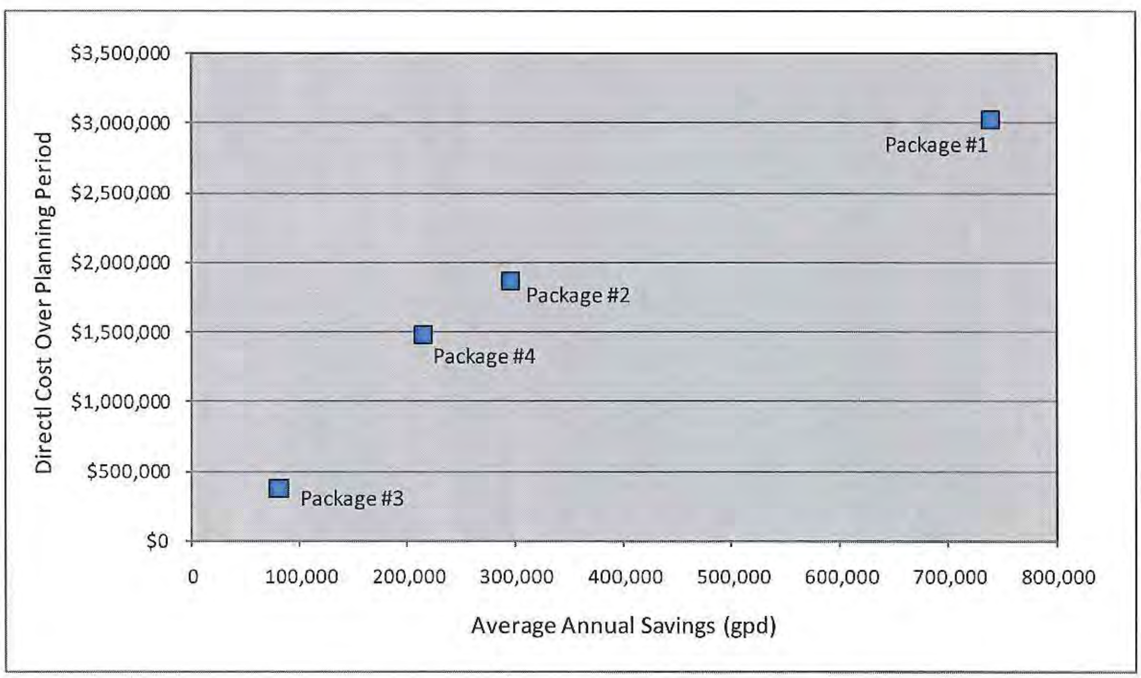


Figure 19 - Comparison of Savings and Costs

This information should be used in concert with Bend's conservation drivers, to determine which package, or subsets thereof, is the most appropriate to implement. Bend understands the environmental benefit of leaving water instream and in the aquifer and is interested in going beyond regulatory commitments to demonstrate strong stewardship of the resource. Bend is also interested in conservation as a mechanism to defer or avoid capital costs and to extend available supplies. As to the latter, the savings of each package should be compared to the volume of water needed to defer capital improvements or source development to determine if conservation can provide the volume of water needed. The direct costs and cost-effectiveness of each package should be compared to potential capital improvements and new sources to determine whether conservation is less expensive or more expensive than those more traditional solutions to water supply needs.

Even if conservation is not sufficient for Bend to avoid the need for capital improvements, the City will still want to implement conservation in order to meet State requirements and to be a good steward of the resource. In that case, each of the packages would be reasonable to implement from a cost effectiveness perspective since their cost effectiveness', which range from $0.80 to $1.01 per ccf of saved water, are all very reasonable. However, the total direct cost of every package is well beyond Bend's current conservation budget. Therefore, a desired conservation budget could be established and any of the packages could be scaled down to meet that budget by eliminating measures and/or decreasing the activity level of measures.

Table 6 Analysis Results – All Measures

Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
					Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 0.5 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	2,029	1,522	5,073	13,698	13,698	126,979	$5,070	$0.04
Faucets - 0.5 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	789	592	1,184	3,434	3,434	31,821	$1,180	$0.04
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Showerhead 2.0 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	18,259	18,259	126,966	$30,430	$0.24
Showerhead 2.0 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	7,104	7,104	49,390	$8,880	$0.18
Showerhead 2.0 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	6,400	6,400	44,850	$1,290	$0.03
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Urinals - Waterless Models	NR	Year Round	Hardware	NR Accounts	138	138	292	1,946	1,946	18,042	$43,780	$2.43
Clotheswashers - Decrease Partial Loads	SF	Year Round	Behavior	SF Households	1,839	1,839	0	6,253	6,253	23,652	$0	$0.00
Clotheswashers - Decrease Partial Loads	MF	Year Round	Behavior	MF Households	642	642	0	2,183	2,183	8,257	$0	$0.00
Faucets - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	6,899	6,899	26,096	$0	$0.00
Faucets - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Showerheads - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,464	4,464	16,885	$0	$0.00
Showerheads - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Toilets - Decrease Flushes	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,870	4,870	18,420	$0	$0.00
Toilets - Decrease Flushes	MF	Year Round	Behavior	MF Households	789	789	0	1,894	1,894	7,163	$0	$0.00
Irrigation Controllers - ET Model	SF	Peak Only	Hardware	SF Households	1,020	1,020	1,020	28,066	42,100	130,107	$255,000	$1.96
Irrigation Controllers - ET Model	MF	Peak Only	Hardware	MF Accounts	57	57	57	16,202	24,304	75,110	$28,500	$0.38
Irrigation Controllers - ET Model	NR	Peak Only	Hardware	NR Accounts	195	195	195	37,191	55,787	172,407	$97,500	$0.57
Irrigation Controllers - Rain Sensors	SF	Peak Only	Hardware	SF Households	862	862	862	7,906	11,859	36,651	$86,200	$2.35
Irrigation Controllers - Rain Sensors	MF	Peak Only	Hardware	MF Accounts	48	48	48	4,548	6,822	21,083	$4,800	$0.23
Irrigation Controllers - Rain Sensors	NR	Peak Only	Hardware	NR Accounts	164	164	164	10,426	15,639	48,333	$16,400	$0.34
Outdoor Irrigation Kits	SF	Peak Only	Hardware	SF Households	2,847	2,135	4,384	19,584	29,376	97,878	$65,773	$0.67
Outdoor Audit	SF	Peak Only	Behavior	SF Households	1,034	259	2,068	7,127	10,690	32,973	$517,000	$15.68
Outdoor Audit	MF	Peak Only	Behavior	MF Accounts	57	14	114	3,980	5,969	18,777	$28,500	$1.52
Outdoor Audit	NR	Peak Only	Behavior	NR Accounts	196	49	392	9,345	14,018	43,323	$392,000	$9.05
Lawn Dormant	SF	Peak Only	Behavior	SF Households	1,725	1,725	0	253,180	379,770	957,710	$0	$0.00
Lawn Dormant	MF	Peak Only	Behavior	MF Accounts	55	55	0	83,309	124,964	315,136	$0	$0.00
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT)	SF	Year Round	Hardware	SF Households	977	977	2,247	22,961	22,961	33,612	$168,530	$5.01
Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT)	MF	Year Round	Hardware	MF Households	380	380	684	8,931	8,931	13,073	$51,300	$3.92
Toilets - 1.6 gpf Ultra Low Flow Toilets (ULFT)	NR	Year Round	Hardware	NR Accounts	166	166	702	9,827	9,827	14,386	$52,670	$3.66
Urinals - 1.0 gpf Models	NR	Year Round	Hardware	NR Accounts	62	62	131	440	440	322	$13,110	$40.68
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Faucets - 1.5 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	17,498	17,498	162,234	$12,680	$0.08
Faucets - 1.5 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	4,294	4,294	39,805	$2,960	$0.07
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Spray Valves - 1.25 gpm Pre-Rinse Spray Valve	NR	Year Round	Hardware	NR Accounts	123	123	369	14,539	14,539	67,397	$47,980	$0.71

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 7 Analysis Results – Package #1 Conservation Potential Assessment

					PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Clotheswashers - Decrease Partial Loads	SF	Year Round	Behavior	SF Households	1,839	1,839	0	6,253	6,253	23,652	$0	$0.00
Clotheswashers - Decrease Partial Loads	MF	Year Round	Behavior	MF Households	642	642	0	2,183	2,183	8,257	$0	$0.00
Faucets - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	6,899	6,899	26,096	$0	$0.00
Faucets - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Showerheads - Decrease Use	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,464	4,464	16,885	$0	$0.00
Showerheads - Decrease Use	MF	Year Round	Behavior	MF Households	789	789	0	1,736	1,736	6,566	$0	$0.00
Toilets - Decrease Flushes	SF	Year Round	Behavior	SF Households	2,029	2,029	0	4,870	4,870	18,420	$0	$0.00
Toilets - Decrease Flushes	MF	Year Round	Behavior	MF Households	789	789	0	1,894	1,894	7,163	$0	$0.00
Irrigation Controllers - ET Model	SF	Peak Only	Hardware	SF Households	1,020	1,020	1,020	28,066	42,100	130,107	$255,000	$1.96
Irrigation Controllers - ET Model	MF	Peak Only	Hardware	MF Accounts	57	57	57	16,202	24,304	75,110	$28,500	$0.38
Irrigation Controllers - ET Model	NR	Peak Only	Hardware	NR Accounts	195	195	195	37,191	55,787	172,407	$97,500	$0.57
Irrigation Controllers - Rain Sensors	SF	Peak Only	Hardware	SF Households	862	862	862	7,906	11,859	36,651	$86,200	$2.35
Irrigation Controllers - Rain Sensors	MF	Peak Only	Hardware	MF Accounts	48	48	48	4,548	6,822	21,083	$4,800	$0.23
Irrigation Controllers - Rain Sensors	NR	Peak Only	Hardware	NR Accounts	164	164	164	10,426	15,639	48,333	$16,400	$0.34
Outdoor Irrigation Kits	SF	Peak Only	Hardware	SF Households	2,847	2,135	4,384	19,584	29,376	97,878	$65,773	$0.67
Outdoor Audit	SF	Peak Only	Behavior	SF Households	1,034	259	2,068	7,127	10,690	32,973	$517,000	$15.68
Outdoor Audit	MF	Peak Only	Behavior	MF Accounts	57	14	114	3,980	5,969	18,777	$28,500	$1.52
Outdoor Audit	NR	Peak Only	Behavior	NR Accounts	196	49	392	9,345	14,018	43,323	$392,000	$9.05
Lawn Dormant	SF	Peak Only	Behavior	SF Households	1,725	1,725	0	253,180	379,770	957,710	$0	$0.00
Lawn Dormant	MF	Peak Only	Behavior	MF Accounts	55	55	0	83,309	124,964	315,136	$0	$0.00
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Spray Valves - 1.25 gpm Pre-Rinse Spray Valve	NR	Year Round	Hardware	NR Accounts	123	123	369	14,539	14,539	67,397	$47,980	$0.71
Total					N/A	N/A	N/A	739,962	980,395	3,760,467	$3,024,785	$0.80

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 8 Analysis Results – Package #2 Hardware Measures: Indoor and Outdoor

					PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Irrigation Controllers - ET Model	SF	Peak Only	Hardware	SF Households	1,020	1,020	1,020	28,066	42,100	130,107	$255,000	$1.96
Irrigation Controllers - ET Model	MF	Peak Only	Hardware	MF Accounts	57	57	57	16,202	24,304	75,110	$28,500	$0.38
Irrigation Controllers - ET Model	NR	Peak Only	Hardware	NR Accounts	195	195	195	37,191	55,787	172,407	$97,500	$0.57
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Total					N/A	N/A	N/A	295,986	336,716	2,007,601	$1,866,132	$0.93

SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 9 Analysis Results –Package 3 Hardware Measures: Outdoor Only

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]			[illegible]	
					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

Table 10 Analysis Results – Package #4 Hardware Measures: Indoor Only

					PARTICIPATION[2]			SAVINGS			COSTS	
					All Customers			Savings For All Customers At Full Implementation (gpd)		Savings For All Customers Over Measure Life		
Conservation Measure	Sector	Seasonality	Hardware vs Behavior	Customer Definition	Participating Customers	Savings Generating Customers	Devices / Rebates / Audits	Annual Average	Peak Season	CCF[1]	Total Direct Cost Over Planning Period	Cost per CCF Saved Over Measure Life
Clotheswashers - Efficient Res. Capacity (In Unit)	SF	Year Round	Hardware	SF Households	3,499	3,499	3,499	47,586	47,586	296,063	$349,900	$1.18
Clotheswashers - Efficient Res. Capacity (In Unit)	MF	Year Round	Hardware	MF Households	611	611	611	8,310	8,310	51,699	$61,100	$1.18
Clotheswashers - Efficient Res. Capacity (Common Area)	MF	Year Round	Hardware	MF Households	611	611	122	8,310	8,310	51,699	$12,220	$0.24
Clotheswashers - Efficient Comm. Capacity	NR	Year Round	Hardware	NR Accounts	7	7	84	9,408	9,408	58,533	$21,000	$0.36
Faucets - 1.0 gpm Bathroom Aerators	SF	Year Round	Hardware	SF Households	5,072	3,804	12,680	25,867	25,867	239,825	$12,680	$0.05
Faucets - 1.0 gpm Bathroom Aerators	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	6,512	6,512	60,365	$2,960	$0.05
Toilets - 1.28 gpf High Efficiency Toilets (HET)	SF	Year Round	Hardware	SF Households	2,029	2,029	4,667	16,232	16,232	188,117	$466,670	$2.48
Toilets - 1.28 gpf High Efficiency Toilets (HET)	MF	Year Round	Hardware	MF Households	789	789	1,420	6,312	6,312	73,151	$142,020	$1.94
Toilets - 1.28 gpf High Efficiency Toilets (HET)	NR	Year Round	Hardware	NR Accounts	344	344	1,455	6,777	6,777	78,543	$218,280	$2.78
Urinals - 0.5 gpf Models	NR	Year Round	Hardware	NR Accounts	689	689	1,457	4,893	4,893	45,363	$145,730	$3.21
Faucets - 0.5 gpm Bathroom Aerators	NR	Year Round	Hardware	NR Accounts	78	59	165	997	997	724	$160	$0.22
Toilets - Leak Detection	SF	Year Round	Hardware	SF Households	981	491	71,866	9,034	9,034	45,101	$9,379	$0.21
Toilets - Leak Detection	MF	Year Round	Hardware	MF Households	382	191	14,203	3,514	3,514	17,562	$2,433	$0.14
Showerhead 1.5 gpm	SF	Year Round	Hardware	SF Households	5,072	3,804	10,144	34,997	34,997	243,352	$30,430	$0.13
Showerhead 1.5 gpm	MF	Year Round	Hardware	MF Households	1,973	1,480	2,960	13,616	13,616	94,663	$8,880	$0.09
Showerhead 1.5 gpm	NR	Year Round	Hardware	NR Accounts	43	32	430	12,160	12,160	85,216	$1,290	$0.02
Total					N/A	N/A	N/A	214,526	214,526	1,629,977	$1,485,132	$0.91

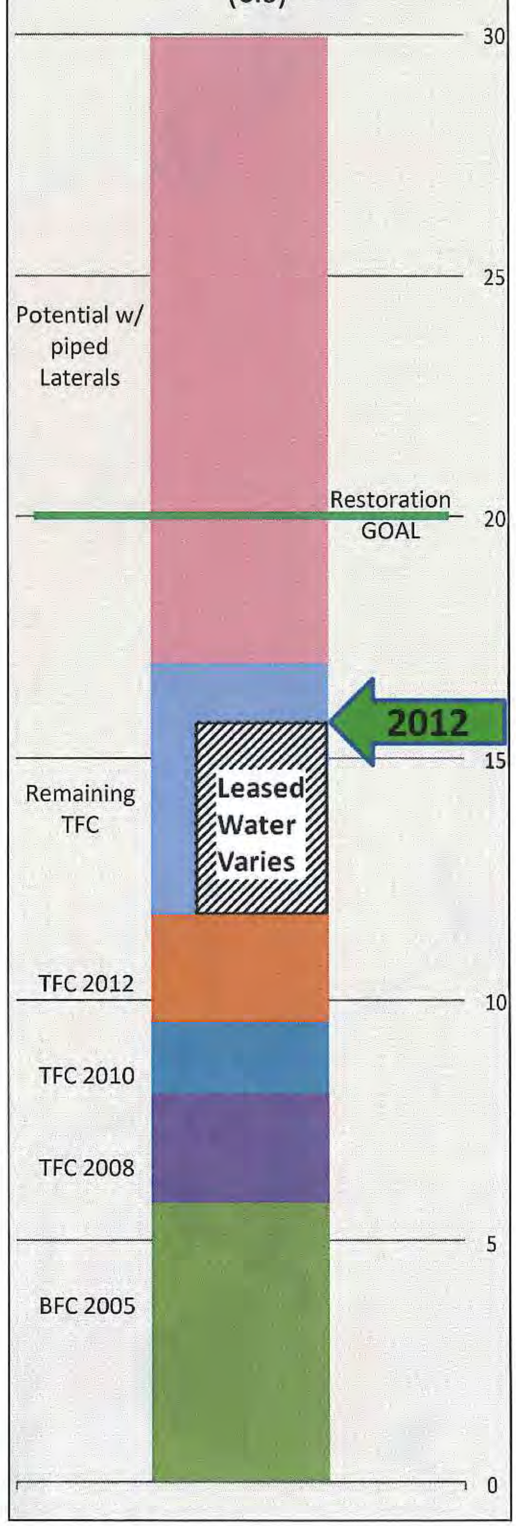
SF – Single Family, MF – Multifamily, NR – Non-Residential

1. Savings from free riders have been omitted from this column, since this number is used in the cost-effectiveness calculation.
2. For the number of potential customers, look at the number of SF households, MF households, MF accounts, or NR accounts (as applicable) in Table 4 Demographics.

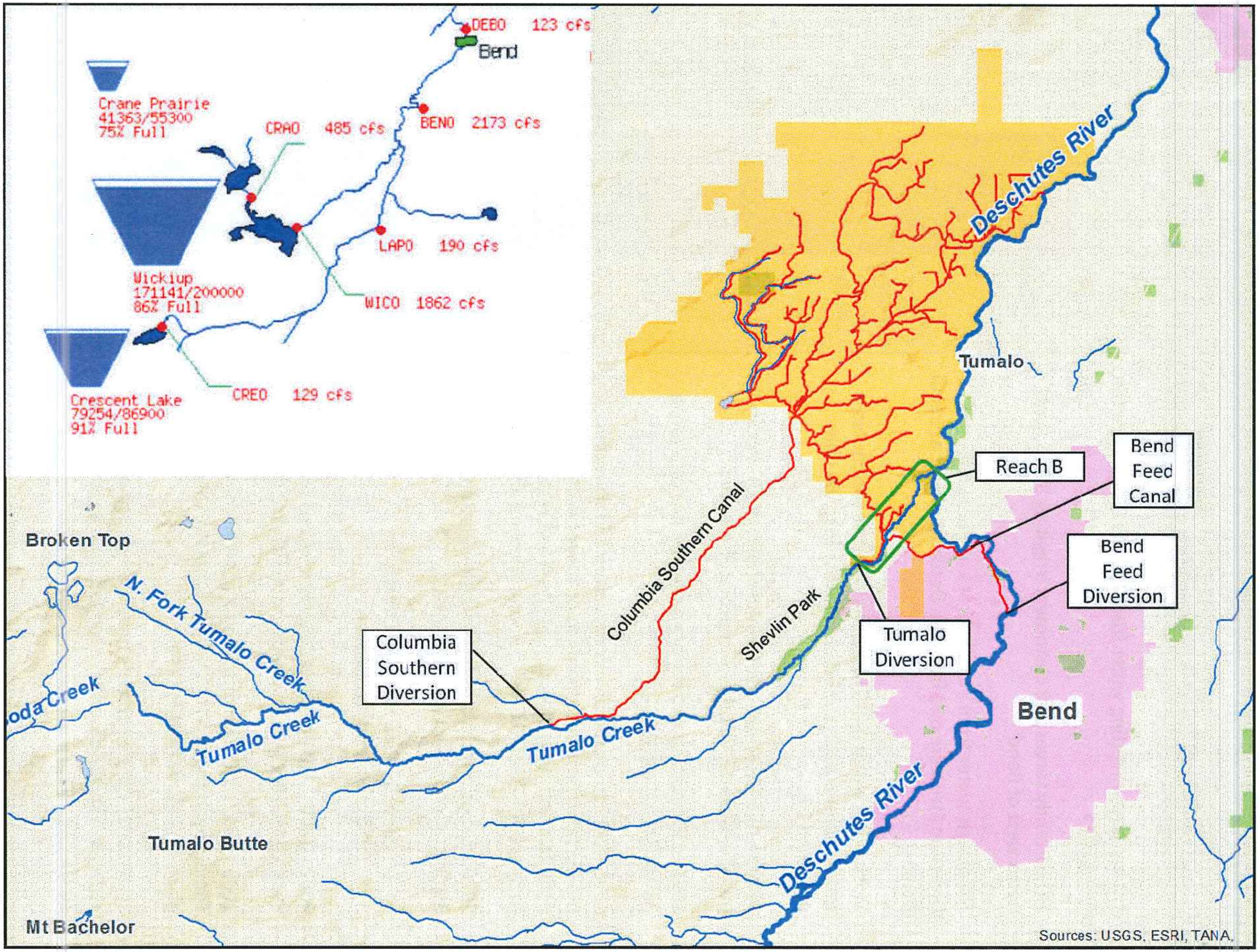
Tumalo Irrigation District
Fact Sheet—2012

- TID has been diverting water from Tumalo Creek since the mid 1880's
- TID currently serves 658 customers irrigating 8,115 acres north west of Bend
- TID diverts water from Tumalo Creek at the Tumalo Diversion Structure and from the Deschutes River at Stiedl Dam.
- Most of the water that TID diverts from the Deschutes is water that has been stored at Crescent Lake, 80 miles upstream.
- 1990's - due to drought, and water shortage TID began the push to conserve water and improve efficiencies
- 1995 - TID financed and replaced the Red Rock siphon, a 72" wood stave pipe.
- 1998 - TID completed an infrastructure and diversion modification project resulting in no longer using the Columbia Southern Diversion or Canal and restoring flow to 9 miles of Tumalo Creek through Shevlin Park.
- 2000 - TID submits Water Conservation Plan and identifies 30,000 AF of conservation potential
  - Phase 1 - Pipe the Feed Canals
  - Phase 2 - Pipe the Laterals
- 2002 - 2005 - TID completed piping sections of the Bend Feed Canal (BFC) which wraps around Awbrey Butte.
- 2008 - 2012 - TID has completed 2 miles of the 6 mile Tumalo Feed Canal (TFC). When complete, this project will place 11.2 cfs in Tumalo Creek.
- Since 2001, TID's customers have leased their water instream. These leases have ranged from 4 cfs to almost 10 cfs

Tumalo Creek Conserved Water (cfs)



BFC = Bend Feed Canal
TFC = Tumalo Feed Canal



DEBO 123 cfs
Bend
Crane Prairie
41363/55300
75% Full
CRAO 485 cfs
BENO 2173 cfs
LAPO 190 cfs
Wickiup
171141/200000
86% Full
WICO 1862 cfs
Crescent Lake
79254/86900
91% Full
CREO 129 cfs
Deschutes River
Tumalo
Reach B
Bend Feed Canal
Bend Feed Diversion
Tumalo Diversion
Columbia Southern Canal
Shevlin Park
Columbia Southern Diversion
Broken Top
N. Fork Tumalo Creek
oda Creek
Tumalo Creek
Tumalo Creek
Bend
Deschutes River
Tumalo Butte
Mt Bachelor
Sources: USGS, ESRI, TANA.

Tumalo Creek Restoration Subgroup

Formed from Resolution 2867 (see handout)

- ✓ 1. Describe Current Status / Learn about Tumalo ID
- ✓ 2. Set Mutual Restoration Goal (20 cfs in Reach B)
- ❑ 3. Create List Mutual agreed projects
- ❑ 4. Create Funding Strategy
- ❑ 5. Determine Partners / Processes / related projects

- ❑ Come back to Council / TID Board with regular updates, policy direction check-ins

Water Conservation on Tumalo Creek by Tumalo Irrigation District

Presented to City of Bend Council
July 18, 2012

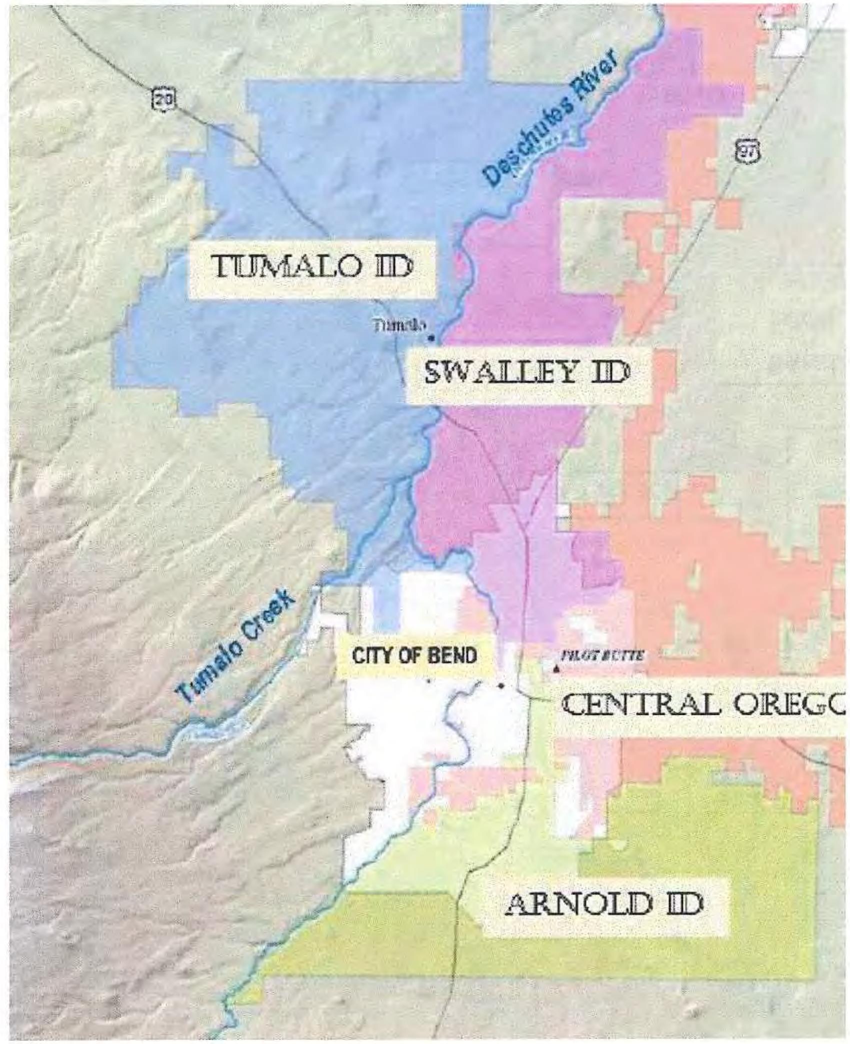
By:

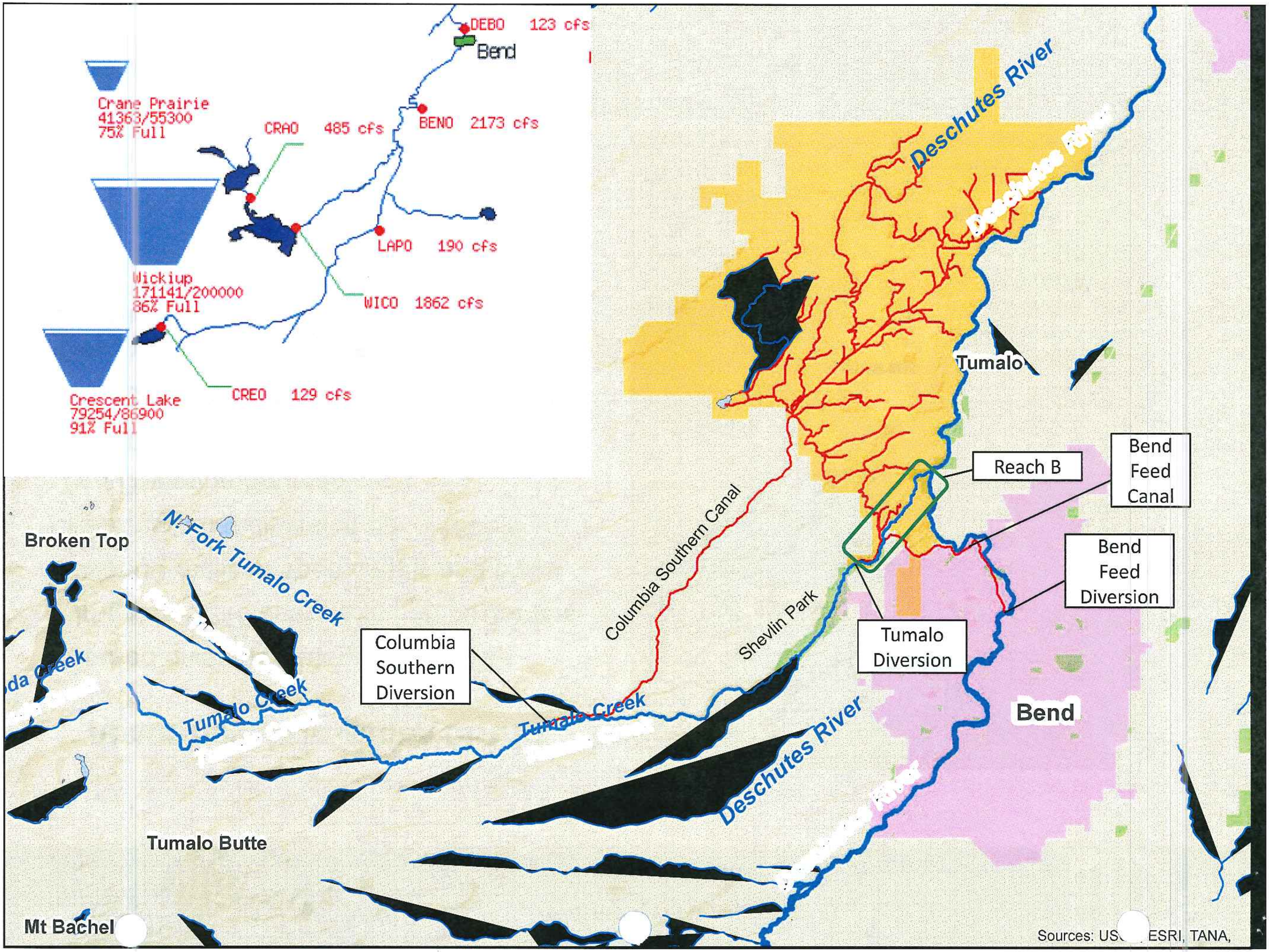
Ron Cochran – TID Board President
Elmer McDaniels, TID Manager
Kenneth Rieck, TID Assistant Manger
Jon Burgi, DEA – District Engineer

Water Conservation on Tumalo Creek by Tumalo Irrigation District

About Tumalo Irrigation District

- Started diverting water in the 1880's
- Irrigates 8,115 acres with 658 customers
- Over 80-miles of open canals and pipes
- Peak summer diversion up to 180cfs
- Two Diversion Sources
    - Tumalo Creek below Shevlin Park
    - Deschutes River near Pioneer Park
- Deschutes River water is natural flow and Crescent Lake Storage

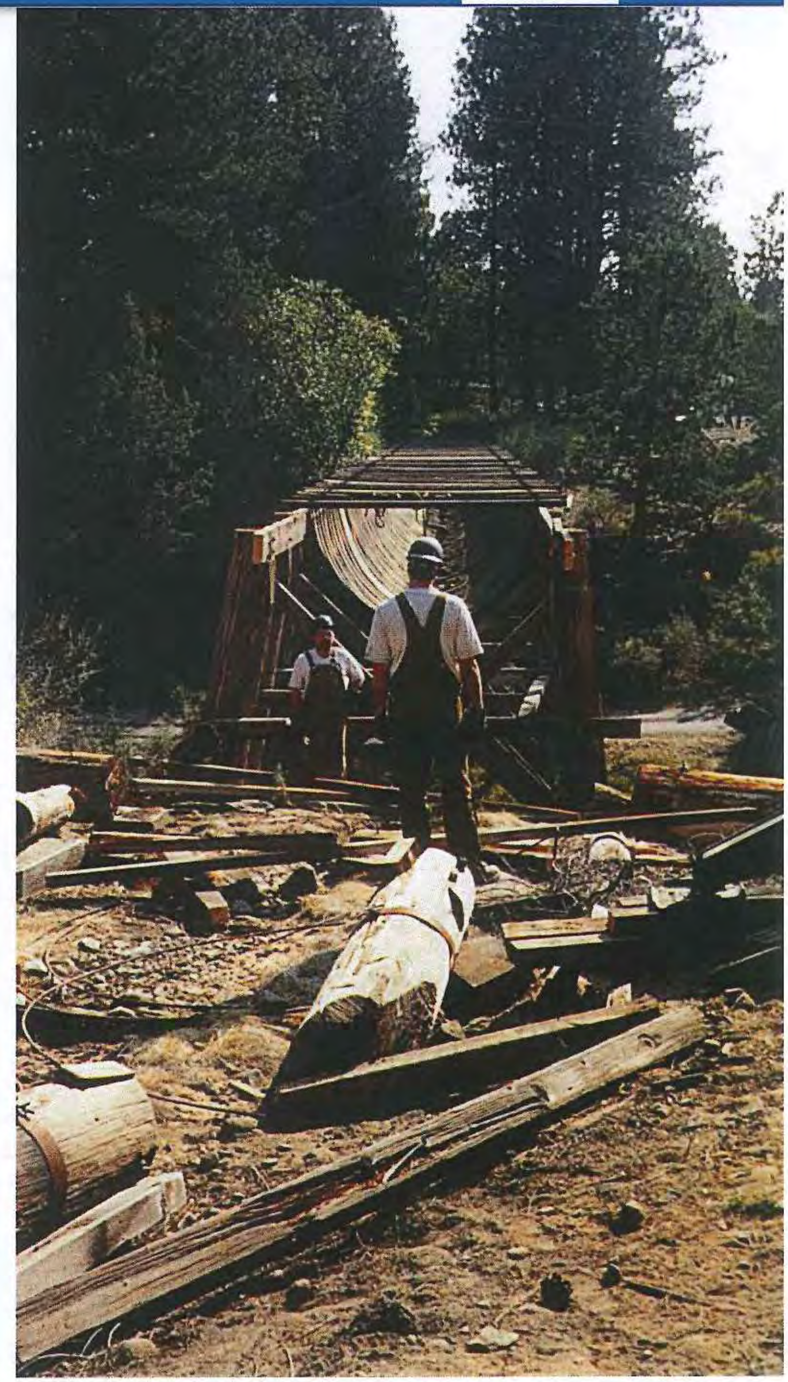




DEBO 123 cfs
Bend
Crane Prairie
41363/55300
75% Full
CRAO 485 cfs
BENO 2173 cfs
LAPO 190 cfs
Wickiup
171141/200000
86% Full
WICO 1862 cfs
Crescent Lake
79254/86900
91% Full
CREO 129 cfs
Deschutes River
Tumalo
Reach B
Bend Feed Canal
Bend Feed Diversion
Tumalo Diversion
Columbia Southern Canal
Shevlin Park
Columbia Southern Diversion
Broken Top
N. Fork Tumalo Creek
Tumalo Creek
Bend
Deschutes River
Tumalo Butte
Mt Bachel
Sources: US ESRI, TANA,

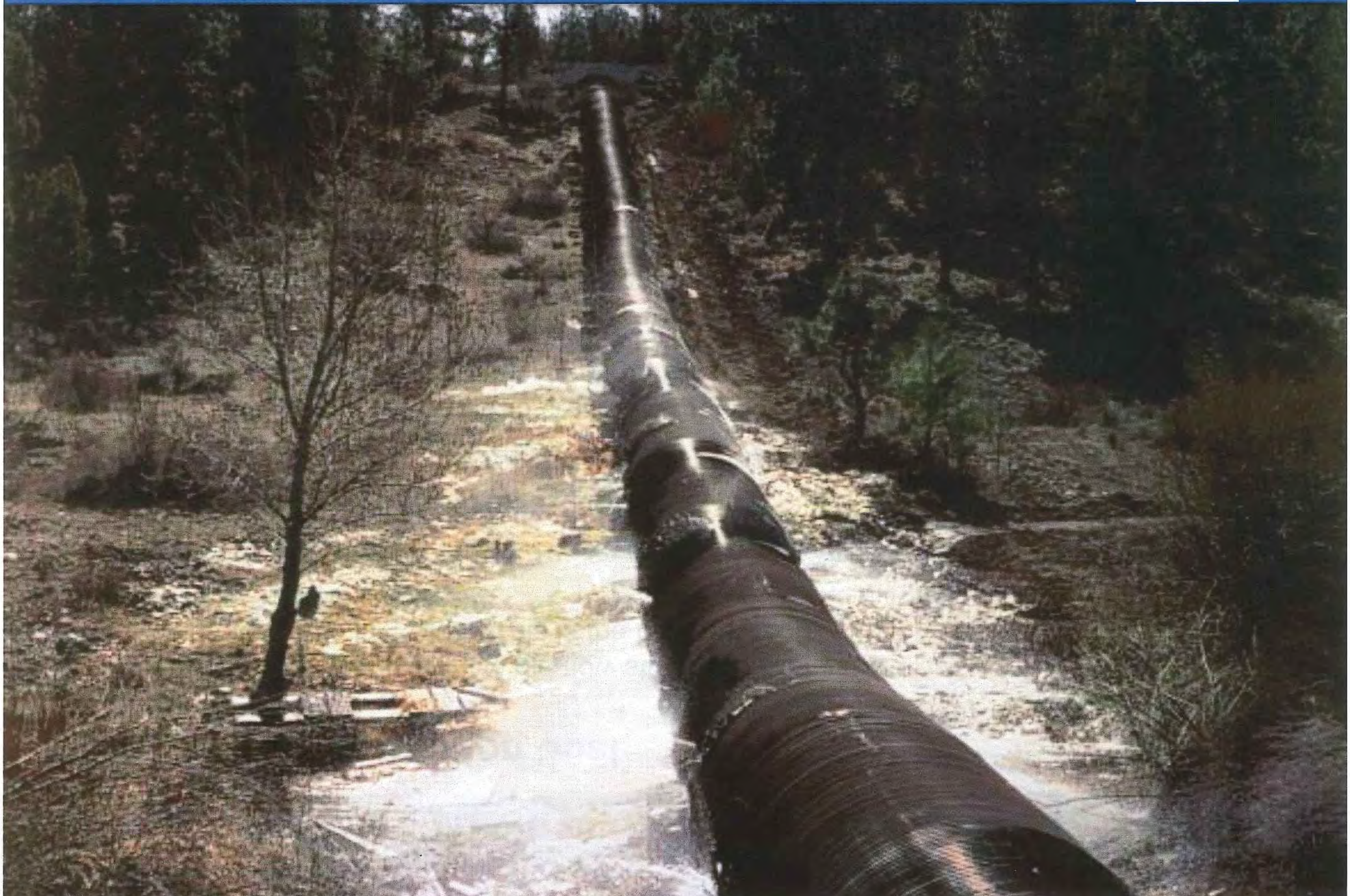
Water Conservation/Piping – Why bother?

- Consistent Delivery of Water
  - Prior to conservation efforts, TID was often unable to deliver full deliveries to users.
- Aging infrastructure
  - Safety and efficiency concerns associated with old flumes, siphons, and threat of canal breaches
- Urbanization
  - Access, Aesthetics, Attractive nuisance (Open Canals)
- Environmental Reasons
  - DEQ Water Quality Issues (Total Maximum Daily Loads)
  - Endangered Species Act (Habitat Conservation Plan)
  - Fishery Issues



Water Conservation on Tumalo Creek by Tumalo Irrigation District

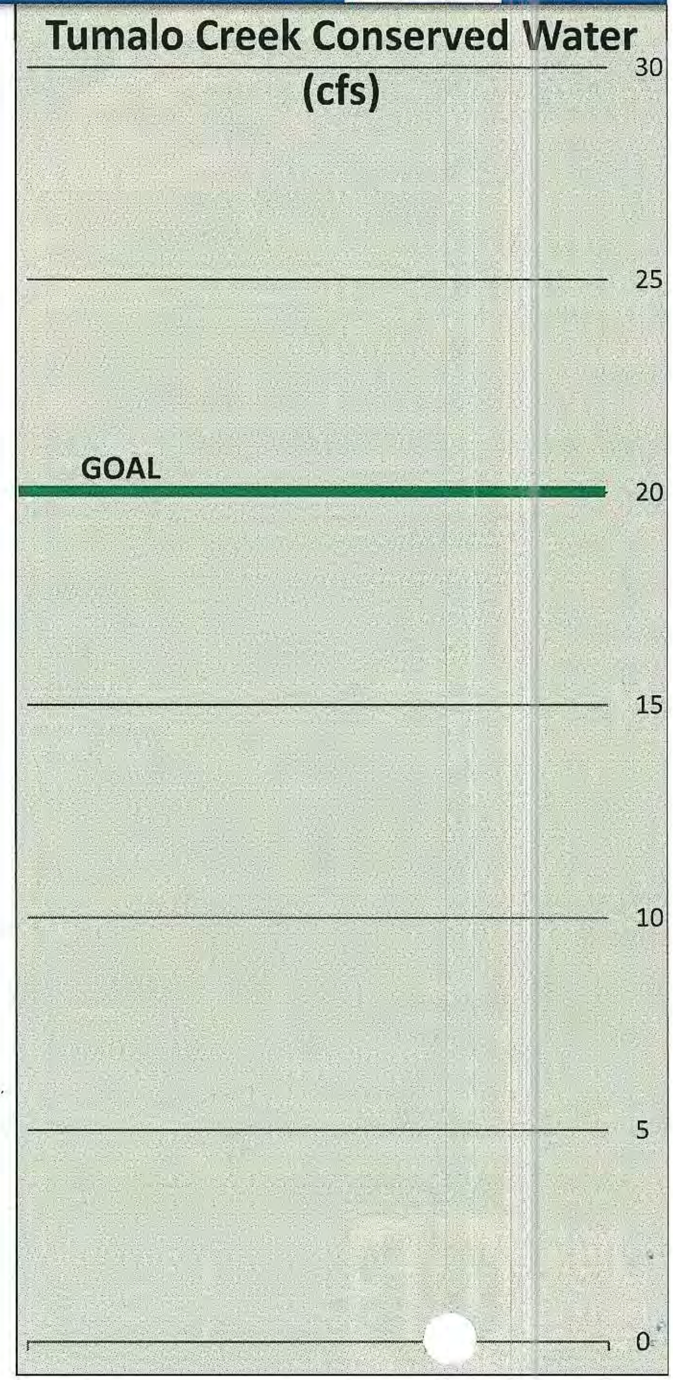
Water Conservation on Tumalo Creek by Tumalo Irrigation District



Setting A Flow Restoration Goal

- Oregon Dept of Fish and Wildlife did flow studies to protect fish around the state in 1980s. This is the best available science. For Tumalo Creek:
  - "Minimum" flow target set for 10 cfs (already met!)
  - "Optimum" flow target set for 32 cfs
- DRC/DWA also set restoration target of 20 cfs (2006 Study)
- Oregon Water Resources has also created a *junior instream water right* on the creek with a priority of 1990, of 32 cfs.

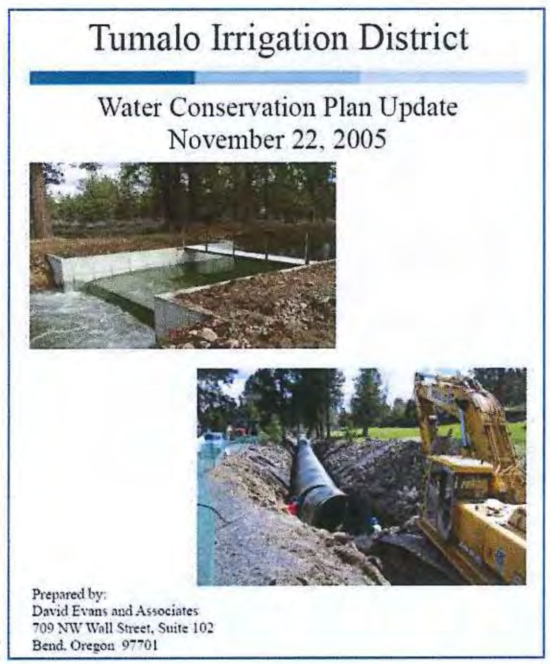
- Subgroup decided to use the attainable goal of 20 cfs.



Water Conservation on Tumalo Creek by Tumalo Irrigation District

Where we began:

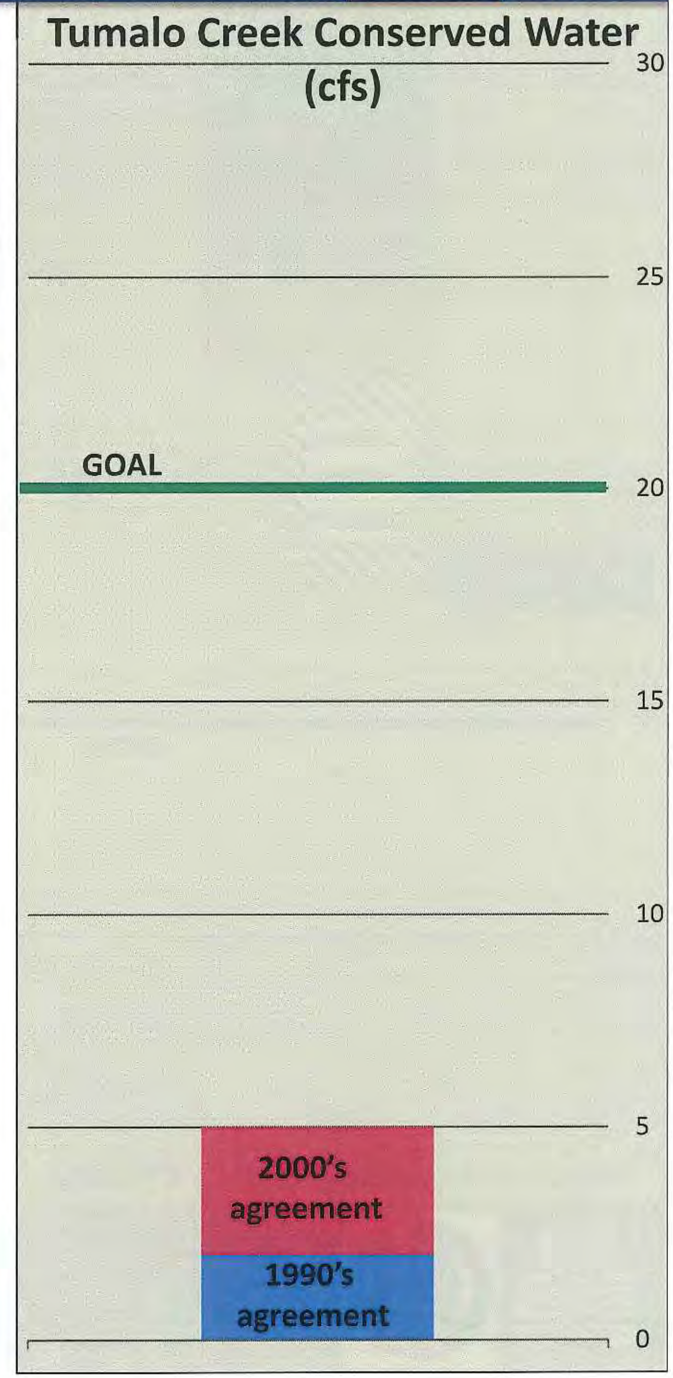
- In the 1990's, due to drought, water shortage and aging/failing infrastructure, TID began the push to conserve water.
- In 1995 TID replaced the Red Rock Siphon
- In 1998 TID completed the "Double Barrel" Project, restoring 9 miles of Tumalo Creek. (see map)
- In 1992 and 2000, TID made Gentlemen's Agreements to leave some water in Tumalo Creek
- In 2000 TID submitted the first Water Conservation Plan from the Agricultural community in the State of Oregon
    - Plan showed Conservation potential of over 30,000 AF



Tumalo Irrigation District

Water Conservation Plan Update
November 22, 2005

Prepared by:
David Evans and Associates
709 NW Wall Street, Suite 102
Bend, Oregon 97701



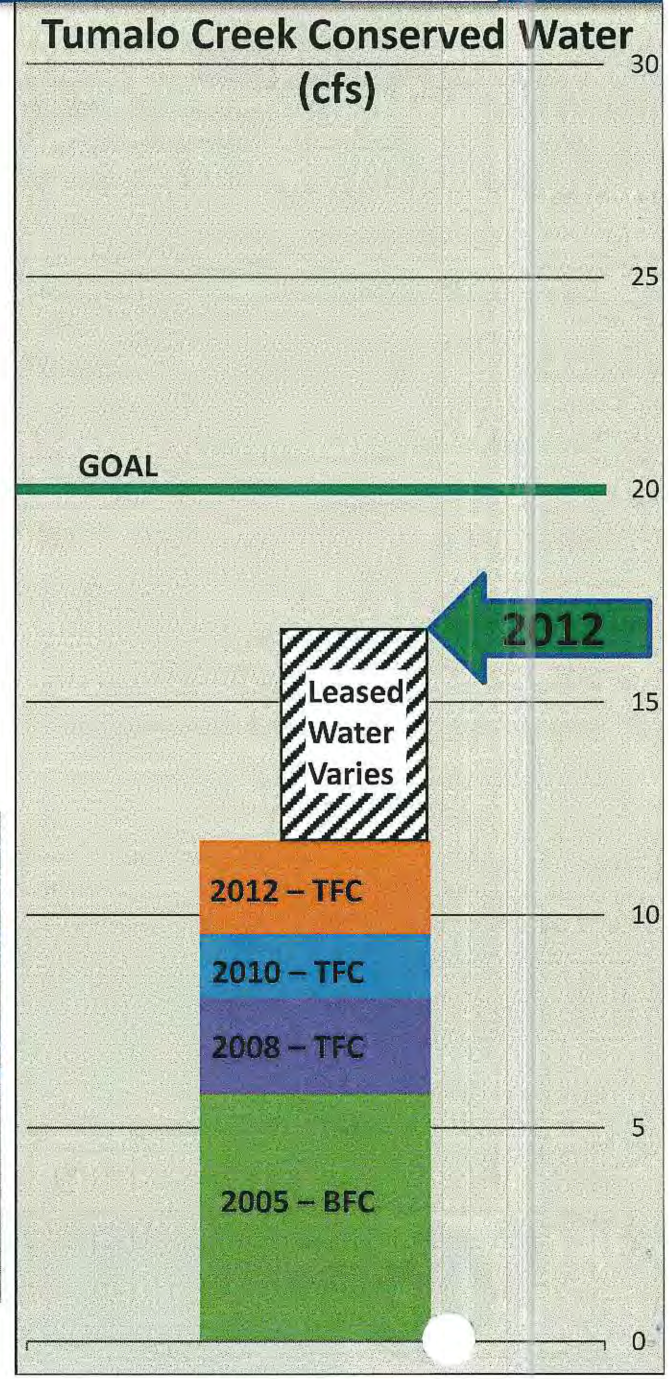
Water Conservation on Tumalo Creek by Tumalo Irrigation District

What we have done:

- The first Phase of the implementation of the Water Conservation Plan was piping both Feed Canals (Bend and Tumalo)
- Bend Feed Canal Projects - 2002 – 2005 Complete
- Tumalo Feed Canal Projects - 2008 – Present

Leasing:

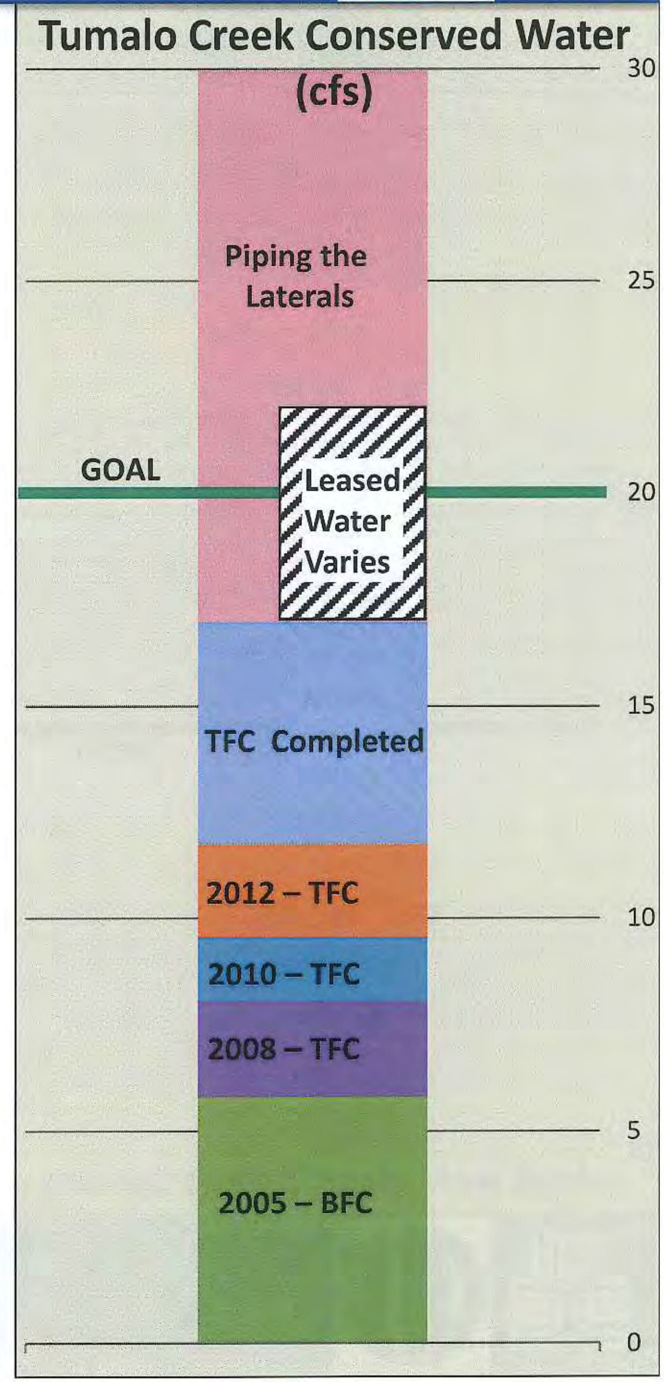
- Since 2001, TID has been leasing water instream. Average of ~5 cfs per year.



What is left to do?

- **Complete the Tumalo Feed Canal**
    - When TFC is completed, there will be 17 cfs protected *senior* water in Tumalo Creek.
    - With current instream leasing averaging ~5 cfs annually, this will protect 22 cfs in Tumalo Creek

- **Begin piping the laterals**
    - By piping the laterals, TID will continue to save water and improve management of the water
    - In addition to conserving water, the laterals will deliver pressurized water to a majority of the district
        - Potentially saving enough power for over 400 homes (5,000,000 kW/hrs per year)

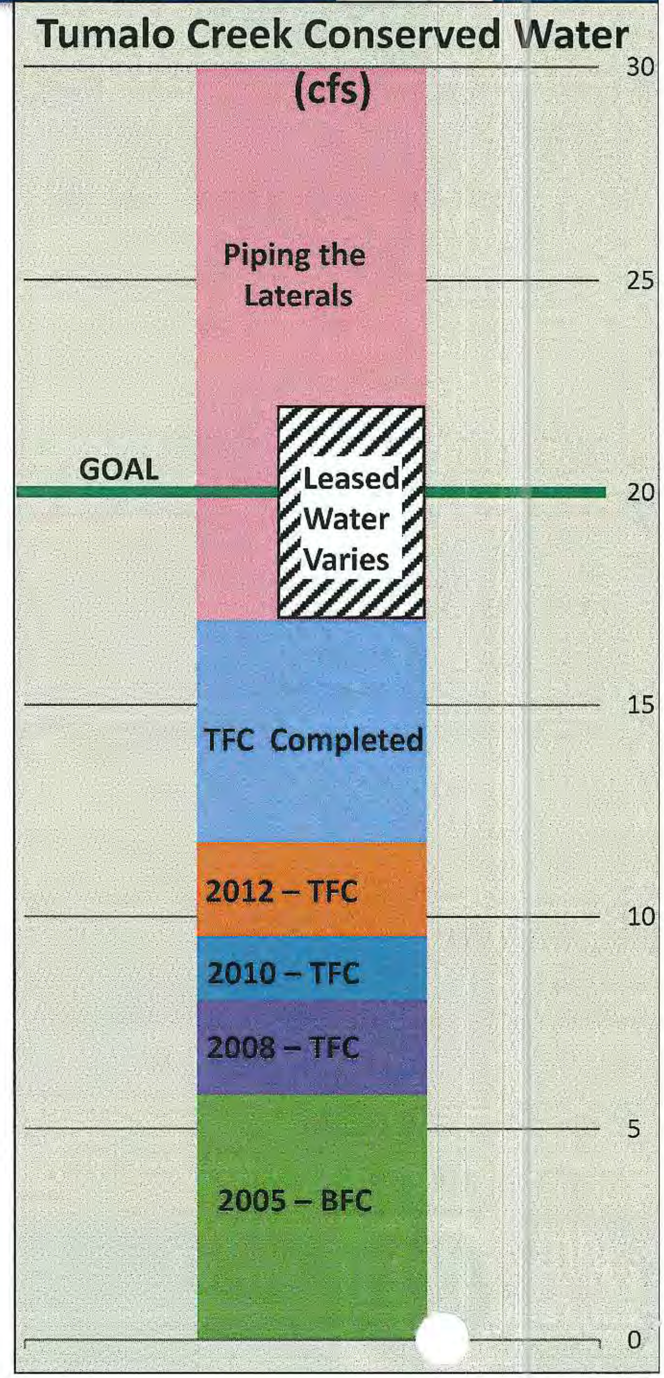


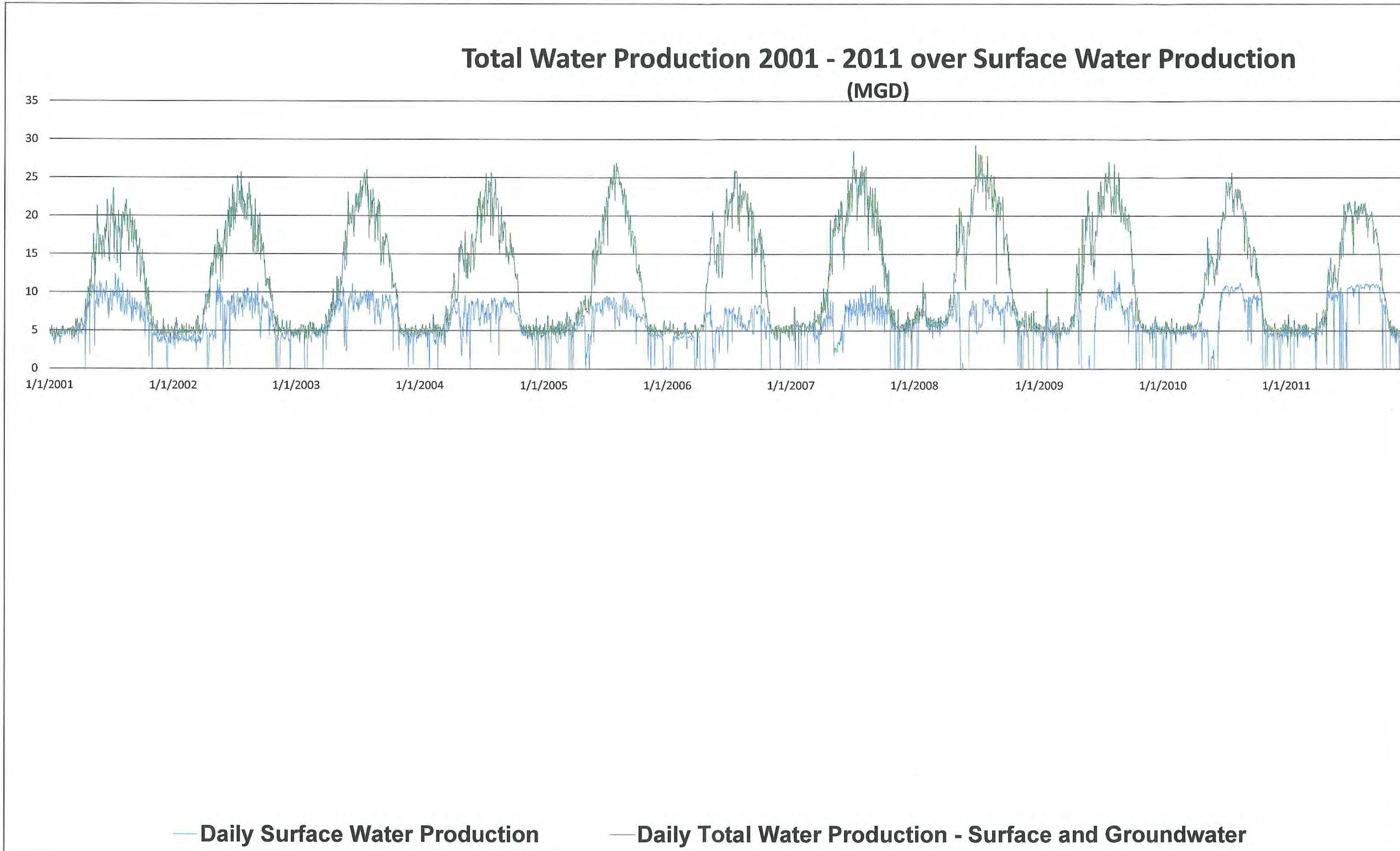
Water Conservation on Tumalo Creek by Tumalo Irrigation District

The Goal is in Sight:

- At completion of Tumalo Feed Canal with Leasing: over _22 cfs will be left instream_.
- When the Laterals are completed, up to 30 cfs could be returned permanently instream.

All **needs can be met....**
Agricultural**,**
Instream**,**
and Municipal




Total Water Production 2001 - 2011 over Surface Water Production
(MGD)
35
30
25
20
15
10
5
0
1/1/2001
1/1/2002
1/1/2003
1/1/2004
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
Daily Surface Water Production
Daily Total Water Production - Surface and Groundwater

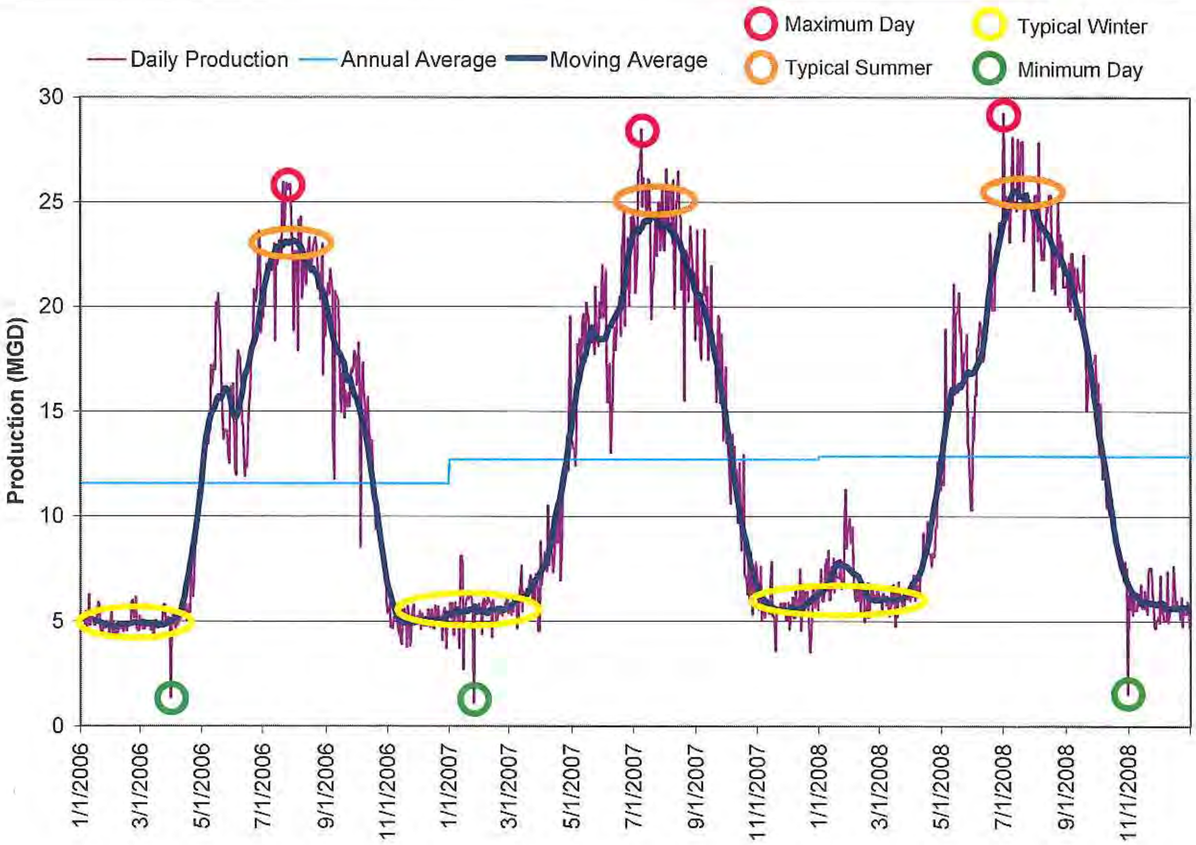


Figure 3.4 – Historical production records for years 2006 to 2008 – Daily production

Table 3.2 – Bend system demand factors (relative to Average Day)

Scenario	Factor
Minimum Day(1)	0.10
Typical Winter Day(1) (2)	0.40
Average Day	1.00
Typical Summer Day(1) (2)	1.85
Maximum Day(1)	2.25
Peak Hour(3)	4.05

(1) Calculated based on historical data from 2006 to 2008

(2) These factors have been adjusted based on the 2009 winter (January) and summer (July) periods used by MSA to develop the calibrated EPS model. Historical records show the typical summer to average day ratio may be closer to 2.

(3) A peak hour to maximum day demand factor of 1.8 has been calculated from hourly production data collected in 2008 and 2009. The 2007 Master Plan used MD:PH ratio of 1.5

City of Bend Water Rights by Seniority, Season of Use

Priority date	Irrigation Season (cfs)	Non-Irrigation Season (cfs)	Notes
Senior to all other rights	6	6	Most senior, year round right Certificate 85526
8/5/1900	2	0	Certificate 31411
9/30/1900	4.5	0	Certificate 31411
6/1/1907	0.02	0	Certificate 31411
9/30/1900	1.314 1.62	0	Certificate 31665 Transfer B-112
4/28/1905	0.186	0	Certificate 31665
6/1/1907	1.103 0.39	0	Certificate 31665 Transfer B-112
10/29/1913	3.98	0	Transfer B-112 Depending on creek flows, portions of this priority date amount may not be available during periods of distribution
12/12/1983	12.2*	12.2	Certificate 85713 *Very Junior and frequently not available during irrigation season
12/12/1983	2.8*	2.8	Permit S-49823 *Very Junior and frequently not available during irrigation season
Senior Water Right *Available* by season of use	**21.113**	**21**	
TOTAL Water Rights	**36.113**	**21**	

(green)	Most senior water rights, available year-round
(blue)	Senior Irrigation Season Only water rights
(orange)	Junior Irrigation Season Only water rights
(purple)	Year-round right, junior during irrigation season

Revised 12-14-12 (Transfer B-112 . 5.99 cfs, now broken out by priority dates)

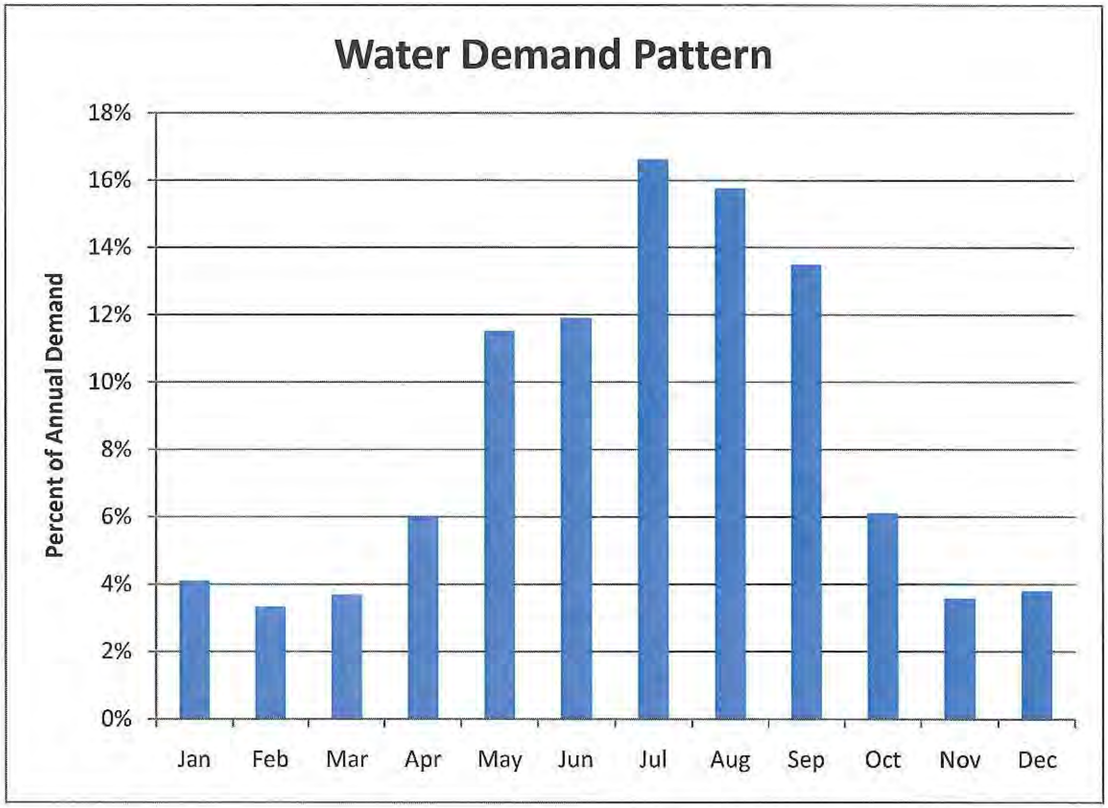


Figure 5. Historical water demand pattern

4 Cost Analysis Assumptions

This section describes some of the assumptions used in the cost analysis.

4.1 Cost Evaluation Period

Deciding whether to re-invest in its surface water supply is an important long-term decision, given that elements of the existing surface water system have lasted over 80-years (since 1926). Although a new surface water project is anticipated to last 80-years or longer, this cost evaluation has been limited to a 50-year time frame. Extending the cost evaluation beyond 50-years will favor the water supply alternative with the lower operating costs.

4.2 Future Cost of Power

A long-term decision on whether to re-invest in the surface water system requires understanding the operational cost differences between a new surface water system and replacing the surface water system with groundwater, so power consumption and costs must be estimated over the evaluation period of 50-years. Data from the Northwest Power and Conservation Council was used to estimate potential power cost increases over the 50-year planning period

City of Bend
Reach "A" Diversion Rate since 1950's

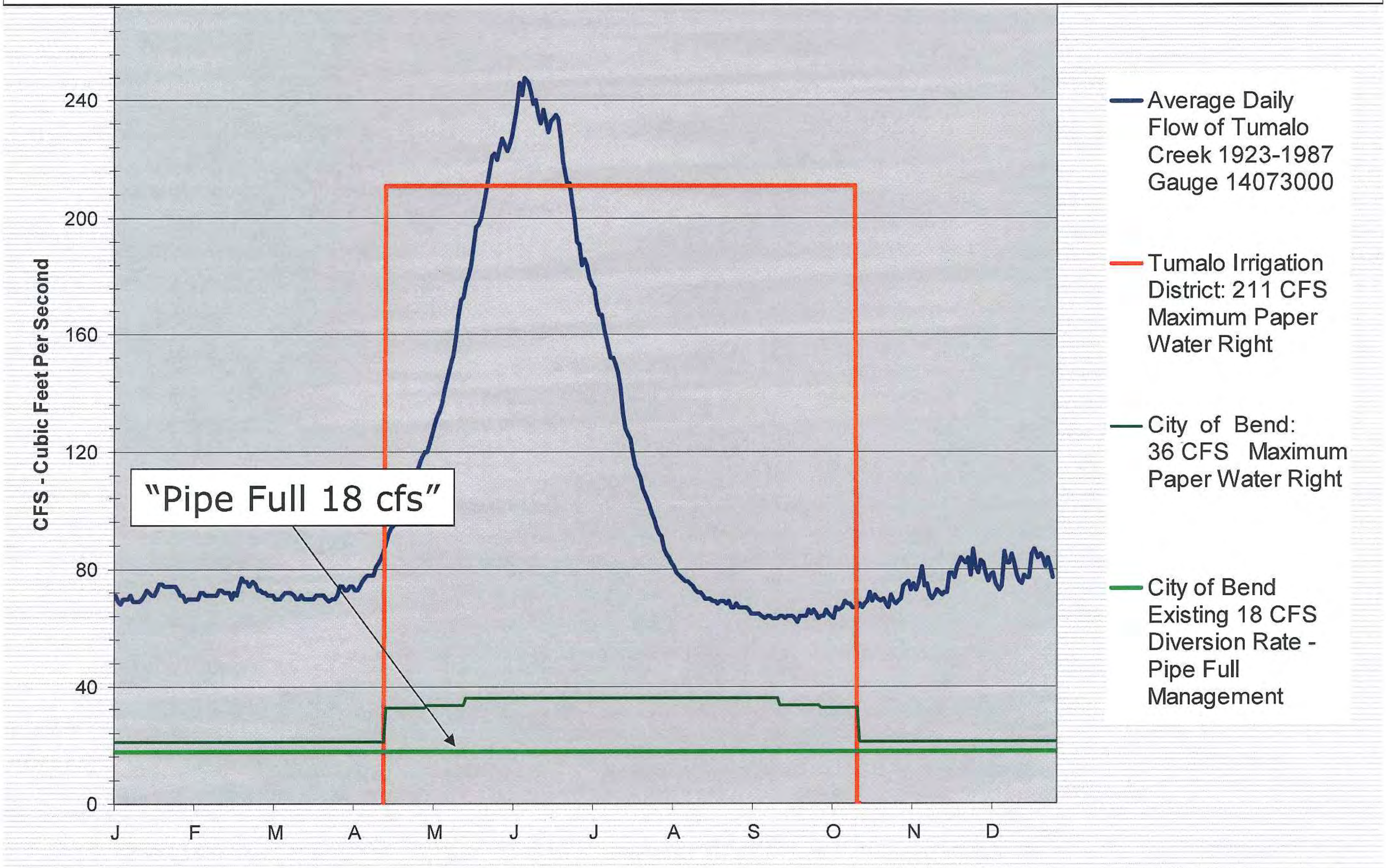


Table 3.3 shows current, 10-year and Build-out demand estimates for the Bend system. Figure 3.5 provides a representation of how the demands have been built up from information relating to residential and non-residential developable areas in the system.

Table 3.3 – Current and projected future water demand summary

Year	Water Demand (MGD)		
	Average Day Demand (ADD)	Maximum Day Demand (MDD)	Peak Hour Demand (PHD)
2008 (1)	12.8	29.2	48.0
10-year projection	21.0 (2)	47.3 (4)	113.4 (5)
Build-out Development (6)	37.1 (3)	83.5 (4)	200.3 (5)

Notes to Table 3.3:

(1) Existing demand based on 2008 water production records.

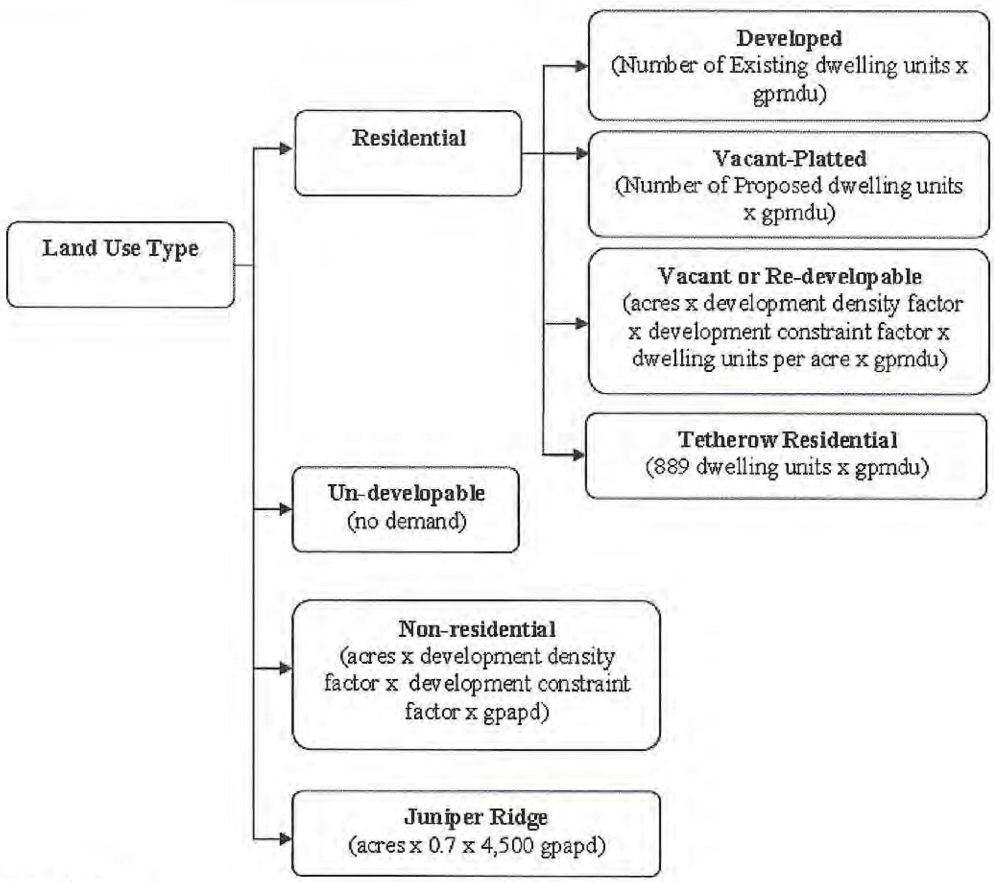
(2) 10-year ADD developed based on 172 gpcpd residential demand and 3,200 gpapd non-residential demand.

(3) Build-out ADD developed based on 172 gpcpd residential demand and 4,000 gpapd non-residential demand.

(4) MDD equals the ADD x 2.25 (based on historical data, see Table 3.2). Note: the 2007 MP used AD:MD of 2.3.

(5) PHD factors based on summer diurnal patterns developed by MSA are 2.87 in residential areas and 1.84 in mixed use areas, with a system wide peaking factor of 2.4. Note: the 2007 MP used PH:MD of 1.5 (textbook value).

(6) Includes Juniper Ridge at 515 acres by 2030 (4,500 gpapd), and Tetherow at 889 residential units



Definitions:

gpmdu: gallons per minute per dwelling unit = 2.4 people per dwelling unit times 172 gallons per capita per day

gpapd: gallons per acre per day

development density factor: 0.85 for residential and 0.7 for non-residential

development constraint factor: Constrained = 0.5, Unconstrained = 1.0

Figure 3.5 – Water Demand Flow Chart
(per *Water Model Development Documentation*, MSA, August 2010)

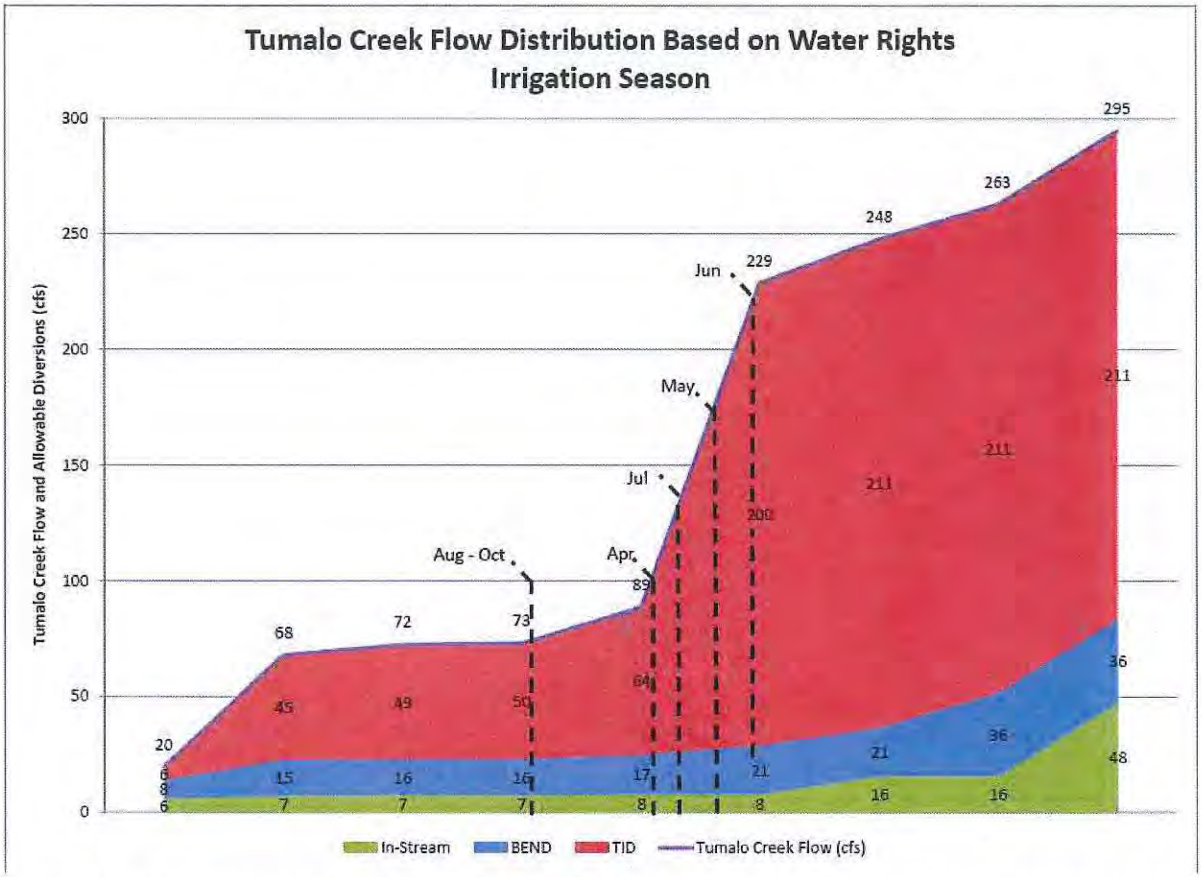


Figure 4. Distribution of Water Rights on Tumalo Creek during periods of low stream flow (vertical dashed lines indicate typical flow values for that month)

Lower water demands also limit the amount of water that would be diverted under the Build alternative. During about one-half of the year, the City's current water demand is 10 cfs or less. In the non-peak season water-use months, it is anticipated that demand will not reach the 21 cfs modeling scenario until approximately 2040. The City is planning for this winter demand to grow over time. However, until it does, lower demand will limit the City's actual diversion during non-peak season water-use months to less than the capacities of the No-Build and Build systems, and to less than what was modeled to assess potential environmental impacts in this memorandum.

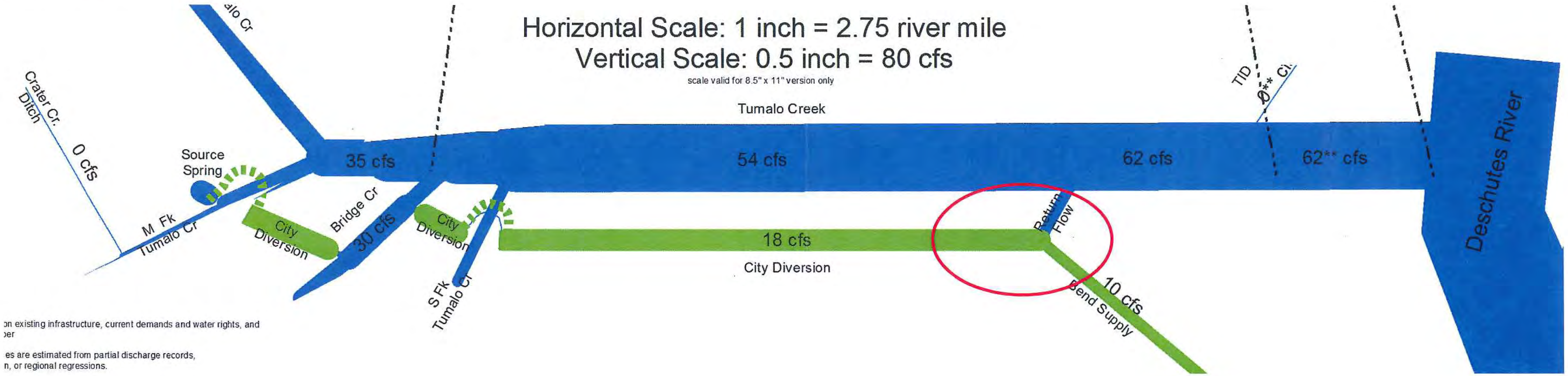
The water supply capacity of the system could be limited by the design of facilities. For example, the design of the water filtration facility is for 21 cfs flow rate on a long-term sustainable basis.

3.4 Hydrology Under the No-Build and Build Alternatives

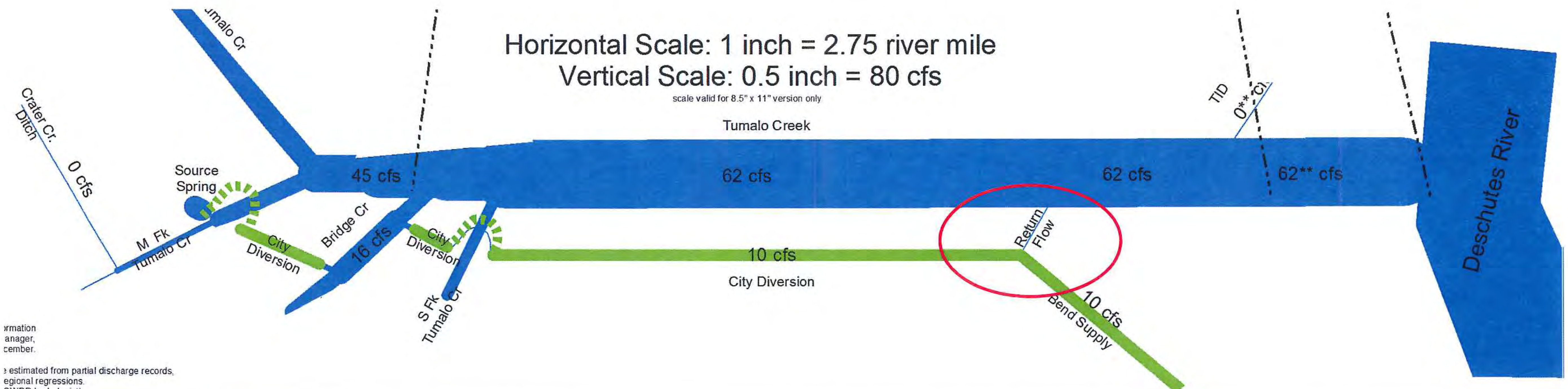
This memorandum provides a description of maximum diversions and a forecast of minimum creek flows under the No-Build and Build alternatives. The purpose of the forecast is to provide a basis for estimation of fish habitat under each alternative. As noted under the "Limitations" section, the diversion scenarios under the Build alternative is simplified and is a maximum. The actual diversions can

NON-IRRIGATION SEASON (WINTER FLOWS, Typical December)

Existing

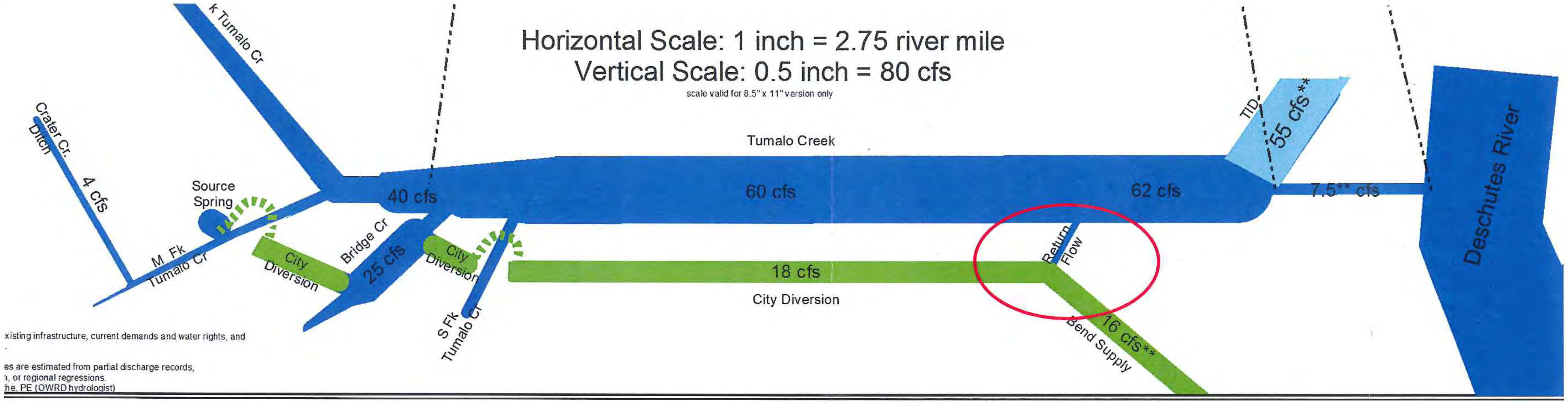


Proposed

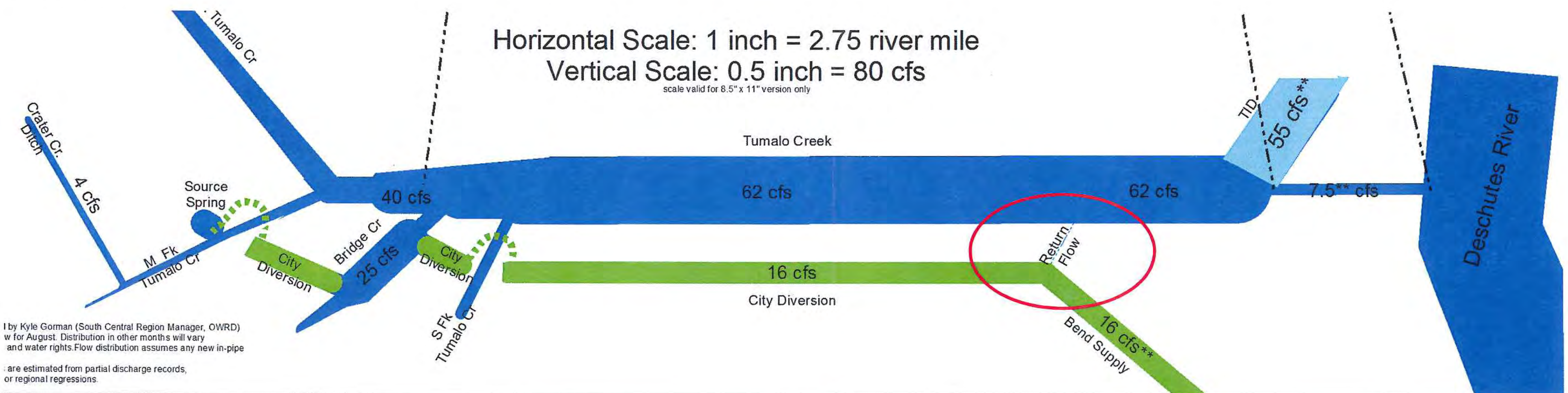


IRRIGATION SEASON (SUMMER FLOWS, Typical August)

Existing



Proposed



HISTORY OF THE WATER SYSTEM

1964 WATER MASTER PLAN

II. HISTORY OF THE WATER SYSTEM

General. Water has played a vital role in the history of Bend, and will be an important factor in shaping the future of the City. The availability of water, its quality, and cost have a great influence on the rate and pattern of growth of any community, and this is particularly true in the case of Bend.

Prior to the founding of the City in 1905, the present site of Bend was noted as a good place to ford the Deschutes River and the last place to get good water before crossing the desert plains. To the westward-bound traveler the inviting shade of the pine trees and the abundant clear, cool water were a welcome sight. It was under the influence of the early development of irrigation and timber resources that Bend became a town.

The Original Supply. In 1905 the Bend Water, Light, and Power Company and John Steidl built the original public water system, utilizing the Deschutes River as the source of supply and laying pipelines to distribute water for domestic use and fire protection.

In the summer of 1923, the flooding of thousands of acres of wooded and meadow lands for the first time, following completion of dams at Crane Prairie Reservoir and Crescent Lake, resulted in prolific blooms of algae. Water released from reservoir storage to the Deschutes River had a disagreeable taste and odor. The Water Company made an unsuccessful attempt to secure a supply of water from Tumalo Creek, and then constructed a filter plant in an attempt to render the water palatable.

In the meantime, the State Engineer had fixed a date for hearings in the matter of adjudication of the waters of the Deschutes River and its tributaries. The City Council, impressed with the necessity of establishing the City's water rights, began an investigation of possible sources of water supply and preparation of data for submission in the adjudication proceedings.

After a personal visit by the City Council to Green Lakes, filings were made in the State Engineer's office on Green Lakes, Soda Creek, Fall River, and Spring River. These applications were held on file until the feasibility and cost of developing these various sources of supply could be determined.

The Dubuis and Redfield Report. Dubuis and Redfield, Consulting Engineers, were retained by the City in 1923 to study the water supply problem. Their report was submitted to the City in May 1924. It was a very thorough study and perceptive analysis of the water situation as it existed at that time.

They investigated and reported upon possible surface water supplies from Green Lakes, Soda Spring Creek, Tumalo Creek, Fall River, Spring River, and the Deschutes River.

Few water yield records were available for Green Lakes, and there was some indication that this source of supply might not be adequate the year around. Surveys made in 1923 showed the Lakes to lie 490 feet below the divide at Tumalo Creek, necessitating an expensive tunnel to make water from this source available by gravity for a municipal supply for Bend.

Dubuis and Redfield concluded that Soda Creek was deficient in supply, and, like Green Lakes, would require tunneling to be made available.

They reported an almost constant flow of cool, clear water from the spring-fed Fall River amounting to 115 to 122 cfs (cubic feet per second), which was considered more than adequate. However, the long distance (29 miles) from Bend and the attendant high construction costs eliminated Fall River from serious consideration at that time.

Spring River with a discharge of about 175 cfs is about 15 miles from Bend. Quality at the source was good, but backwater from the proposed Benham Falls Reservoir would cover the springs with about 40 feet of water. The consultants recommended setting aside consideration of Spring River until the idea of constructing Benham Falls Dam was definitely abandoned.

The 1924 report describes Tumalo Creek as a stream which rises on the eastern slopes of Ball Butte and Broken Top Mountain about 20 miles west of Bend, with a large part of its watershed in the Deschutes National Forest. The lowest flow recorded prior to the report was 46.5 cfs in September 1915, the mean daily flow for the same year being 83.3 cfs. The quantity and quality of this supply were judged to be more than adequate. At that time, water rights of Tumalo Creek were held jointly by the State of Oregon and the Deschutes County Municipal Improvement District.

The Deschutes River was still the source of water supply for Bend during the Dubuis and Redfield study. Treatment consisted of filtration and chlorination. The quantity of water available from the Deschutes River was sufficient, but taste and odor problems were difficult to handle by treatment methods then available.

The final selection of a source of supply lay between Tumalo Creek and the Deschutes River. Tumalo Creek had several advantages as compared to the Deschutes River. The gravity pressure of the Tumalo supply provided more reliable fire protection, since it was not affected by power outages or pump failures. Water from Tumalo Creek was of better quality than that pumped from the Deschutes. Estimated annual operation costs for the Tumalo supply were less than one-half those for the Deschutes supply, but the initial construction costs of the Tumalo supply were more than three times those for development of the Deschutes source. The total annual operation, depreciation, and interest charges were calculated by Dubuis and Redfield to be decidedly in favor of the gravity supply from Tumalo Creek, and they recommended that this source be acquired and developed.

Pursuant to this report, the City acquired the water system from the private company in 1926 and constructed a pipeline of 5 mgd (million gallons per day) capacity from Tumalo Creek to the City of Bend. The filter plant on the Deschutes was abandoned and removed. Since 1926, the municipal water supply has been obtained entirely from Tumalo Creek.

Reports by John W. Cunningham and Associates. A series of brief reports on the Bend water system were prepared by John W. Cunningham and Associates from 1948 to 1954.

In the first of these, in May 1948, they observed that the experience in 22 years of operation of the Tumalo supply had demonstrated the wisdom and soundness of the decision to utilize this source of supply. They commented that other sources should be considered only in case it proved impossible to get an enlargement of water rights from Tumalo Creek. They suggested that the City could always fall back on Deschutes River water, and stated that new water treatment techniques would make it possible to produce a high quality water in contrast to the results obtained with older methods in 1925. They reported the fact that the original Bend water right on Tumalo Creek amounted to 6 cfs or 3.88 mgd, and that this was subsequently augmented by the purchase of 2 cfs from users in the Tumalo irrigation project, making a right to use of 5.17 mgd in 1948. They pointed out that the low flow of Tumalo Creek at the point of diversion by Bend is adequate for any reasonable increase to meet the needs of the City, but that this must be accompanied by reduction in irrigation use, and that irrigation users must get their supply from some other source. The report recommended that the City make every effort to acquire additional water rights from Tumalo Creek up to 15 cfs. The length of the original 14- and 16-inch welded steel pipeline is given as 62,000 feet (11.75 miles), the available head as 1,150 feet, and the carrying capacity as 5.5 to 6.0 mgd. Reservoir storage in the City amounted to 3 mg (million gallons) in two steel tanks. The 1948 study showed the maximum daily use to be 420 gallons per capita. It suggested that universal metering of services might reduce water use by as much as 50 percent and that the cost of metering was only a frantion of the cost of increasing the available water supply by an equal amount. The 1948 report recommended, in addition to universal metering, construction of a 5 mg reservoir on Aubrey Butte, a cross-town high pressure main, and improvements to the water distribution system. It recommended that the construction of a storage reservoir on the north slope of Pilot Butte be deferred.

In May 1949, a supplement was issued to the May 1948 report. The City Council acted on the 1948 report by adopting an initial program of constructing the 5 mg reservoir on Aubrey Butte and a 0.5 mg reservoir on Pilot Butte. The May 1949 supplement brought cost estimates up-to-date and added further detail on some of the problems.

In July 1949, the City Council asked their consultants for a reappraisal of earlier recommendations, which resulted in a second supplemental report dated 1 August 1949. This dealt principally with reservoir sites, materials of construction, and other details, but introduced the idea of constructing, in stages, a second parallel pipe line from Tumalo Creek to the City.

A letter report, dated 7 September, 1949, considered flow conditions in sections of the original pipeline which were installed above the hydraulic gradient.

Cunningham and Associates made another report on 12 September 1950. It stated that the earlier recommendation for installation of water meters on all services had been rejected by the Council. The report mentions the fact that there are no favorable damsites on Tumalo Creek for construction of storage reservoirs to conserve excess winter runoff for summer use. This study raised the question as to whether it was necessary to construct 12 miles of pipeline to the original point of diversion when water of only slightly greater turbidity could be obtained from Tumalo Creek at a distance of only 6 miles from the City. A proposal was made for diversion at a point about 1-1/2 miles upstream from the west boundary of Shevlin Park. The water was to be carried by gravity to the City Limits, and thence pumped to the reservoirs. The plan was to use this source only in the summer months, at times of maximum demand for water and minimum turbidity in the creek. The new line was to be 16-inch diameter, 26,500 feet long, with a capacity of 3.5 mgd.

On 7 April 1953, a letter report was filed with the City preliminary to pipeline improvements for increasing the Tumalo Creek supply. The scheme for diversion above Shevlin Park had met with objection because of possible water pollution by livestock in the portion of the creek above the diversion, and the plan was eliminated when the bond issue was voted upon. In addition, the City acquired, by purchase, more water rights on Tumalo Creek in the amount of 3 cfs or 1.9 mgd, bringing the City's total water right at that time to 11 cfs or 7.1 mgd. This was greater than the capacity of the original pipeline, so that immediate construction was recommended to utilize the full water right. Consideration was given to installation of booster pumps on the existing line, but this idea was rejected because of the already high pipeline velocities and the cost of extending power lines to the booster pump locations near the upper end of the pipeline. The earlier proposal for construction of a second parallel line in stages was reiterated with the suggestion that certain sections could be constructed advantageously in the first stage of the work.

Letter reports of 16 September 1953 and 27 January 1954 were concerned with determining friction coefficients for sections of the existing pipeline, with rerouting of portions of the line which were above the hydraulic gradient.

Finally, a letter of 2 January 1954 from Cunningham and Associates presented an estimate for construction of a second parallel pipeline all the way from the existing point of diversion to the City. The first section of the new 12- and 14-inch line was laid in 1954, two sections of the line were placed in service in 1956, and the line was completed in 1957. The combined capacity of the two lines is 11.1 mgd, which is just equal to the present water rights held by the City or 17.17 cfs.

A reservoir of 1-1/2 mg capacity was constructed at Pilot Butte in 1960.

Other Studies. The City Water Department made a hydraulic analysis of the water distribution system in 1958 using the McIlroy Analyzer at Washington State College. The results of this study have been the basis for elimination of several hydraulic "bottlenecks" in the system and have served as a guide in determining the proper size of new mains.