Presented to:

City of Bend, Oregon

Water Management and Conservation Plan Final Report

December 2004

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Prepared by:

Economic and Engineering Services, Inc.
111 SW 5th Avenue, Suite 1670
Portland, Oregon 97204
(503) 223-3033

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Glossary[1]

Amendment, Water Right* Alters the conditions of a water right, for example, in order to add an additional point of appropriation.

American Water Works Association (AWWA) A professional organization serving the drinking water supply profession, primarily in North America.

Audit, Water System * A systematic accounting of water throughout the production, transmission, and distribution facilities of a water system.

Available Supply The maximum amount of reliable water supply, including surface and groundwater sources and purchases under secure contracts.

Average Day Demand (ADD) A water system's average daily use based on total annual water production divided by 365.

AWWA See American Water Works Association.

CCF A unit of measure equal to 100 cubic feet of water or 748 gallons.

CFS Cubic feet per second.

Conservation Rate (also Increasing Block Rate) A pricing structure in which the amount charged per unit of water (i.e., dollars per 1,000 gallons) increases as customer water consumption increases.

Consumption* The act or process of consuming water through use, waste, etc.

Consumptive Use Water use that permanently withdraws water from its source; water that is no longer available because it has evaporated, been transpired by plants, incorporated into products or crops, consumed by people or livestock, or otherwise removed from the immediate water environment.

Cooling Tower Equipment that uses water to regulate air temperature in a facility, either by rejecting heat from air-conditioning systems or by cooling hot equipment.

Customer Class A group of customers (e.g., residential, commercial, industrial, institutional, wholesale) defined by similar water-use patterns and costs of service.

Demand* The rate or volume of water used for a specific purpose.

Demand Forecast A projection of system wide future water demand or of future demand by a specific customer class.

Diversion An alteration in the natural course of a stream for the purpose of water supply, usually causing some of the water to leave the natural channel. See also "Withdrawal".

Drought An extended period of below-normal precipitation that can result in water supply shortages, increased water demand, or both.

Dual-distribution System A water distribution system that uses one set of pipes to distribute potable water and a separate set to distribute water of lesser quality (e.g., nonpotable reclaimed water).

Evapotranspiration (ET) Water lost from the surface of soils and plants through evaporation and transpiration, respectively.

Extension, Water Right An extension of time granted by Oregon Water Resources Department to a water right holder in order to complete construction and/or apply water to full beneficial use.

GPD Gallons per day

GPCD Gallons per capita per day

GPHD Gallons per household per day

Groundwater Water beneath the earth's surface; specifically, that portion of subsurface water in the saturated zone, where all pore spaces in the alluvium, soil, or rock are filled with water.

Groundwater Recharge Replenishment of a groundwater supply through natural conditions (e.g., percolation) or artificial means (e.g., injection).

Leak Detection Methods for identifying water leakage from pipes, plumbing fixtures, and fittings.

Maximum Day Demand (MDD) The highest daily recorded rate of water production in a year.

Maximum Monthly Demand The highest water use in any given month of the year. Reported in terms of an average rate over that month or as a total volume of monthly use.

MDD See Maximum Day Demand.

Glossary[1]

Meter An instrument that measures water use; often installed by a water utility to measure end uses, such as uses by a household, building, facility, or irrigation system.

MGD* Millions of gallons per day.

Mitigate Any action that helps offset impact of another action or project.

Non-consumptive Use Water withdrawn for use but not consumed and thus returned to the source.

Non-revenue Water* Water demand for which no revenue was collected. Calculated by taking the difference between the total amount of water produced less the total volume of water metered and sold.

Peak Day Demand* The highest daily recorded rate or volume of water produced from all water sources combined in the course of a year.

Peak Demand The highest total water use experienced by a water supply system, measured on an hourly, daily, monthly, or annual basis.

Peaking Factor The ratio of peak day to average day demand for a given year.

Per Capita Use The amount of water used by one person during a standard period of time; in relation to water use, expressed in gallons per capita per day.

Point of Appropriation* The authorized location of water diversion or withdrawal from a source.

Pricing Signals Rate structures that encourage water conservation.

Production* Water produced from a source or multiple sources.

Reclaimed Water (also Reclaimed Wastewater) Treated, recycled wastewater of a quality suitable for nonpotable applications, such as landscape irrigation, decorative water features, and nonfood crops; also described as treated sewage effluent.

Residential End Use of Water Study (REUWS) The Residential End Uses of Water study (1999) published by the American Water Works Association Research Foundation.

Surface Water Supply Water supplied from a stream, lake, or reservoir.

Transfer (also Conveyance of a Water Right) The passing or conveyance of title to a water right; a permanent assignment as opposed to a temporary lease or disposal of water.

Unmetered Water Water delivered but not measured for accounting and billing purposes.

Water Conservation (1) Any beneficial reduction in water loss, waste, or use, (2) reduction in water use accomplished by implementation of water conservation or water-efficiency measures, (3) improved water management practices that reduce or enhance the beneficial use of water.

Water Conservation Measure An action, behavioral change, device, technology, or improved design or process implemented to reduce water loss, waste, or use.

Water Reclamation The treatment of wastewater to make it reusable, usually for nonpotable purposes; includes water recycling.

Water Recycling The treatment of urban wastewater to a level rendering it suitable for a specific, direct, beneficial use.

Water Right Under the prior appropriation system, a property or legal claim to withdraw a specified amount of water in a specified time frame for a beneficial use.

Water System A series of interconnected conveyance facilities owned and operated by a drinking water supplier; some utilities operate multiple water systems.

Water Use* See "Demand"

Withdrawal Water diverted or withdrawn from a surface or ground water source.

[1] Except where noted with an "*", all definitions obtained from "*Water Use and Conservation*" (2001, Amy Vickers)

Executive Summary

E.1 Introduction

The City of Bend is committed to sound management of the water resources of Central Oregon for the good of the local community, the broader region, and the environment. As the city continues to grow and develop, water conservation will be utilized in combination with development of water supplies to meet the community's needs.

The City is submitting this Water Management and Conservation Plan (WMCP) in accordance with Oregon Administrative Rules Chapter 690 Division 86 and Division 315. This WMCP: 1) is an update to Bend's expired 1998 WMCP as required by Division 86 Rules, 2) satisfies a condition placed by the Oregon Water Resources Department (WRD) on a permit extension application related to the City's Lava Island water right, and 3) would also fulfill any Division 86 requirements associated with the submittal of any new water right permit applications that may occur during the time period covered by this plan. The City anticipates submittal of another WMCP update five years from now to address longer term issues.

Per the Division 86 Rules, this WMCP describes the City's water uses, water needs, water conservation program and plans for development of an existing water right to avoid water supply deficiencies in the near term. In addition to meeting the rules' requirements, this WMCP demonstrates Bend's continuing effort to serve as a steward of the region's water resources. These efforts go beyond Bend's legal obligations and include progressive planning, cooperation and participation in local and regional mitigation discussions, dedicating resources to workable mitigation solutions, operating and maintaining the water system using techniques designed to conserve water and reduce Bend's impact on the environment, and sponsoring outreach and education throughout the Deschutes Basin.

E.2 Compliance with Division 86 Rules

This WMCP satisfies the Division 86 Rules by including the following elements:

- A Municipal Water Supplier Description, complete with a discussion of supply sources, service area, adequacy of supplies, water usage, water rights, and other information.
- A Municipal Water Conservation Element which describes the City's conservation program and details conservation measures the City is committed to pursuing within the next five years. As required by the Division 86 Rules, "benchmarks" for each conservation measure are provided with firm dates for completion.
- A Municipal Water Curtailment Element which explains how the City is prepared to curtail water usage in the event of an emergency that disrupts availability of water supply.

- A Municipal Water Supply Element which projects water demand consistent with population growth forecasted by Deschutes County and associated development in Bend's water service area. These future demands are compared to available supply. Alternative sources of supply as well as expanded conservation actions are evaluated and compared with ground water development under the Lava Island water right.

As documented in the respective elements of this WMCP update, each of the items listed in WRD's work plan associated with the City's last WMCP has now been addressed.

Per the Division 86 Rules requiring any affected local governments the opportunity for comment on the consistency of this plan to land use plans, the city of Bend provided a draft copy of the WMCP to Deschutes County for review. No comments were received. In addition, the City held a public open house to discuss the report on October 12, 2004. Two members of the public attended. Copies of the WMCP were also submitted to the local ODFW and OWRD offices, the Upper Deschutes Watershed Council, ReSource and the City of Redmond. No comments were received from these entities.

Bend anticipates submitting an updated WMCP five years following the approval of this WMCP or earlier should Bend's water supply or demand situation described herein change significantly. This plan also anticipates additional groundwater permits will be required in addition to the development of the existing Lava Island groundwater permits.

E.3 Overview of Findings

E.3.1 Growth in Demand

Bend's dramatic growth in the 1990's and early 2000's is projected to continue. This will, in turn, affect Bend's customer base and the community's need for water. Bend estimates that maximum day demand will increase from 26 MGD in 2003 to 46.5 MGD by 2025 and 55 MGD by the year 2035. Based on Bend's analysis of future production needs and available supply, Bend calculates demand will exceed supply by 2007 or earlier depending upon rates of growth and weather impacts. These estimates incorporate the savings realized through the implementation of additional conservation measures and a demand buffer of 10%.

E.3.2 Conservation Measures

The City has upgraded its water conservation efforts dramatically since submittal of the previous WMCP in 1998. In the conservation element of this WMCP, Bend commits to carrying out even more conservation activities during the coming five years leading up to the next submittal. For each water conservation measure identified, a benchmark has been established as shown in Table ES-1. Based on the City's understanding of the rules, these benchmarks fully comply with State requirements for the Conservation Element of the WMCP.

Table ES-1 City of Bend Summary of All Conservation Measure Benchmarks for 2004-2008		
Benchmark	**Start Date**	**Frequency or Completion**
Metering		
Fully meter Juniper system customers	Fall 2004	Dec. 31, 2004[1]
Periodic verification of all commercial meters over 3-inch size	Ongoing	Every 2 years
Replace all small meters on a rolling 15-20 year cycle, or as needed based on billing data indicating inaccuracies. Automated Meter Reading batteries have a 12 to 15 year life, and will tie directly to the meter replacement schedule.	Ongoing	15-20 year rolling replacement schedule
Periodic verification of all source meters (models that Bend purchases are not designed for field adjustments)	Ongoing	Every 2 years or as needed
Install permanent metered fill stations and develop portable metered hydrant program.	Spring 2005	June 30,2006
Water Auditing		
Perform water audit accounting for uses and potential losses of water	2003 (using 2002 data)	Annual
Leak Detection		
Periodic leak detection surveys – at least 10 miles of water mains	2005	Every five years
Develop and provide brochure for customers on using meters for leak detection; and distribute toilet tank leak detection dye tablets.	2004	Annually
Perform flow audit calculations to verify inflows match outflows, for each Bridge Creek transmission line.	2004	Annually
Rate Structure		
Continue to expand and refine water use data collection and analysis, and expand breakdown of customer classes.	2003	June 30, 2005
City Council decision on whether/how to modify rate structure. Based on review of options for cost-of-service rate structure, including differing rates for different customer classes; and/or tiered rates, seasonal differential, or other approaches.	2003	June 30, 2006
Continue to utilize customer bills to communicate water conservation messages and incentive programs	2003	At least four times per year; with focus on irrigation season.
Public Education		
Upgrade Web site to more fully convey the City's WaterWise program	2004	Annual
Continue sponsorship and participation in approximately three to five annual events attended by the public	Ongoing	Annual
Print and radio advertising, with focus on irrigation season	Ongoing	Annual
School tours and speakers bureau	Ongoing	Annual
Periodically review and upgrade printed handouts and related materials	Ongoing	At least every other year
Continue funding Customer Field Representative position, to provide customer outreach and enforce irrigation restrictions.	Ongoing	Annual, during irrigation season

[1] Metering benchmark subject to Juniper area legal proceedings.

Table ES-1 (Continued) City of Bend Summary of All Benchmarks for 2004-2008		
Benchmark	**Start Date**	**Frequency or Completion**
Technical and Financial Assistance		
Review odd-even day irrigation restrictions and determine whether/how to modify. Possible exemption for those sites using weather-based irrigation systems.	2004	Dec. 31, 2005
City-managed Greenwood Cemetery: Install with Maxicom irrigation control system.	2003	Dec. 31, 2004
City Landscape Retrofit Project: Budget for replacement of landscape irrigation system at one site per year	2003	Annually
City Landscape Sites: Complete maintenance and management plan.	2003	Dec. 31, 2004
Bend-La Pine School District Irrigation Agreement: Partner with school district to provide technical assistance to implement weather-based watering control at all new and existing sites.	2003	Ongoing, as budget allows
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.	2003	Ongoing
Water audits for selected large customers. Audits of turf fields will be completed as part of partnership described above.	2004	4 large site audits per year
Irrigation audits will also become part of standard contracts for City-funded irrigation improvement projects. Contracts will include performance standards and correction actions.	2004	As projects occur
Continue to expand waterwise partnerships using Central Control Technology, including new large landscape partners.	2003	Add one new site per year
Fixture Retrofit/Replacement		
Toilet retrofit program feasibility survey	2004	Dec. 31, 2005
Reuse, Recycling, Non-potable		
Perform 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.	2004	Dec. 31, 2008

One noteworthy conservation measure the City has implemented already is the residential metering program, a program to install meters at all residential customer connections. This program was required by the Water Resources Department as a condition of the last WMCP, to be completed by mid-2004 though Bend completed it in March 2004. The effects of this program on conservation are significant. Bend estimates an average 15% to 25% reduction in demand for residential customer following installation, though it is impossible to determine the exact amount of savings from this class of use. The reasons for not being able to determine range from the other estimated uses of water used operationally for areas like main flushing, reservoir cleaning, fire flow testing and the existing unmetered hydrant uses and that there were both metered and unmetered uses in the residential class during the time covered under this report.[2] These estimated uses and the hydrant program are being addressed elsewhere in this

[2] The U.S. EPA's "Water Conservation Plan Guidelines" indicate savings from a universal metering program such as Bend's may reduce end use by 20%.

plan. Conservation is important because it acts as a means to stretch available water supplies. The metering and customer reclassification programs also have the added benefit of supplying data to Bend about consumption volumes and patterns of use of the Residential and other classes. With this information, Bend can learn new ways to improve day-to-day water system operation and develop conservation measures tailored to specific customer classes in the future.

E.3.3 Future Supplies

Conservation alone cannot meet the challenges associated with the City's projected water needs and Bend recognizes that in addition to conservation, tapping new supplies will help meet future demand. Therefore, Bend requests initial diversion of 5 MGD under its existing Lava Island water right to augment its current available supply of 31.2 MGD. The process necessary for Bend to begin initial withdrawal of the undeveloped Lava Island right of 5 MGD is two-fold: first, Bend will request approval of the permit extension for the right of 5 MGD; second, Bend will request approval of a permit amendment to move the points of appropriation to a more suitable location that takes advantage of existing infrastructure.

This 5 MGD may give Bend approximately six years of additional supply depending on rates of growth in demand and annual weather conditions and conservation. Due to the long timeframe for new groundwater development, it is anticipated that Bend may submit additional new groundwater applications during the time period covered by this plan, based on population forecasts contained within, to achieve a 20-year supply path. During this time, Bend intends to continue working with state agencies, local governments, and regional stakeholders to develop a coordinated water management plan for the basin with the goal of being able to access further ground water in the future to meet the demands of growth, as well as meet the other water use goals for both agriculture and increased flow for instream uses.

E.4 Conclusion

The City of Bend is committed to sound management of water resources within Central Oregon. Bend's investment in residential metering of over $4.5 million is paying off with to-date reductions of over ten percent in per capita residential use. The City looks forward to continued collaboration with other organizations and WRD in ensuring a balanced and effective program for water supply in the region.

Section 1

Introduction

The City of Bend is pleased to present its Water Management and Conservation Plan (WMCP) based on the requirements of the Oregon Administrative Rules Chapter 690 Division 86 (Division 86 Rules). This WMCP: 1) updates Bend's expired 1998 WMCP, 2) fulfills a condition placed on Bend's Lava Island water right extension application by Water Resource Department (WRD), and 3) would also fulfill any Division 86 requirements associated with the submittal of any new water right permit applications that may occur during the time period covered by this plan. This updated WMCP represents a continuation of Bend's commitment to proper management of its water resources.

1.1 Description of Recent Efforts

In recent years, Bend has made great strides in its efforts to manage and deliver water within a framework of stewardship of the water resources of Central Oregon. The City's efforts in this regard go well beyond the requirements of the Division 86 Rules. This is based on a regional vision that recognizes the multifaceted demands on water resources for the good of the community, economy, and environment.

In keeping with this regional vision, Bend is actively engaged with other groups that have a stake in how water is managed in Central Oregon. This City is building this perspective into a range of activities related to water supply and related environmental considerations. These activities range from Bend's daily operations to long term strategies for meeting the needs associated with growth. The following subsections provide some examples of Bend's leadership in this regard.

1.1.1 Planning for Bend's Water System

In the past, like so many municipalities, when supply was needed, Bend obtained a new source and moved on to the next challenge without much discussion. Today, for the first time, conservation planning—in part represented in this WMCP—is occurring simultaneously with an update to the City's Water Supply Plan. By completing this process together, Bend is able to take a much broader view of the complexities of delivering water and meeting the water supply challenge in a proactive way. The choices Bend makes in choosing a water supply alternative may have multiple benefits to the entire basin, rather than just meeting the needs of Bend's customers. The broadening of the City's internal approach has already produced real benefits by increased cooperation with local purveyors and other water users in the region such as the new intertie agreement between the City and Avion Water Company for meeting demand in the event of an emergency. This intertie improves system reliability during the summer.

1.1.2 Groundwater Mitigation in Deschutes Basin

Since the inception of the Deschutes Basin Steering Committee, the City has been in the continuing mitigation rule development. For example, Bend agreed early in the process to help fund research by the U.S. Geological Survey (USGS) to learn more about the abundant groundwater resources in the region and surface water connections. The City voluntarily put its own new groundwater permits "on hold" temporarily for the good of basin planning.

As the planning process continues, the City of Bend intends to stay the course for the development of a workable water management policy for the long term good of the Deschutes Basin. Growth in the region, however, has not stopped during this policy process. Bend will need additional water supplies, beyond what water conservation efforts can provide, to meet the needs of growth. Bend is also committed to working in partnership with the local agricultural community interest to meet ongoing challenges for the region.

1.1.3 Assessment of Water Supply and Mitigation Alternatives

In light of Bend's new conservation planning paradigm shift and the rapidly evolving policies regarding the Deschutes Basin, the City contracted with Newton Consultants, Inc. and the Deschutes Resources Conservancy to complete a Water Supply Alternatives Study. This report has helped to educate water users in the basin and explain the many complexities of water supply planning. A key piece of the report was the important discussion about what criteria should be used when choosing a water supply source for the City. In the past, regulatory compliance was the key criterion. Today the City's criteria have been broadened to include three main topics: 1) regulatory compliance, 2) effectiveness, and 3) sustainability. The evaluation of alternatives has utilized a region-wide perspective, considering aspects applying throughout the Deschutes River Basin. This approach demonstrates that the City is committed to wise stewardship of surface and ground water resources for all basin residents.

1.1.4 Metering / Water Quality Protection

In past years, Bend's residential customers were not metered. At the time, the policy to not meter residential customers had full support of the public. For perspective, this policy decision was made when water use in the region was predominantly agricultural and when municipal use totaled less that ¼ of one percent of all water diverted in the basin.

Today, even though Bend's customers' demands still measure less than 1% of all the water diverted for beneficial uses, public policy has shifted. Now, the public recognizes that efficient water management should include comprehensive measurement of water used. The City has just completed a major project to meter all of its customers. This $2.5 million project was implemented throughout the City's water system and completed in March 2004, except for the newly-acquired Juniper area (the Juniper area is slated for metering in 2004). Other meter-related accomplishments include:

- The installation of Automated Meter Reading (AMR) technology will allow much more efficient meter reading that will save fuel, labor, and make data gathering more flexible in the future.

- Monthly meter reading keeps the price signal close to daily use patterns of Bend's customers and conserves water. And, when combined with modifying Bend's rate structure gradually in the future, this will have the potential to be one of the most effective tools for controlling water demand.

- The installation of cross connection protection at every meter will prevent the potential of each water service connection from contaminating the entire system from back pressure or backflow events in times of pressure loss or system failures that can occur due to main breaks or other unforeseen events.

- With meter installation now complete, Bend can examine the customer classification and rate system to assess how Bend can further improve management of the water supply and customer service. For example, a revised billing classification system with more targeted customer classes like restaurants, laundries, hotels, etc. will improve data on water usage, allowing Bend to target its conservation efforts for maximum effectiveness.

- New Standards and Specifications have been developed for Bend's installation of irrigation systems within the right-of-way in streets, medians, and round-abouts to require full metering and other state-of-the-art water conservation practices.

1.1.5 Basin Participation, Outreach, and Education

The City has been recognized as a leader in basin restoration, supply planning and related efforts throughout the basin. This is appropriate, since water does not recognize jurisdictional boundaries. Bend has been extensively involved in organizing regional conferences on water management; educating the public and water-related industries; cooperating with local, state and federal elected officials; and working with the State agencies. Cooperative efforts include a wide range of efforts. Examples include information sharing; developing cooperative agreements, contracts and memorandums of understanding; cooperative planning efforts, lobbying and many other methods of cooperation. A sampling of the organizations and activities Bend has been involved with include:

- Deschutes Coordinating Group, a subbasin planning effort through the Bonneville Power Administration as part of the greater Columbia River watershed.
- Central Oregon Cities Organization (COCO); the City of Redmond and other local and regional water purveyors, and Bend LaPine School District
- Local Irrigation Districts – Central Oregon ID, Tumalo ID, Swalley ID, Arnold ID, North Unit ID, Squaw Creek ID, collectively known as the Deschutes Basin Board of Control.
- Trade Association participation such as Oregon Water Resources Congress, Pacific Northwest Section Region Water Conservation Committee (AWWA) and Emerald Subsection partner with American Water Works Association, the Irrigation Association,

Oregon Landscape Contractors Association and the Oregon Association of Water Utilities (OAWU).

- Cooperation and sponsorship with local Non-Profits working on many related conservation efforts both within the Bend Urban Growth Boundary (UGB) and beyond, including: The Deschutes Resources Conservancy, reSource, 3E Strategies, *From the Ground Up*, Upper Deschutes Watershed Council, Central Oregon Environmental Center, Sustainable Landscapes, Central Oregon Flyfishers and others.
- Cooperation with the local Watermaster and Region Manager for the Oregon Water Resource Department
- Cooperative and partnership agreements with other state agencies including Oregon Department of Environmental Quality, Oregon Department of Transportation, Oregon State Parks and Recreation, Oregon Sustainability Board, Oregon Department of Energy, Oregon State University Extension Service
- Cooperative relationships with federal agencies including U.S. Forest Service, U.S. Bureau of Reclamation, and the Bureau of Land Management and the Department of Energy as a Rebuild America Partner.
- Presentations and education efforts aimed at a wide range of trade associations, schools and civic groups with an interest in water management.

1.2 Extension and Amendment of Lava Island Water Right

The supply and demand-side management techniques Bend describes within this WMCP will continue to help stretch available supplies to meet new customer water demand. But the gains from such techniques will reap less benefit over time as the "low hanging fruit is picked". For example, the recently completed metering program is believed to have the single most dramatic effect upon demand, resulting in an estimate of 15% to 25% reduction in use per residential customer on average (exact amounts of reduction per customer cannot be determined)[1] . Eventually, Bend foresees that at some point increasing efforts to alter management techniques will reap smaller and smaller gains.

Furthermore, the gains from altering management techniques probably cannot keep up with demand from an ever increasing customer base. In fact, even with conservation efforts described in this WMCP, the water demand forecast shows that demand will surpass supply by 2005 approximately. As such, Bend believes additional supplies are necessary to help meet demand. To forestall a shortage of available supply, Bend requests approval of its extension application for the Lava Island right of 5 MGD and approval of an application for amendment of this right to allow multiple points of appropriation. Approval of this request will allow Bend to meet its short term needs, while still requiring proper management of the resources. Moreover, the City remains committed to participation in further implementation of best management practices and seeking regional solutions to the area's water needs under future potential mitigation plans.

[1] The U.S. EPA's "Water Conservation Plan Guidelines" indicate savings from a universal metering program such as Bend's may reduce end use by 20%.

1.3 Organization of this WMCP

This WMCP is organized into four sections, representing the four major elements as required in the Division 86 Rules:

- Section 2, the Municipal Water Supplier Description, provides an overview of Bend's water system, including service area, population served, water rights, production, demand, adequacy and reliability of water supplies, and infrastructure.

- Section 3, the Water Conservation Element, describes Bend's conservation efforts since approval of its 1998 WMCP and its planned conservation measures for the next five years. For each of these measures, a "benchmark" is provided tying specific activities to a schedule for implementation.

- Section 4, the Water Curtailment Element, represents Bend's assessment of the vulnerability of the water system to deficiencies from events such as natural disasters or source contamination. This element also provides a detailed curtailment plan should a supply deficiency occur.

- Section 5, the Water Supply Element, presents the City's water demand forecast, and compares available supply to projected demand. Development of the Lava Island water right is presented as a means of forestalling water shortages, at least in the near term. This water source is compared with other supply alternatives and with additional, more extensive water conservation options. Based on this comparison, the Lava Island right is the cornerstone of Bend's effort to meet anticipated, near-term customer demands.

Section 2

Municipal Water Supplier Description

2.1 Introduction

The Municipal Water Supplier Description of Bend's WMCP provides information about Bend's water system. This information sets the stage for depicting the present condition of the City's water needs and is used as a basis for the Water Supply Element (Section 5) in evaluating future water supply needs, available supply options, and the role that alternative sources of supply—including conservation—can play in meeting future demand.

This section provides a map of the water system and associated key infrastructure elements, reviews the sources of supply and municipal water rights, describes Bend's production and metered demands, assesses the adequacy of supply, and calculates system losses.

2.2 Geography, Climate, and Population

Bend is centrally located in Oregon. Along its eastern border lies Central Oregon's high desert plateau and along its western border is U.S. Forest Service land. Running through the service area is the Deschutes River. Topographically, Bend is relatively flat except for several high buttes about the city.

At an elevation of 3,628 feet, Bend's climate is typical of the high desert plateau with cool nights and sunny days. Average winter season temperatures range from 40 to 50 degrees Fahrenheit and the coldest months are December through February during which record temperatures were measured around -25 degrees Fahrenheit. Summer season averages range from 60 to 80 degrees Fahrenheit and the warmest months are July, August, and September during which record temperatures have reached over 100 degrees Fahrenheit.

As of July 2003, the City of Bend had a population 62,900 as estimated by the Population Research Center at Portland State University. As discussed later in this WMCP, population growth has been exceptionally high in the Bend area since 1990 and the Deschutes County population forecast predicts continued high growth.

2.3 Water System Map (Div. 86-0140[8])

The City's water system is supported by an extensive network of pipes, pumps, reservoirs and disinfection facilities. Exhibit 2-1 shows the location of many of the major components of the water system, including the location of Bend's ground and surface water sources and their points of diversion, storage facilities, the treatment facility, major transmission and distribution lines, pump stations, and interconnections. A description of some of these components follows.

Wells Bend has 16 wells found throughout the service area which produce ground water. Water is pumped to the reservoirs and/or to the distribution network. Table 2-1 lists each of the wells.

Table 2-1
City of Bend
Summary of Wells

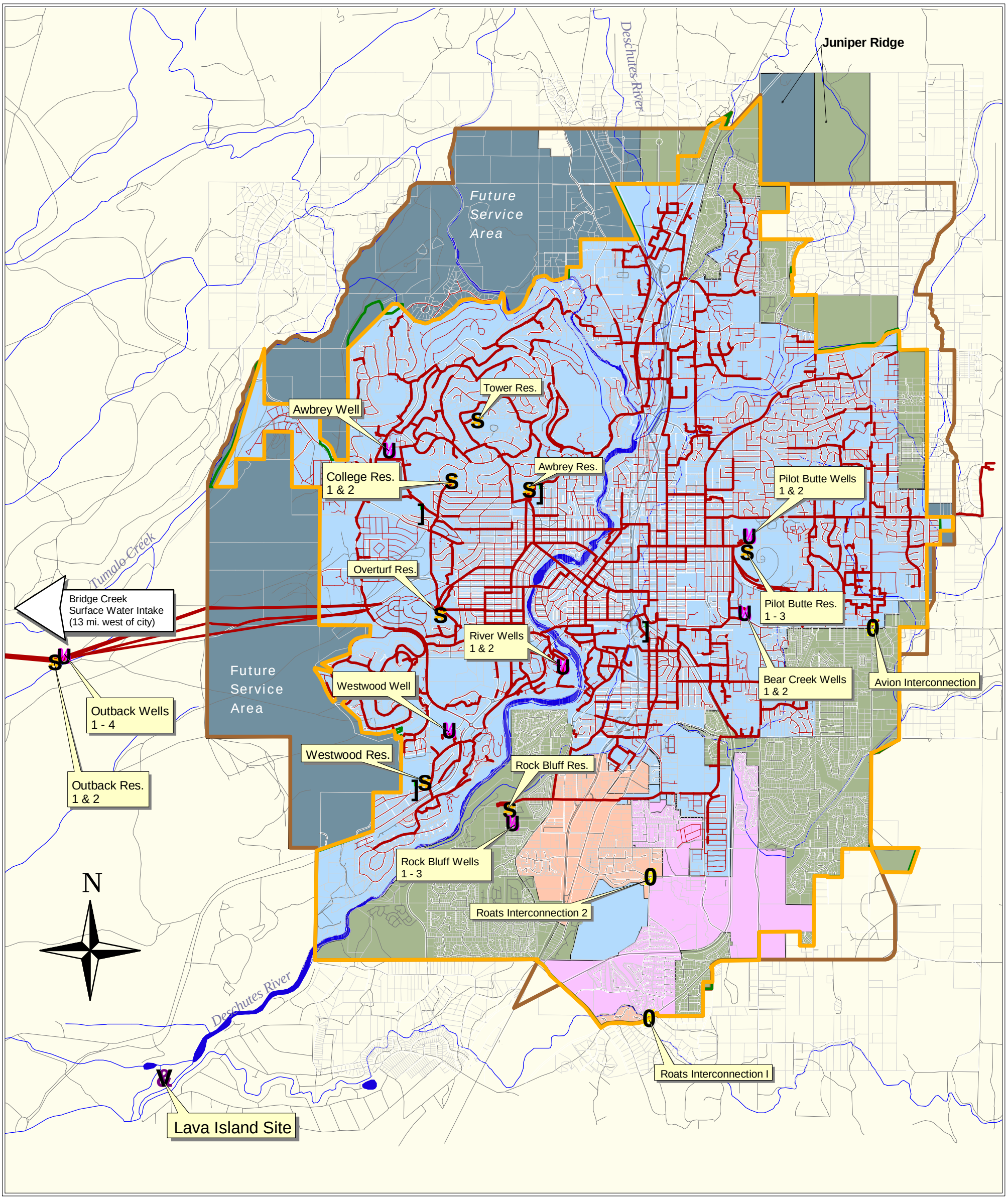
Well Name	Well Depth (Ft.)	Installed Pumping Capacity per Wellfield[1] (GPM)
Awbrey Glenn (Copperstone)	700	975
Bear Creek Well I	970	2,100
Bear Creek Well II	1,100	
Outback I	700	1,650
Outback II	751	
Outback III	850	2,200
Outback IV	850	
Pilot Butte I	1,065	2,380
Pilot Butte II	1,060	
Pilot Butte III	1,041	
River Well I	900	3,840
River Well II	800	
Rock Bluff I	812	2,090
Rock Bluff II	800	
Rock Bluff III	850	
Westwood	331	730

(1) Well capacity changes depending on hydrologic system pressure (i.e. if other wells are operating). Therefore, these capacities represent the combined wellfield pumping capacity.

System Pipe Sizes In addition, the city has a water distribution network consisting of 1,938,921 linear feet of pipe (367 miles). A summary of that pipe inventory is shown Table 2-2 below.

Table 2-2
City of Bend
Summary of System Pipe Sizes

Nominal Pipe Size in inches	Total Length (ft)	% of Total
2–6	393,499	20.3%
8-12	1,324,295	68.3%
14-20	191,520	9.9%
22-36	29,607	1.5%



Legend

- Avion or Roats Interconnections
- Lava Island Site
- Existing Well
- Reservoir
- Pump Station
- Bridge Creek Surface Water Intake (off map)
- City Limits
- Urban Reserve Area
- Major Water Lines
- Minor Water Lines
- Rivers
- Roads
- Urban Growth Boundary
- Bend Service Area
- Future Bend Service Area
- Roats Water System
- Avion Water Company
- Old Juniper Utility Company (Bend Service Area)

0.5 0 0.5 1 Miles

EXHIBIT 2-1
City of Bend
Water System Map

Div. 86-140 [8]

March 2004

Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

03/12/2004 5:03:14 PM M:\ArcView\Bend\Bend.apr

Finished Water Storage The City also has 13 reservoirs (tanks) totaling 26.5 million gallons. The location of each reservoir is shown in Exhibit 2-1. Summaries of available storage and overflow elevation for each reservoir are provided in Table 2-3.

Table 2-3
City of Bend
Finished Water Storage Summary

Reservoir Name	Storage in millions of gallons	Overflow Elevation (ft)
Awbrey	5.0	3,795
College I	0.5	4,123
College II	1.0	4,118
CT Basin	1.5	4,011
Outback I	2.0	4,011
Outback II	3.0	4,011
Overturf	3.0	3,871
Pilot Butte I	1.5	3,782
Pilot Butte II	1.0	3,880
Pilot Butte III	5.0	3,782
Rock Bluff	1.5	3,880
Tower	1.0	4,244
Westwood	0.5	3,872
Total	**26.5**	

2.4 Bend's Service Area

Bend is one of three drinking water providers in the city. The two other providers are the Avion Water Company and the Roats Water System and their service territories are noted in Exhibit 2-1. The approximate number of water service connections within city limits served by Avion was over 5,400 and more than 750 for Roats. Comparatively, Bend had approximately 18,300. (More detailed service connection data for Bend is provided in Section 2.5.3).

Until 2002, the Juniper Utility Company was also a water service provider within the city limits. However, in April of that year, the City incorporated Juniper into its service area as a result of legal proceedings and began operating the system. These legal proceedings for the ownership of Juniper's infrastructure and water rights, among other issues, are currently underway between seven homeowner associations, an irrigation district, the former utility company owner, and a school district.

Also included in Exhibit 2-1 is Bend's current service area, the Urban Growth Boundary (UGB), and the Urban Reserve Area (URA). The City's water service area covers approximately 70% of the total area within the city limits and includes downtown Bend.

The UGB is a legal boundary separating urban land from rural land. Under Oregon state law, each city or metropolitan area in the state is required to designate an urban growth boundary within which a 20-year supply of land is to be identified for future development. When the UGB boundary was delineated by the City's planning staff in 1998, it was thought that the UGB had a

20-year supply of developable land, however due to significant growth since 1998, the UGB likely no longer contains a 20-year supply of available land. Therefore the City may need to expand its UGB to meet the buildable-land inventory requirements. These requirements are set forth in Oregon state statute and administered by the Department of Land Conservation and Development. As a result, City planning staff will update the current UGB, though a final planning document will not be available until approximately 2005. One area likely to fall within the new UGB is Juniper Ridge (not to be confused with the Juniper area which was once within the water service area of the Juniper Utility Company). This 500 acre area is shown in Exhibit 2-1. It is slated for future industrial use and several concepts for development of this area have been proposed.

Beyond the UGB is the urban reserve area (URA) which contains areas that the City may consider for future expansion of the UGB. The URA was also delineated in 1998. The City's planning efforts to update the UGB may also involve changing the UGA boundary.

2.5 Sources of Supply (Div. 86-0140[1])

The City of Bend meets almost all customer demand through ground water withdrawal and surface water diversion. The remaining demand is met through wholesale water purchase from the Roats Water System (former Juniper Service area) and the Arnold Irrigation District (non-potable). These sources are described below.

Ground Water Since Bend's previous WMCP (1998), Bend has relied on ground water to meet all new demand and increasingly has used ground water to meet a larger portion of existing demand. In 2003, an average of 6.38 MGD (millions of gallons per day) of ground water was produced from Bend's multiple points of appropriation. The wells range in depth from 330 feet to 1,100 feet and draw water from the large Deschutes Aquifer. The aquifer's primary recharge zone is located in the Cascade mountain range where the annual recharge rate is estimated at or 2,456 MGD or 3,800 CFS (cubic feet per second). A large portion of the ground water discharges into the Crooked River, downstream on the Deschutes River from Bend, and a few miles upstream from Lake Billy Chinook.

Surface Water Despite increased usage of ground water, surface water is still a major source of water. In 2003, an average of 5.07 MGD of water was diverted.

The City of Bend maintains a Bridge Creek surface water intake facility some 11 miles from the community. This structure has been in service since 1926 when the City and the Department of Agriculture signed an agreement which laid the foundation for this municipal surface water source. The agreement provides that municipal drinking water is the highest use of the watershed and established the watershed boundaries of about 7,700 acres.

The intake structure is a corrugated metal building with steeply pitched roof to handle high snow loads. This building was initially constructed to provide both housing for the intake keeper and as a screening structure for the surface water. The basic layout is that the building is integral with the dam across Bridge Creek. The water flow through the bottom of the south sidewall which acts as a first large debris screening point. The water then enters dual screening areas

approximately 8' X 14' X 6'. The water flows from underneath the fine meshed screens, passes through the screens and then out the east wall of the building into the transmission pipelines. The two screening chambers are designed so that one side may be dewatered for cleaning and maintenance, while the other side can maintain constant and necessary flows of about 10.6 MGD, limited by the size of the pipes. The intake screening equipment and control valves are located on the southern portion of the building and the former living quarters are located on the northern portion of the building. The building is approximately 2,000 square feet in size and is no longer used as an intake keeper residence. A new caretaker building was constructed in the late 1970's for the intake keeper about 90 yards north of the intake building. See pictures in Appendix D.

Above Bend's point of surface water diversion, Bridge Creek flows are supplemented by diversion of natural springs located in the Tumalo Creek drainage basin. At Bend's diversion facility, a dam across Bridge Creek constructed in the 1920's allows for diversion into two transmission mains, one of which was constructed in the 1920's along with the dam and the other in the 1950's. These mains have a maximum combined capacity of 10.6 MGD. Diverted water is transported into the city to an overflow structure at Bend's Outback site. The overflow structure is designed such that it sends all the water to the on-site disinfection facility or, during times of low demand, returns some of this raw water to Tumalo Creek.

Interconnections (Div. 86-0140 [7]): The City of Bend service area in the former Juniper Utilities area can be served domestic water from the Roats Water system. There are two connections between the City distribution system and the Roats system. On the Southern boundary of the City system, there is a 4-inch connection controlled by a pressure reducing valve. Another 2-inch connection exists near the Bend Golf Club on Country Club Drive. These connections serve as customer delivery points only. There is no formal interconnection agreement between Roats and the City.

The Roats Water system serves unchlorinated groundwater to all of its customers and the City provides both chlorinated surface and groundwater to all of its customers. This chlorination dichotomy presents equity issues between City customers in this area. The City has installed chlorination facilities at the well sites in the Juniper area and combined with recent distribution main connections between Juniper Service Area and the City, Roats water is no longer being purchased by the City. These connections will remain in place and functional but in the "off" position to provide potential redundant source water for City customers, but are not considered a part of normal operations or an active source of supply now or in the future.

The connection with Avion is located at the NE corner of the intersection of 27th Street and Bear Creek Road. This interconnection made between a 16-inch C-900 Avion distribution line and a 12-inch ductile iron distribution line to the City system. The connection is controlled by a pressure reducing valve, which operates when the pressure differential between the Avion system and the City system reaches preset levels. There is also a chlorination facility at this location to provide chlorine residual when the unchlorinated Avion water flows into the City system. Without this chlorine facility, the Avion water would dilute the City chlorine residual to unacceptable levels. Under the agreement with Avion, this connection can supply a maximum of 1 MGD in the short term.

Other Supply The entire Juniper area's irrigation needs are met by the Arnold Irrigation District although some of the wells operated by the City within the Juniper area can provide a supplemental source to help meet irrigation demands. This irrigation water is non-potable and is transported in pipes separate from the drinking water supply pipes. Bend does not have an interconnection with the pipes used for non-potable water.

2.5.1 Water Rights (Div. 86-0140[5])

The City holds rights to 36.1 cfs of surface water rights. Of this total amount 15 cfs of surface water rights are available only in winter when community demand is low and have very limited value to the City. In addition, surface water supply can be reduced by drought conditions and low flows in Tumalo Creek and can restrict surface water diversions to 11.72 cfs or 7.6 MGD in accordance with shared rights with Tumalo Irrigation District. In terms of available surface water in a drought year the City can only realize 11.2 cfs or 31% of the paper surface water rights.

The City of Bend holds 44.24 cfs or 28.6 MGD of groundwater rights. The Lava Island right, 7.75 cfs or 5.01 MGD, is the only undeveloped groundwater right remaining in the City groundwater inventory. Over the years the groundwater rights have been amended, transferred and certificated to provide sources of water where community needs have developed in a logical manner. The Lava Island rights are scheduled to provide community water for the next few years in accordance with several long-range master planning studies. The City has focused on groundwater sources close to reservoirs and high demand areas for increased efficiencies and storage capabilities. Lava Island groundwater is and has always been an integral part of the community water supply planning and development process for future citizens.

Bend's surface water rights total 23.3 MGD (36.1 CFS) and all have been certificated except one which was authorized by decree. Of the 23.3 MGD (36.1 CFS), only 3.9 MGD (6 CFS) is unrestricted. Of the remaining 30.1 CFS, 9.7 MGD (15 CFS) is available only during the winter, defined as October through April. The remaining rights permitting 9.8 MGD (15.1 CFS) have restrictions which are dependent upon the flows of Tumalo Creek, for which Bridge Creek is a major tributary. Table 2-4 show these variable flow restrictions. Since Tumalo Creek flows are shared with the Tumalo Irrigation District, the irrigation district's available flows also are shown.

Table 2-4
City of Bend
Variable Flow Restrictions on Tumalo Creek

Natural Flow of Tumalo Creek (CFS)	Water Available to Bend (MGD / CFS)	Water Available for the Tumalo Irrigation District (MGD / CFS)
100	11.45 / 17.72	53.31 / 82.48
80	10.65 / 16.48	41.05 / 63.52
70	10.08 / 15.59	35.17 / 54.41
60	9.41 / 14.56	29.37 / 45.44
50	8.49 / 13.14	23.82 / 36.86
40	7.57 / 11.72	18.28 / 28.28
30	6.66 / 10.30	12.78 / 19.70

Creek flows diminish due to variations in snow pack levels, seasonal run-off changes, and drought. Historically, a September creek flow represents the lowest flows of the year and typically measure between 60 and 70 CFS. Historically, flows have been measured at 30 CFS which restricted the City's diversion capabilities to 6.7 MGD (10.3 CFS). Assuming a typical September creek flow of between 60 and 70 CFS, Bend has 6 CFS (the unrestricted right) plus 14.56 CFS, or a total of 13.3 MGD (20.6 CFS) available for diversion. For planning purposes, Bend conservatively assumes a creek flow of 40 CFS during the summer which would allow for 7.6 MGD (11.72 CFS).

Table 2-5 displays the following water right information in tabular format for each right: source of water; locations/facilities name; the type of beneficial use; application, permit, transfer, and certificate number; priority date; source of water; maximum instantaneous quantity allowed; maximum instantaneous rate diverted or produced; average monthly and daily diversions; and completion dates.

None of the Juniper water rights are listed in this table because they are currently not in Bend's name. As previously described, legal proceedings are underway to sort out the issues surrounding the transfer of these rights and other related issues. Water rights held by the former Juniper Utilities and currently under legal proceedings are dedicated to serving the Juniper area and will not add to the City inventory of groundwater for community needs in the future. The customer demand in the Juniper area is balanced with the water rights under dispute.

Table 2-5
City of Bend
Tabular List of Water Rights

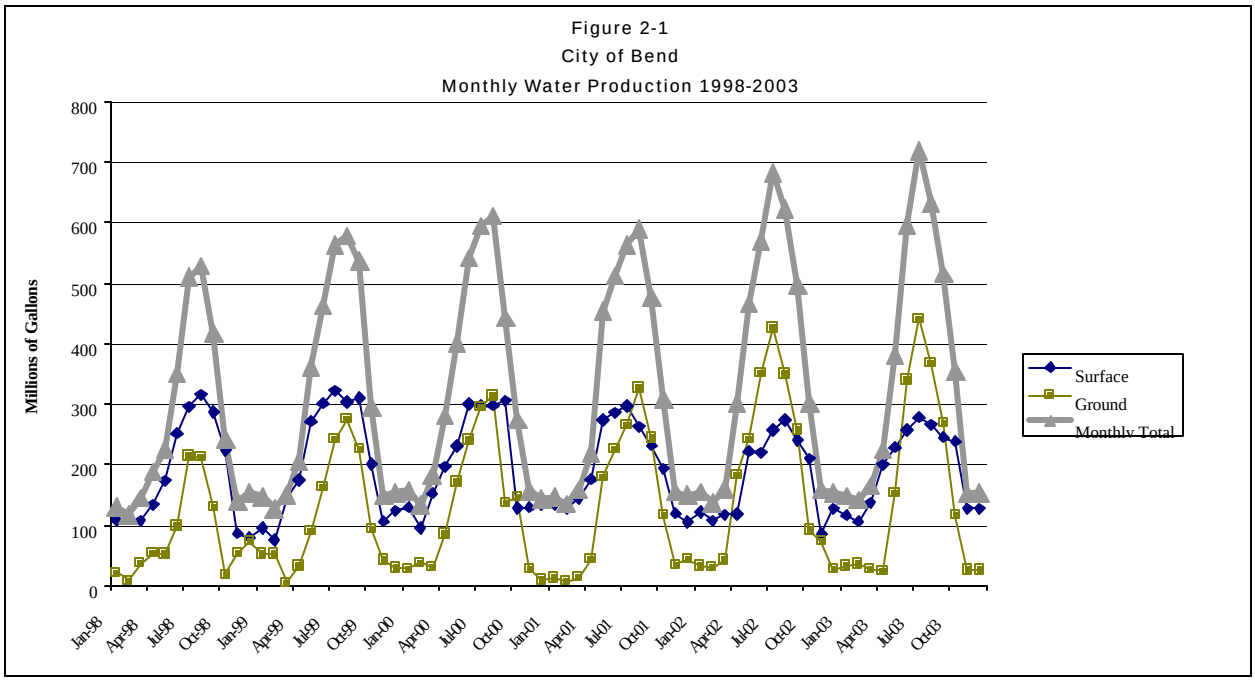
Source Type	Location or Facility Name	Beneficial Use Type	Application File No.	Permit, Transfer or Certificate	Priority Date	Rate (CFS)	Total Permitted Rate (CFS)	Diversion/Production Rates (10)				Completion Date	Water Quality (12)
								Max. Rate Diverted/Produced (CFS)	Annual (MG)	Daily Ave. (MGD)	Monthly Ave. (MG)		
GW	Lava Island	Municipal	G-4677	Permit G-4435	11/8/1968	7.75	7.75	0.0	0.0	0.0	0.0	(1)	Not Applicable
GW	Outback #1, 2, 3, & 4	Municipal	G-12226	Permit G-11380									Not Applicable
GW	Bear Creek #1	Municipal	G-12226 (2)	T-7845 & T-7852	9/7/1990	10	10	10	749.2	2.1	62.4	(3)	Not Applicable
GW	River Well #1 & 2	Municipal	G-5644	Permit G-4946		2.7						(3)	Not Applicable
GW	River Well # 1 & 2	Municipal	G-5644 (4)	Certificate 68702		0.9						Certificated	Not Applicable
GW	Pilot Butte #1 &2	Municipal	G-5644 (5)	T-7009		7.57						10/1/2012	Not Applicable
GW	Bear Creek # 1 & 2	Municipal	G-5644 (6)	T-9408		4.87						10/1/2008	Not Applicable
GW	Copper Stone # 1	Municipal	G-5644	T-7009	10/31/1971	7.57	16.04	16.04	918.3	2.5	76.5	2009 (11)	Not Applicable
GW	Westwood Well	Municipal	G-8695	Permit G-8565	12/22/1978	2.45	2.45 (7)	1.6	123.8	0.3	10.3	(3)	Not Applicable
GW	Rock Bluff #1, 2, & 3	Municipal	G-11942	Permit G-11379									Not Applicable
GW	Pilot Butte #3	Municipal	G-11942 (8)	T-8342	6/30/1989	8	8	6.7	344.4	0.9	28.7	(3)	Not Applicable
Ground Water Total Rate							**44.24**						
SW	Bridge Creek	Municipal		Certificate 49823	12/12/1983	15	15.00 (9)					Certificated	None
SW	Tumalo Creek	Municipal		Decree	First Priority	6	6					Decree	None
SW	Tumalo Creek	Municipal		Certificate 31411	9/30/1900	4.5						Certificated	None
SW	Tumalo Creek	Municipal		Certificate 31411	8/5/1900	2						Certificated	None
SW	Tumalo Creek	Municipal		Certificate 31411	6/1/1907	0.02	6.52					Certificated	None
SW	Tumalo Creek	Municipal		Certificate 31665	9/30/1900	1.314						Certificated	None
SW	Tumalo Creek	Municipal		Certificate 31665	4/28/1905	0.186						Certificated	None
SW	Tumalo Creek	Municipal		Certificate 31665	6/1/1907	1.103	2.603	16.40	2,256.73	6.18	188.06	Certificated	None
SW	Tumalo Creek	Municipal		Transfer B-112	10/29/1913	5.99	5.99					Certificated	None
Surface Water Total Rate							**36.113**						
GW	Bear Creek	Municipal	13097	Pending	--	12	12	0	0	0	0	Application Submitted	
GW	Pilot Butte	Municipal	13098	Pending	--	12	12	0	0	0	0	Application Submitted	
Pending Water Rights Application Total							**24**						

Footnotes:

(1) Extension Application submitted June 26, 2003, OWRD final approval is pending OWRD's receipt of completed WMCP.
(2) Permit G-11380 was amended two points of appropriation added.
(3) Extension Application was submitted to OWRD in October 2003.
(4) Permit G-4946 was partially perfected (Certificate 68458) for 8.47 cfs, then 7.57 cfs was transferred (T-7009). The remaining 0.90 cfs was assigned a new certificate number (68702) and Certificate 68458 was cancelled.
(5) Transfer T-7009 added three points of appropriation – Pilot Butte #1 & 2 and Awbrey Glen – at a rate of 7.57 cfs (this rate is noted in footnote 4, as well).
(6) Permit G-4946 was partially perfected for a second time (Certificate 79994) for 4.86 cfs, then 4.87 cfs was transferred (T-9408) by adding two additional points of appropriation – Bear Creek 1 & 2. Certificate 79994 was canceled. Note that production from RW #1 and 2, and PB #1 & 2 was used in the Claim of Beneficial Use prepared when requesting partial perfection for Certificate 79994.
(7) Permitted amount is 1,100 gpm.
(8) Permit G-11379 was amended, one point of appropriation was added – Pilot Butte #3.
(9) 15 cfs available during winter only.
(10) For water year 2002/2003 (Oct. 2002 through Sept. 2003). Maximum diversion rates shown are historic peaks for all periods recorded.
(11) Bend intends to certificate portions of the right as use of the right increases.
(12) Notations in the "Water Quality Limitations and Parameters" are in reference to OAR 690-086-140(5)a which requires identification of sources which are listed as water quality limited and the associated water quality parameters for which the source was listed. The OAR also requires identification of stream flow dependent species in the source and if the source falls within a critical ground water area. In Bend's case, none of these apply.

2.5.2 Production (Div. 86-0140[4])

Monthly production by source and total monthly production from 1998 through 2003 is shown in Figure 2-1.



Source: Bend's daily production reports

As evident in the Monthly Total line on Figure 2-1, the peak season months (April through October) show an increase from 1998 to 2003 of 28%. The winter months (November through March) also show an increase, though at 7% from 1998/1999 and 2002/2003. Some possible explanations of the different rates of increase are that the summer time-only population in Bend, the "snowbird" population, is growing at a faster rate than the winter time-only population and/or summer tourism and the associated services surrounding summer tourism are growing at a faster rate than winter tourism. Other explanations could be changes in outdoor irrigation annually to match seasonal temperatures and the metering program previously described are changing demand patterns.

The other interesting trend to note is the increasing reliance on ground water versus surface water. For the period shown, total annual ground water production increased by an average 18.1 million gallons, while surface water production remained relatively flat. The trend of increasing ground water use is consistent with City practice to minimize impacts of drinking water production practices on the Deschutes River ecosystem since the City believes that groundwater production has less of an impact than surface water diversions. It is well known in the Deschutes Basin that the regional aquifer is massive and recharges 3800 cfs on an annual basis which equates to over 2 billion gallons per day. (Reference "A Peculiar River – Geology, Geomorphology, and Hydrology of the Deschutes River, Oregon, Jim E. O'Conner, Gordon E. Grant, Editors, pp 31-49) Bend has chosen groundwater to meet new water demands over the long term because it is renewable resource. Groundwater is a sound choice for future municipal

supplies when considering water quality, water availability, reliability and environmental impacts to the basin. The impacts of groundwater use has the added benefit of being attenuated over time and space due to the large magnitudes of water in the regional aquifer and the high annual recharge rate. The lack of change in surface water usage is explained also by restrictions placed on these rights during peak season.

Monthly production volumes were aggregated to annual volumes to allow for the calculation of a peaking factor. By comparing average day demand, which is calculated by averaging production over the entire year, and maximum day demand, the highest day of production recorded in a particular year, a peaking factor can be calculated. Table 2-6 shows this data along with annual and seasonal production.

Table 2-6
City of Bend
Historic Production and Peaking

	1998	1999	2000	2001	2002	2003
Annual Production (MG)	3,142	3,733	3,919	3,866	4,205	4,178
Average Day Production (MGD)	8.6	10.2	10.7	10.6	11.5	11.4
Maximum Day Production (MGD)	21.5	22.4	23.2	23.6	25.7	26.0
Peaking Factor	2.50	2.19	2.16	2.23	2.23	2.26
Peak Seasonal Production (MGD)[1]	11.7	14.3	15.0	14.9	16.4	16.3

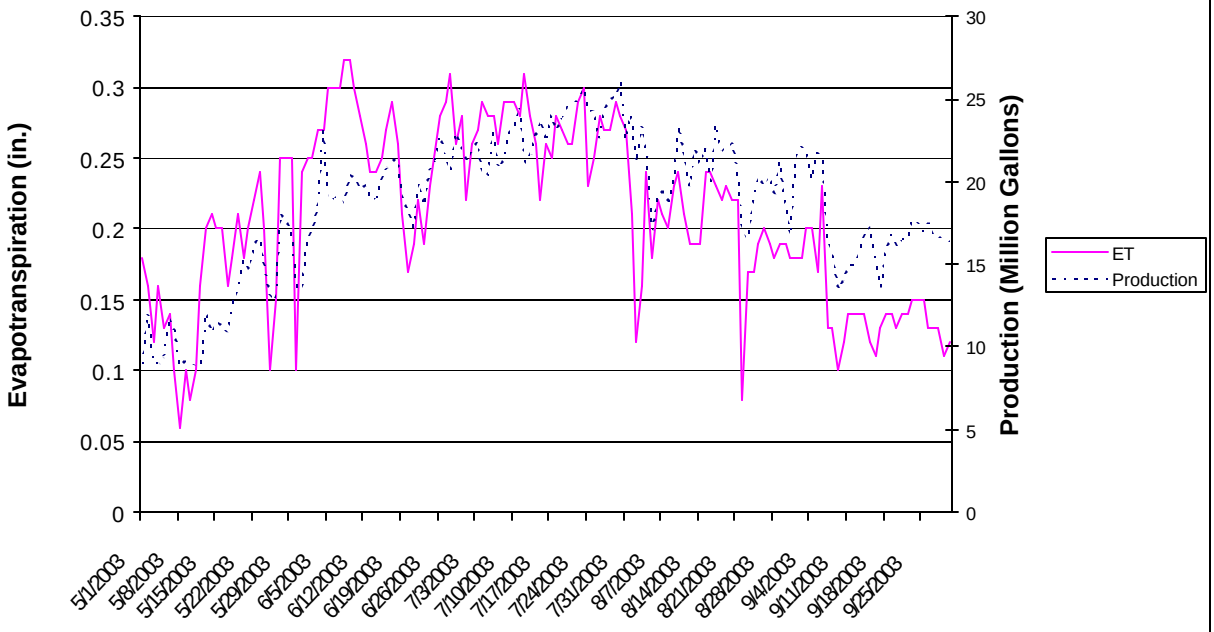
(1) Peak season defined as April through October.

Shown in Table 2-6 the peaking factor decreased from 1998 to 1999, a noteworthy decrease of 12%, and then remained relatively constant the remaining years. This scenario may be due to the City's conservation efforts and the long lasting impacts of these efforts on maximum day demand. The decrease may be attributable to weather as well. In 1998 extraordinary precipitation during the summer may have suppressed average day demand, leading to a high peaking factor in that year relative to following years. Minor annual changes in the peaking factors are expected since some seasons are drier than others. The peaking factor is an important element of the demand forecast because it is used to forecast maximum day demand based on the average day demand forecast. The peaking factor value which is used for forecasting maximum day demand described in the Water Supply Element Section 5 is 2.26 and calculated by averaging peaking factors from 1998 to 2003 shown in Table 2-6.

Peak demand rates and the peaking factor are directly related to evapotranspiration (ET), a measure of the water lost from the surface of soils and plants through evaporation and transpiration, respectively. ET is expressed as a depth (in inches) of water lost per day. ET is influenced by climatic conditions, including temperature, precipitation, wind, and humidity, among other influences. Figure 2-2 shows daily ET at Bend's weather station from May 1, 2003 to September 30, 2003, the time frame when ET levels are greatest during the year. As evident from the figure, ET can fluctuate significantly from day to day.

Bend, like many other water providers, has found a direct relationship between changes in ET and changes in demand.

Figure 2-2
City of Bend
Relationship between Evapotranspiration and Production
May through September



In addition to ET, Figure 2-2 provides daily water production readings allowing for a comparison between ET and production in 2003: As evident, production fluctuations track changes in ET closely during the summer months due to changes in customer demand of water for irrigation. As a side note, demand during late summer was higher than demand in early summer, even at similar ET levels. This is possibly due to customers' perceived need for irrigation versus the actual need or because customers' irrigation habits are slow to change.

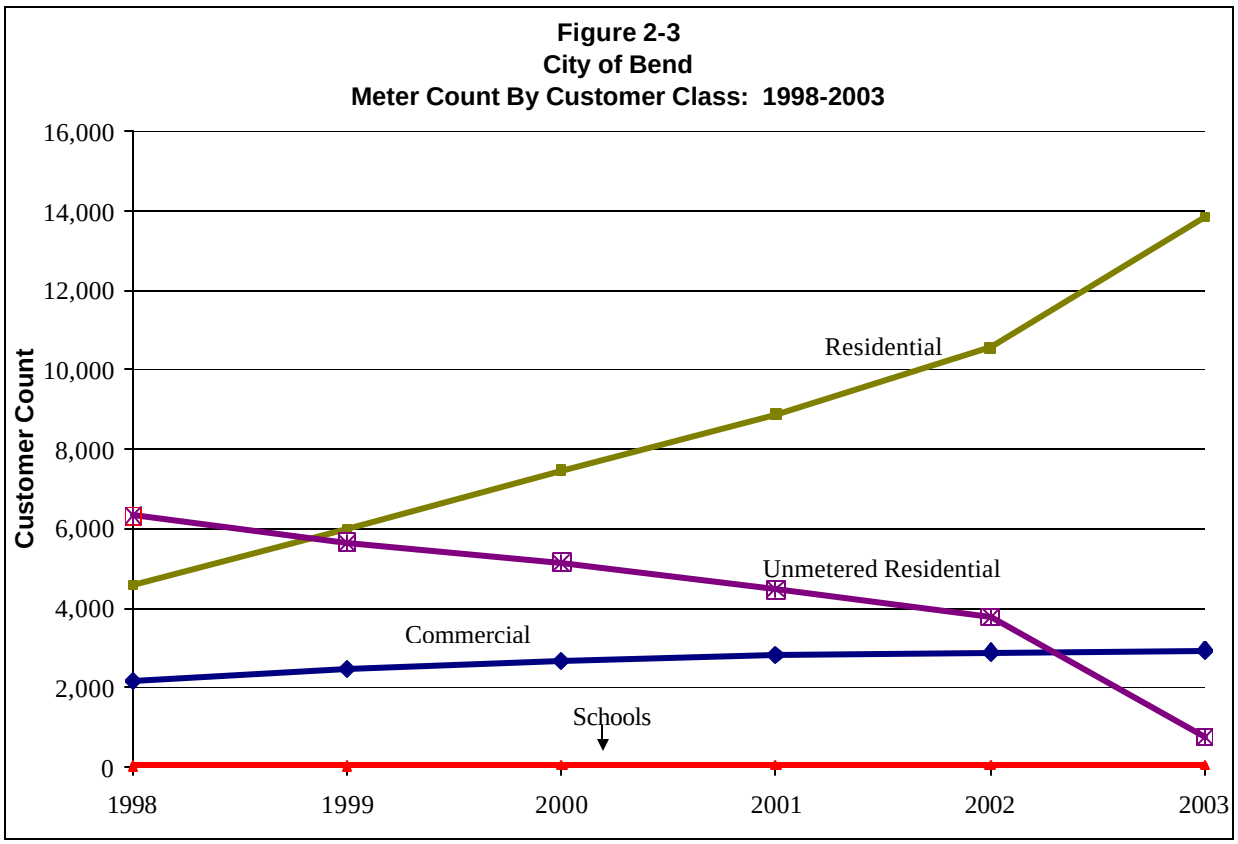
2.5.3 Retail Customer Descriptions (Div. 86-0140[6])

Bend categorizes its customers into three customer classes: Residential, Commercial, and Schools. Bend does not have any wholesale customers. Residential, the largest of the three classes, includes single family homes and duplexes with a shared meter.

Bend did not compare current water use to that reported in the 1998 report because there was such significant change in customer classification, use of metering and report generating capabilities. Any comparison of the two periods would not provide useful information as it would not be an "apples-to-apples" report. The next update to this WMCP will allow greater opportunity to see water use trends at the various customer class levels.

The Commercial class is the second largest of the classes and includes almost every other customer type which the Residential class does not. For example, customers covered under the

Figure 2-3 graphically depicts the number of customers by meter class from 1998 through 2003. Shown on Figure 2-3 is a customer type called "Unmetered". The "Unmetered" customer class is a subset within the Residential class and represents that portion of customers within the Residential class that were not metered. Juniper accounts are not represented in Table 2-7.



Source: City billing records

In addition, the Commercial heading includes industrial; commercial; multifamily complexes; local, regional, state (including educational institutions) and federal government; private educational institutions; and non-profit organizations. Public K-12 school customers fall within the third and smallest customer class called Schools as measured by meter count.

Table 2-7 shows the same data (in tabular format) as presented in Figure 2-3. The number of meters categorized in the Residential customer class shows a large increase while the number of unnmetered customers decreased to 743 by the end of 2003. The Residential class meter increase is representative of the large population growth Bend has experienced and Bend's aggressive metering program, a program mandated by the Water Resources Department. This program is described below and explains the increase in Residential customer accounts and the coinciding drop in the number of unmetered customers.

The Commercial class meter count depicted in Figure 2-3 and Table 2-7 shows a gradual increase in the number of meters, indicative of increased economic activity in the area. The number of Schools meters also increased during this time period, though the increase is imperceptible in the Figure 2-3. The Schools meter count increase measured 26% from 1998 to 2003, with the greatest growth in 2000 due to one or more new schools being built with multiple meters and the addition of new meters at existing schools.

Table 2-7
City of Bend
Number of Accounts by Customer Class: 1998-2003

	1998	1999	2000	2001	2002	2003
Commercial	2,154	2,463	2,668	2,801	2,890	2,941
Residential	3,822	5,234	6,713	8,135	9,807	13,825
Schools	28	28	36	36	38	38
Unmetered	6,315	5,647	5,151	4,461	3,766	743
Juniper (1)	-	-	-	-	-	744
Totals	**12,319**	**13,372**	**14,568**	**15,433**	**16,501**	**18,291**

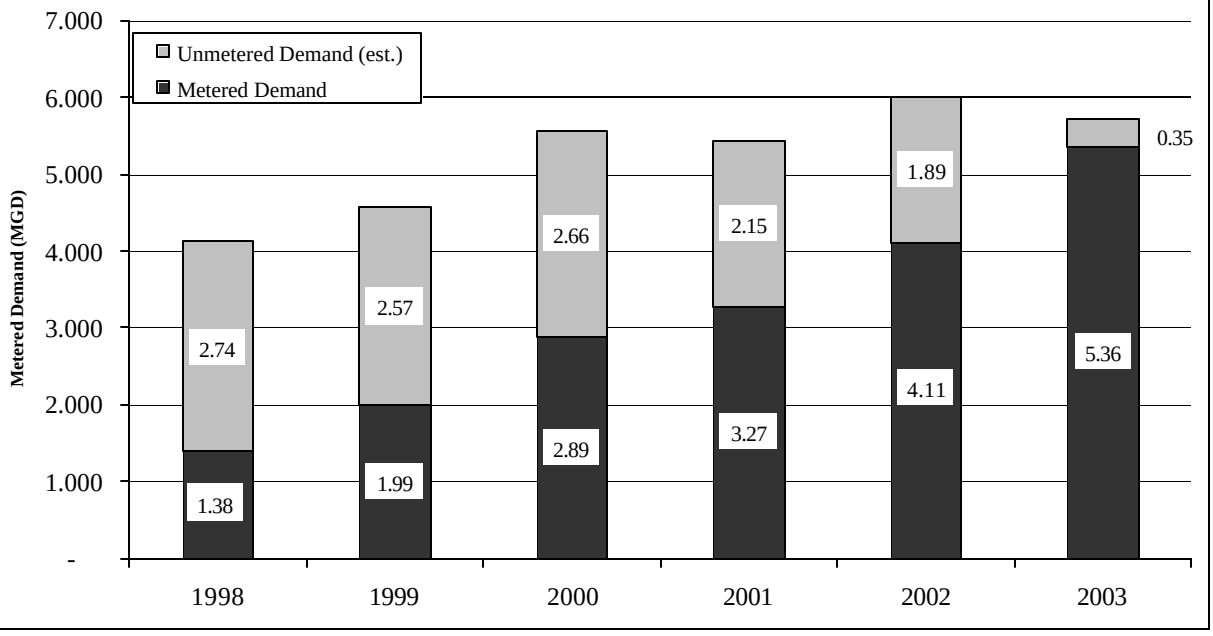
(1) Estimated number of accounts in Juniper for 2003.

Bend's Metering Program As shown on Table 2-7, over 6,300 Residential customers were unmetered in 1998, but by the end of 2003, all but 743 unmetered customers, excluding the Juniper customers, were metered. Under a Water Resources Department metering mandate, residents who were customers of Bend at the time the mandate was issued were required to be metered by May 2004. Bend finished the task two months early (March 2004). Since the unmetered Juniper area was not yet incorporated into Bend's service area at the time of the mandate, these customers were not counted as part of the mandate's requirements. However, Bend intends on metering these customers by end of the 2004 and has budgeted to do so.

Current Residential Population (Div. 86-0140[2]) The City assumes that only 68% of the total city population is served by Bend as documented in Bend's 1996 Water Master Plan. For practical planning purposes, a rounded number of about 70% is used throughout this WMCP in representing the portion of the City's population served by its own municipal water supply system. Applying this percentage to the most current population figure for the city yields a service population estimate of about 44,000 in 2003. This number results from a July 2003 estimate of city wide population of about 62,900 - as reported by Portland State University's Population Research Center.

Residential Demand Figure 2-4 shows total residential demand, disaggregated by metered and unmetered residential customers. The results are discussed below following a description of the method used to obtain residential demand.

Figure 2-4
City of Bend
Historic Average Day Demand of the Residential Class



Metered demand in Figure 2-4 was calculated using readily available data from the City's billing system, however unmetered demand was obtained through indirect means. To calculate consumption of the unmetered Residential customers, Bend estimates that residential customer demand for the non-metered residential customer was 20% greater than a metered Residential customer.[1] This is based on the expectation that customers use less water when they are billed based on metered use. The number of unmetered Residential accounts was multiplied, then, by an average day demand per account inflated by 20% of the metered Residential class. The results of the calculation are presented in Table 2-8.

[1] As described in Section 1.2, the difference in demand could be 15% to 25%. Bend settled on 20% as an average when calculating demand of the unmetered Residential class.

Table 2-8
City of Bend
Historic Residential Demands

	1998	1999	2000	2001	2002	2003
Metered ADD per Account (GPD) (1)	362	380	431	402	419	388
Metered Accounts (2)	3,822	5,234	6,713	8,135	9,807	13,825
Metered Demand Subtotal (MGD) (3)	1.38	1.99	2.89	3.27	4.11	5.36
Unmetered ADD per Account (GPD) (4)	434	456	517	482	503	466
Unmetered Accounts (2)	6,315	5,647	5,151	4,461	3,766	743
Unmetered Demand Subtotal (MGD) (5)	2.74	2.58	2.66	2.15	1.89	0.35
Total (MGD)	**4.12**	**4.57**	**5.55**	**5.42**	**6.00**	**5.71**
Total Demand per Account (GPD) (6)	406	420	468	430	442	392
Gallons Per Capita Per Day (7)	164	169	189	173	178	158

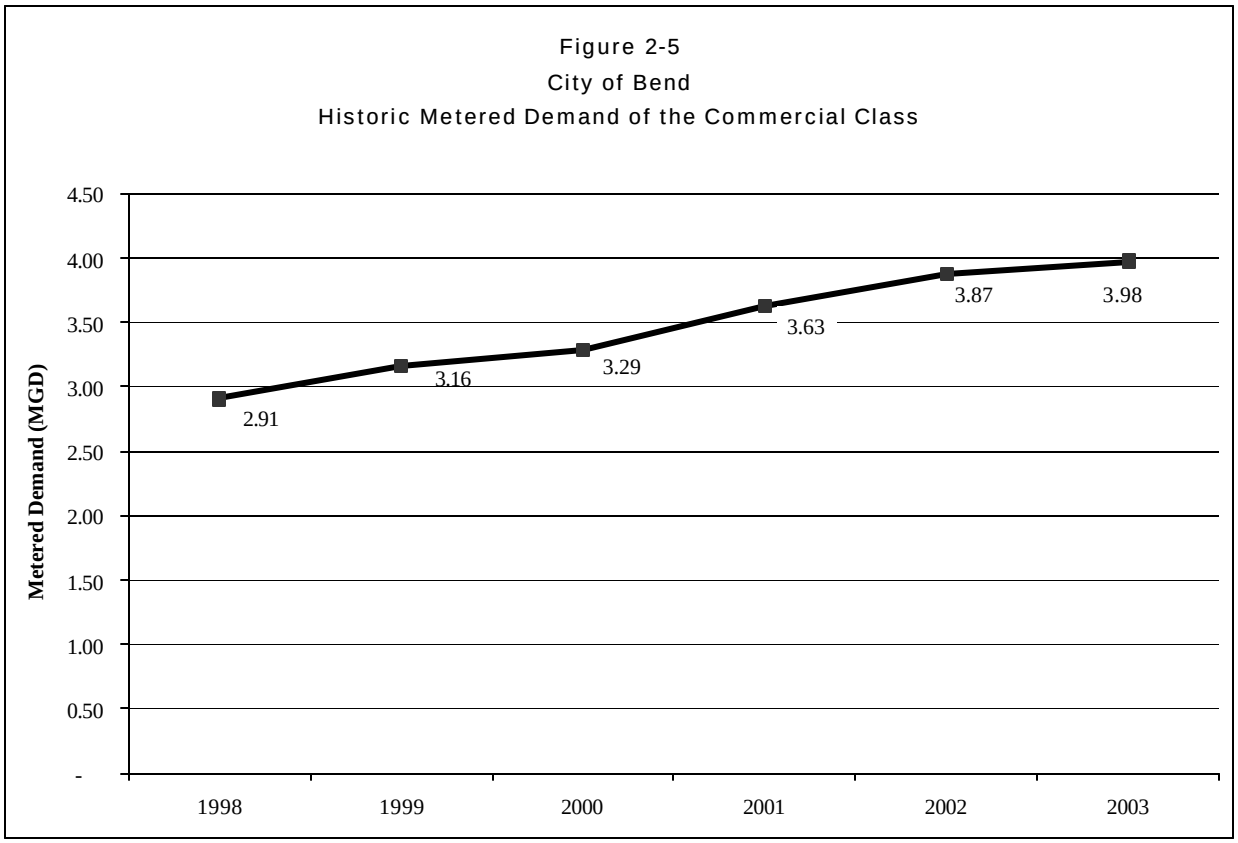
(1) Obtained by dividing "subtotal" row by "metered accounts" row.
(2) See Table 2-7.
(3) From City billing records.
(4) Assumed to be 20% greater than metered ADD.
(5) Calculated by multiplying "unmetered accounts" and "unmetered ADD per account".
(6) Calculated by dividing "Total" by the combined number of "metered accounts" and "unmetered accounts".
(7) Calculated by dividing "Metered ADD per Account" and "Unmetered ADD per Account" by the Census 2000 estimate of 2.48 persons per owner-occupied residence ("owner-occupied residence" translated to "Residential account" for purposes of this calculation).

According to Figure 2-4 and Table 2-8, total residential demand increased from 1998 to 2003. In addition to providing demand by residential metered and unnmetered customers, Table 2-8 also shows the total demand per account and the estimated per capita demand of metered Residential customers from 1998 to 2003. Total demand per account ranged from a high of 468 gallons per day (GPD) to a low of 392 GPD and averaged 426 GPD. Bend believes this demand could have been higher, but attributes the effects of its conservation program—which has primarily focused on reducing maximum day demand—to have limited demand per account. Residential water use varies considerably by region, climate and weather conditions (especially temperature and rainfall), socioeconomic factors and other customer characteristics. In the United States, regional differences in average per-capita residential demand are primarily attributable to variations in outdoor water use. (Reference Handbook of Water Use and Conservation, 2001, Amy Vickers, pp 12, 13) The daily demand per person averaged 172 gallons per capita per day (GPCD). As compared to the prior five-year average of 175 GPCD from 1998 through 2002, the partially metered 2003 demand shows a ten percent reduction.

Though weather probably played a role in the annual changes of demand over this six year time period, 2003 demand per account indicates a demand lower than the previous five years. Bend attributes much of this decrease to Bend's successful meter installation program. Note that the unmetered Juniper customers are not included in Figure 2-4; Juniper is described in detail later in this section.

Commercial Customers Table 2-7 shows Bend's Commercial class accounts increasing from 2,127 in 1998 to 2,941 in 2003, representing approximately 38% increase. During this same time period, demand increased approximately 37%. Figure 2-5 shows this increasing demand.

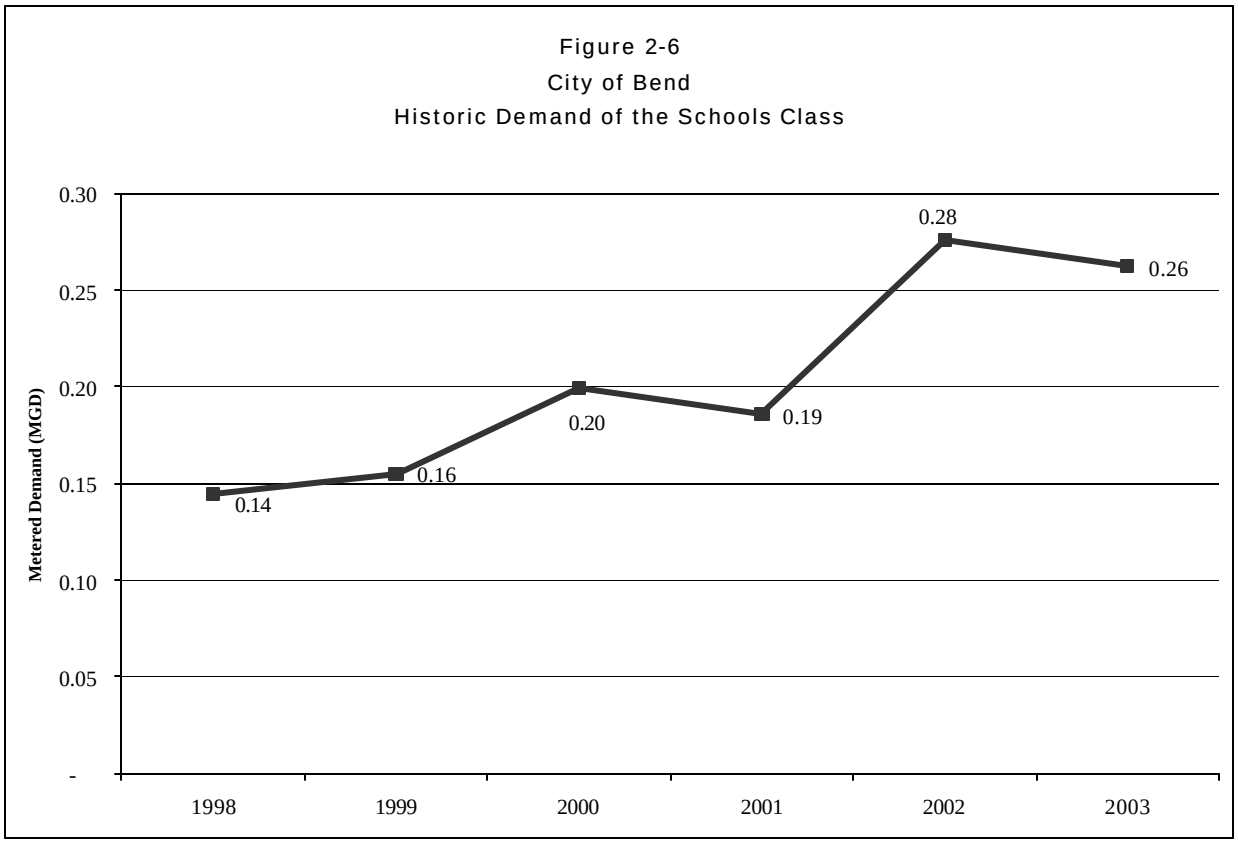
Figure 2-5
City of Bend
Historic Metered Demand of the Commercial Class



Source: Bend's billing records.

Schools Customers The number of metered accounts for the Schools class increased from 28 in 1998 to 38 in 2003. Demand for this class jumped about 100% over this time period, owing partly to the increase in the number of new schools (which is reflective of an increase in the population served by Bend) and also due to a large increase in summer demand. In particular, during the summer months (considered April through November) of the years 2000 and 2001, ADD was 0.09 MGD and 0.10 MGD, respectively, whereas the summer months' demand in 2002 was 0.20 MGD. The increase may be a result of the construction of two new schools in 2001, one of which was a high school with considerable amount of new turf area. Also, in 2000, Pilot Butte Middle School switched from irrigating with non-potable irrigation district water to City water adding to the overall summer increases in latter years. Figure 2-6 shows the Schools customer class' historical demand.

Figure 2-6
City of Bend
Historic Demand of the Schools Class



Source: Bend billing records

Juniper Area Juniper area customers include 738 residential customers and six commercial type customers, including a golf course club house, RV park, two churches, and two mobile home parks. None of these customers are currently metered. Bend budgeted to fully meter Juniper customers in 2004 though the exact date will be known following the results of legal proceedings. In addition to several wells that serve the area's domestic needs operated by the City, the Roats Water System provides domestic water to a portion of the former Juniper service area. Irrigation water is supplied by the Arnold Irrigation District with supplemental water supplied by the groundwater wells which were owned by the former operator of the Juniper system but now are operated by the City.

Because neither detailed historic production nor demand data is available, demand for the residential class in the Juniper area was determined by applying the average day demand for the City of Bend's metered residential class of 396 gallons per household per day. The demand for the RV park, churches, and mobile home parks was assumed to be the same as the average day demand for the Commercial class, or 1,309 gallons per customer per day.[2] Together, demand in the Juniper area was assumed to be 300,102 gallons per day.

[2] An average of 2,653 commercial service connections for 1998 to 2003 used 3.47 MGD which equates to 1,309 gallons per customer per day.

2.6 System Losses (Div. 86-0140[9])

A water audit was used to estimate non-revenue water, including water losses. A water audit is best described with a simple equation: total annual water produced on one side of the equation, and all uses of water—metered, unmetered, and non-revenue—on the other side. The water audit equation looks like this:

Annual Production = Metered Sales + Unmetered Sales + Non-Revenue Water

Generally, unmetered sales represent a volume of water which was purchased through one or more customer types for a flat fee. In Bend's case, unmetered sales represents sales to unmetered Residential customers and through the use of hydrant permits. Current hydrant permits are essentially a flat rate fee system that allows unlimited volumes of water to be drawn from hydrants when a permit is issued. Typically, these permits are obtained by contractors for construction purposes, dust control and temporary irrigation for revegetation or hydroseeding in construction zones.

Non-revenue water is a common component of system demand as a result of a variety of occurrences and activities. Examples of non-revenue water includes main flushing, street cleaning, fire fighting and training, meter inaccuracies, line breaks, leakage, and theft. Bend has estimated an annual average demand for main flushing (4 MG), street cleaning (1.0 MG), fire fighting and training (0.6 MG), and major breaks (0.1 MG). These numbers are thought to be conservatively low based on information gathered from system operators but are reflective of the magnitude of use for each purpose. In addition, the city's reservoirs are drained annually for cleaning and inspection. Bend estimates that up to 40% of this water is sold, while the remaining water is drained (not sold). These activities represent "known non-revenue water".

The remaining elements of water use within the accounting are those considered as water loss or unknown non-revenue water. Water loss is a factor in any water system and is often described in terms of its relative percentage of production. Table 2-9 shows the results of the water audit for Bend from 1998 to 2003 and how water loss was calculated. The city's average over the period from 1998 to 2003 is 10.2%. However, the numbers also show a general trend of reduced loss through time. This trend is thought to be associated with the city's metering program. Since 2000, the city has been aggressively pursuing a fully metered system campaign. As additional meters have been installed, the accuracy of known water use has increased, resulting in improved estimates of water loss and lower volumes of unmetered use. The more recent numbers years from 2001 through 2003 are thought to be more representative of the system's actual losses (i.e. less than 10%). These lower numbers of loss are also supported by recent leak detection surveys conducted by the city and the fact that most of the distribution system is comprised of relatively new pipe. The city believes that its existing system losses are less than 10% as the recent numbers show and that future audits with the new metering data will continue to support that conclusion.

Table 2-9
City of Bend
Bend Water Audit Calculation

	Production (MG)	Metered Sales (MG)	Unmetered Sales (MG)		Known Non-Revenue Water (MG)					Total Demand (MG) (3)	Water Loss (4)	Water Loss as a Percent of Production
			Unmetered Residential (2)	Hydrant Permits	Main Flushing	Street Cleaning	Fire Fighting & Training	Reservoir Maintenance (1)	Major Breaks			
1998	3,142	1,618	1,000	183	4	1	0.55	10.8	0.06	2,817	325	10.3%
1999	3,733	1,935	939	183	4	1	0.55	10.8	0.06	3,073	660	17.7%
2000	3,919	2,328	971	183	4	1	0.55	10.8	0.06	3,497	422	10.8%
2001	3,866	2,587	786	183	4	1	0.55	13.8	0.06	3,576	290	7.5%
2002	4,205	3,014	691	183	4	1	0.55	13.8	0.06	3,908	297	7.1%
2003	4,184	3,501	126	183	4	1	0.55	13.8	0.06	3,830	354	8.5%
Totals	**23,049**										**2,348**	**10.2%**

(1) In preparation for reservoir cleaning, approximately 60% of reservoir capacity is not sold. Increase in 2001 represents construction of a new 5 MG Pilot Butte reservoir in 2000 and subsequent cleaning one year later.
(2) Production for or demand of Juniper customers is not reflected in the data in Table 2-9.
(3) Summation of Metered Sales, Unmetered Sales, and Known Non-Revenue Water.
(4) Water loss calculated by subtracting Total Demand from Production.

Before concluding this discussion, it is important to also note that the city will be installing metered truck filling stations in the near future. Funds have been allocated in the 04/05 FY budget to construct water truck filling stations that are fully metered in several locations across the community in addition to studying a variety of metered hydrant devices to better monitor this use. Metered hydrant use and fill stations have also been included in the conservation benchmarks for this WMCP. The city's present system for monitoring this use is based solely on the number of hydrant permits authorized – the number of which often times may not accurately reflect that actual use in this category. In fact, the large loss number reported in 1999 was believed to be associated with several major construction projects in the area, including the Bend Parkway elevated roadway by-pass. During that period, water used for construction of this and other state and local agency projects was not metered, adding substantially to the reported losses for the city's water system. As a conservative estimate of hydrant use over the period 1998 through 2003, an assumption was made in Table 2-9 that an average number of permits were authorized each year. However, in some years such as 1999, the actual unmetered hydrant use was thought to be substantially higher than that reported based on the noted average number of permits. The future installation of metered filling stations will improve the estimate of water used in the area for construction and greatly improve the city's estimate of system loss.

2.7 Assessment of Source Adequacy and Reliability (Div. 86-0140[3])

As previously stated, Bend's sources include ground water, surface water, and interconnections with other local utilities. The historical and future adequacy and reliability of these sources are summarized and described in the following text.[3]

Historical Adequacy In the 1970's, demand rarely exceeded the total allowable surface water diversion rates. However, as demand increased, the surface water restrictions—previously described in the "Water Rights" subsection 2.5.1—have limited Bend's ability to divert more water. As a result, Bend decided to rely on ground water as a means to meet new demand. Ground water was a particularly favorable choice since these rights were not restricted. Combined these sources have been adequate to meet demand.

Historical Reliability The fact that ground water did not have restrictions and surface water did meant Bend viewed the reliability of the sources differently. Regarding reliability of ground water, this source has proven reliable for the City of Bend without significant interruption. Specifically, ground water supply has not been subject to restrictions due to, for example, water quality contaminants from human activity nor has Bend had to curtail production as a result of droughts. Also, since the aquifer from which Bend draws ground water is so large relative to regional demand, Bend has not experienced measurable decreases in aquifer levels.

[3] For purposes of this section, the terms "adequacy" and "reliability" are in regard to the interplay between restrictions associated with Bend's water rights and demand. Not discussed thoroughly in this section of the WMCP are emergency scenarios associated with catastrophic events which compromise the sources reliability, such as prolonged droughts, a catastrophic wild fire in the Bridge Creek watershed, or a system-wide power failure which renders Bend's pumps ineffective. These scenarios, along with Bend's ability to meet such challenges, will be discussed in the Curtailment Section of the WMCP.

Regarding the reliability of surface water, the seasonal flow restrictions placed upon some of Bend's surface water rights have had the potential to significantly impinge upon Bend's ability to divert water, particularly during peak season. In addition, surface water is vulnerable to water quality contamination as a result of a wildfire in the Bridge Creek watershed. Such fires are relatively common (the last one in the late 1970's) and, when they occur, will degrade water quality to the point where some water quality standards are exceeded, rendering the water undrinkable without expensive treatment.

For Bend's other water supplies—interconnections with Avion Water Company, Roats Water System, and the purchase of irrigation water from Arnold Water District—it is difficult to gauge adequacy and reliability because these connections are new additions to Bends system. Recall that Bend constructed an interconnection with Avion in 2003 and acquired the Juniper area in 2002. The Arnold Irrigation District and Roats Water System provide irrigation and some domestic water, respectively to the Juniper area, and Juniper area wells supplement irrigation district supplies when necessary. With respect to Bend's short history with these sources, these sources have been both adequate and reliable.

Future Adequacy and Reliability Combined, the City's current sources are not adequate to meet the future demand due to the fact that demand is projected to outgrow available rights. (The calculation of this date is fully described in Sections 5). The overall water right situation in the Deschutes Basin is complex due to required mitigation and associated and pending lawsuits, policy decisions, unique hydrology, and public interest. Though Bend intends to continue working toward resolutions of these complex and important issues in the Basin, new applications will be necessary. The City of Bend believes that the application/permit process will take considerable time given the regulatory and public process.

To ensure adequate supply in the immediate future, Bend intends to apply for an amendment of its remaining undeveloped rights in the amount of 5.0 MGD or (7.75 CFS) from the Lava Island site (Application File Number G-4677) to other points of appropriation (Bend received a proposed final order from WRD for an extension of the Lava Island rights, however the order is conditioned to require an approved WMCP. This WMCP serves that purpose). Additionally, WaterWatch has contested the Lava Island PFO and has filed a facial challenge of the new WRD Groundwater Mitigation Rules. When approved, this amendment can meet Bend's near-term demands until resolution of the larger regional issues described above. When approved, the amendment can help Bend's near-term demands until resolution of the larger regional issues described above.

The reliability of Bend's sources is anticipated to remain at the same level as described above because no new restrictions upon any of the sources are anticipated. Other sources (Avion, Roats) may not be reliable due to growth of other providers.

Section 3

Municipal Water Conservation Element

3.1 Introduction

A Municipal Water Conservation Element is a required element of a Water Management and Conservation Plan under OAR 690-086-150. This section presents the Conservation Element for the City of Bend. Each item required under OAR 690-086-150 is addressed. These include a progress report on accomplishments since submittal of the last WMCP in 1998; a summary of current and planned conservation activities and "benchmarks" for each category of activity; and information on Bend's measurement and reporting of water use. In addition, this technical memorandum provides an estimate of the quantity of water that will be saved through Bend's conservation program. This estimate is used later, in the demand forecast presented in Section 5 of this WMCP.

3.2 Summary of Findings

Table 3-1 lists all of the actions, or "benchmarks" the City plans to carry out during the period 2004 – 2008. It is anticipated the City will submit an updated WMCP in 2009, and conservation actions for later years will be addressed based on experience during the 2004-08 time period. Based on the City's understanding of the Division 86 Rules, these benchmarks fully comply with State requirements for the Conservation Element of the WMCP.

As discussed later in this section, the City estimates that this combination of activities will reduce average daily demand by approximately 710,000 gpd. In percentage terms, this is 6.4 percent of 2003 average day demand. This percentage will be used for purposes of adjusting the demand forecast in the WMCP. For purposes of the WMCP, it is assumed that these savings will be achieved in stages over a ten-year period beginning in 2004. For the five year period ending in 2008, the goal will be to achieve one-half of this percentage (3.2%).

Table 3-1 City of Bend Summary of All Benchmarks for 2004-2008		
Benchmark	**Start Date**	**Frequency or Completion**
Metering		
Fully meter Juniper system customers	Fall 2004	Dec. 31, 2004[1]
Periodic verification of all commercial meters over 3-inch size	Ongoing	Every 2 years
Replace all small meters on a rolling 15-20 year cycle, or as needed based on billing data indicating inaccuracies. Automated Meter Reading batteries have a 12 to 15 year life, and will tie directly to the meter replacement schedule.	Ongoing	15-20 year rolling replacement schedule
Periodic verification of all source meters (models that Bend purchases are not designed for field adjustments)	Ongoing	Every 2 years or as needed
Install permanent metered fill stations and develop portable metered hydrant program.	Spring 2005	June 30, 2006
Water Auditing		
Perform water audit accounting for uses and potential losses of water	2003 (using 2002 data)	Annual
Leak Detection		
Periodic leak detection surveys – at least 10 miles of water mains	2005	Every five years
Develop brochure for customers on using meters for leak detection; and distribute toilet tank leak detection dye tablets	2004	Annually
Perform flow audit calculations to verify inflows match outflows, for each Bridge Creek transmission line	2004	Annually
Rate Structure		
Continue to expand and refine water use data collection and analysis, and expand breakdown of customer classes	2003	June 30, 2005
City Council decision on whether/how to modify rate structure. Based on review of options for cost-of-service rate structure, including differing rates for different customer classes; and/or tiered rates, seasonal differential, or other approaches	2003	June 30, 2006
Continue to utilize customer bills to communicate water conservation messages and incentive programs	2003	At least four times per year; with focus on irrigation season.
Public Education		
Upgrade Web site to more fully convey the City's WaterWise program	2004	Annual
Continue sponsorship and participation in approximately three to five annual events attended by the public	Ongoing	Annual
Print and radio advertising, with focus on irrigation season	Ongoing	Annual
School tours and speakers bureau	Ongoing	Annual
Periodically review and upgrade printed handouts and related materials	Ongoing	At least every other year
Continue funding Customer Field Representative position, to provide customer outreach and enforce irrigation restrictions	Ongoing	Annual, during irrigation season

[1] Metering benchmark subject to Juniper area legal proceedings.

Table 3-1 Continued City of Bend Summary of All Benchmarks for 2004-2008		
Benchmark	**Start Date**	**Frequency or Completion**
Technical and Financial Assistance		
Review odd-even day irrigation restrictions and determine whether/how to modify. Possible exemption for those sites using weather-based irrigation systems	2004	Dec. 31, 2005
City-managed Greenwood Cemetery: Install with Maxicom irrigation control system	2003	Dec. 31, 2004
City Landscape Retrofit Project: Budget for replacement of landscape irrigation system at one site per year	2003	Annually
City Landscape Sites: Complete maintenance and management plan	2003	Dec. 31, 2004
Bend-La Pine School District Irrigation Agreement: Partner with school district to provide technical assistance to implement weather-based watering control at all new and existing sites	2003	Ongoing
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	2003	Ongoing
Water audits for selected large customers. Audits of turf fields will be completed as part of partnership described above	2004	4 large site audits per year
Irrigation audits will also become part of standard contracts for City-funded irrigation improvement projects. Contracts will include performance standards and correction actions	2004	As projects occur
Continue to expand waterwise partnerships using Central Control Technology, including new large landscape partners	2003	Add one new site per year
Fixture Retrofit/Replacement		
Toilet retrofit program feasibility survey	2004	Dec. 31, 2005
Reuse, Recycling, Non-potable		
Perform 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	2004	Dec. 31, 2008

3.3 Progress in Implementing Conservation Measures from 1998 WMCP (Div. 86-0150[1])

The City of Bend submitted its previous WMCP to the Oregon Water Resources Department (WRD) in 1998, and it was approved in 1999. As required under the Division 86 Rules, Table 3-2 provides a progress report with respect to the conservation measures described in the 1998 Plan. It should be noted that some of the specific items listed in 1998 have been modified or replaced with other activities, as the City's conservation program has developed. For example, a number of public education activities have been carried out that were not specifically identified in 1998, while other activities planned in 1998, such as distribution of indoor-low flow kits, have been replaced with activities emphasizing outdoor water-use efficiency.

For many of the items listed in Table 3-2, additional detail is provided in the next section entitled Current and Planned Conservation Program Activities.

Table 3-2
City of Bend
Progress in Implementing Conservation Measures from 1998 WMCP

Item	Status	Comments
Customer Meters [1,2]	✓	• Meter installation program implemented to convert all unmetered customers. Approximately 6,000 conversions completed from 1998 through March 2004 (nearly 100% of previously unmetered customers). Program completed in March 2004 at an approximate cost of $4,500,000..
Irrigation restrictions	✓	City has continued irrigation restrictions as documented in 1998 plan. Morning/evening hours; and odd/even days.
Public information and education	✓	• Implemented print and radio advertising program to promote efficient landscape irrigation. Initial campaign in 2002, followed by expanded outreach effort 2003. • In-house City communications manager produces press releases, provides programming for local cable TV show, and articles in City's newsletter. • City employed communications firm to survey customer attitudes and practices to inform public information program and conservation plan. • Public presentations on water conservation need and techniques. Hiring of first FTE in 2000 permitted expansion of this activity. Over 100 presentations made since then to local boards, Rotary Clubs, service clubs, and elected officials. • City employs a Water Customer Field Representative who makes 500 to 1,200 contacts with customers per year. Educating customers to ensure compliance with irrigation restrictions is large part of this position. • Partnership with Central Oregon Environmental Center: event booth for distributing conservation literature. • Developed & delivered LAWN irrigation guide with rain gauge to help customers optimize irrigation systems. • Held Water Summit workshop: "Seeing Things Whole – the Deschutes River through Bend." Explained connections between water supply, water quality and related issues in region. Over 100 attendees.
Middle School Education program	Modi-fied	Education program modified from 1998 WMCP. Activities have included: • Contribute funding to Oregon High Desert Museum "Make a Splash Day," an annual event drawing school children regionally and statewide. • Partnered with ReSource. Deschutes County reaches over 5,000 students annually in the region, with conservation message on water, solid waste and compost. • High Desert Museum. Annual summer In-service to teachers, about water issues in Central Oregon and statewide. • Obtained grant from Bureau of Reclamation to provide Project WET curriculum guides for local teachers (Water Education for Teachers). • Provide speaker on water issues annually for high-school Advanced Placement classes. • Coordinate tours to watershed intake; and field trips meeting requests from teachers within Bend-La Pine School District. • Adult Education: Central Oregon Community College: City established annual Spring landscape series with very high community attendance and provides speakers to Turf Management Program.

Table 3-2 Continued City of Bend Progress in Implementing Conservation Measures from 1998 WMCP		
Item	**Status**	**Comments**
Leak detection [1]	N/A	1998 WMCP reported previous leak detection studies that found minimal leakage. Much of system is relatively new, ductile iron pipe and is not susceptible to leakage. Metering program has identified customer line leakage and City works with customers to get these repaired.
Main replacement	N/A	1998 WMCP reported on recent main replacement, but did not specify additional main replacements. City has implemented replacement of high-maintenance and undersized mains in older parts of city (e.g. 1920s and 1930s), combining benefits for conservation, operation and reliability. Have spent $1.6 M to replace over 9,000 lineal feet of water line since 1998.
Incentive programs	✓	1998 WMCP indicated that incentive programs involve the metering program (see above). No further incentive programs were identified.
Hardware distribution	N/A	1998 WMCP indicated low flow kits would be provided to customers during the meter application process. However, City has shifted emphasis to outdoor water-use efficiency. Current kits distributed focus on outdoor use and include rain gauges, lawn-watering guides, and assorted information on topics such as low water-using plants, tips to avoid wasting water, and water conservation FAQ sheets.
Evaluate adoption of conservation rate structure [1]	✓	Listed in WRD workplan. City commissioned report on options for conservation rate structures. Further action deferred pending installation of meters (see further discussion in this document).
Wastewater reclamation/reuse	✓	1998 WMCP indicated no opportunity for reuse within city. However, City wastewater system has implemented plan to deliver reclaimed water to golf course and development outside city (Resort at Pronghorn).
Education on irrigation application rates [1]	✓	• City has developed outreach programs to educate customers on proper landscape application rates, as well as appropriate soil amendments and landscape design. Partnerships with local landscape and building industry and other organizations. • Obtained grant from Bureau of Reclamation to provide Certified Landscape Irrigation Auditor training for local landscapers in partnership with Irrigation Association and local Oregon Landscape Contractors Association office.
System water audit [1]	✓	This WMCP presents audit performed using 2002 data. Future audits will be improved with the additional meter conversions since 2002.
Meter testing	✓	1998 WMCP indicated all 1.5" and 2" meters would be replaced beginning in 1997. All meters up to 2" diameter are replaced on a 15 to 20 year cycle, or sooner if customer meter data indicates change from normal use. Larger meters are tested every two years and repaired or replaced as needed.
Large user water audit	✓	1998 WMCP indicated $5,000 budgeted for large user water audit (e.g. schools and Community College). City hired contractor to perform audits of three large playing fields for Bend-La Pine School District, summer 1999. Results demonstrated large potential for conservation benefits to School District, leading to agreement for weather-based irrigation program.
Collect and refine water use data [1]	✓	Listed in WRD workplan. The City has been collecting data through its billing system and this will improve further as full implementation of metering is completed in 2004.

Table 3-2 Continued City of Bend Progress in Implementing Conservation Measures from 1998 WMCP		
Item	**Status**	**Comments**
Target non-residential accounts, esp. schools and hotels /motels.	✓	Listed in WRD workplan. City has worked with School District to reduce irrigation usage. School District agreed to implement weather-based irrigation. City is establishing weather station to support the system and assisted securing grant funding for computer and software. City added Large Landscape Specialist position to assist large irrigation users. City performed water audit on one hotel/restaurant site to gain data for this customer class. City evaluated EPA WAVE program for hotels/motels but main benefits were for indoor use. City focusing on outdoor use instead.
Source measurement and reporting	✓	City measures and reports source production as required by State rules.

1. Identified in WRD Work Plan
2. The City has budgeted to meter Juniper customers by mid-2004. Juniper area was acquired by the City in 2002.

3.4 Current and Planned Conservation Program Activities

This section describes Bend's current conservation activities. While specific details of the program may change from time to time, the City plans to continue these general types of activities at a similar level of effort during the time period 2004-08. This time period is the focus of the conservation benchmarks, because the City anticipates submitting an updated WMCP in the following year, 2009. At the end of each section, a table of "benchmarks" is provided. The benchmarks, as required in the Division 86 Rules, are specific commitments which the City will carry out according to the schedule indicated in each table.

3.4.1 Metering, Meter Testing and Maintenance (Div. 86-0150[4b,c])

Metering of Water Services In 1998 when the previous WMCP was prepared, Bend had over 6,000 unmetered residential customers, representing over half of all water accounts in the city. Converting these accounts to metered accounts has been a central focus of the City's water management program since then, and all previously unmetered customers will be metered as of May 2004. With the conversion process completed, the City now has the capability to gather accurate data on water usage in all of its customer classes. The City also has source meters on all of the sources of supply.

One area still unmetered is the approximately 750 customers within the Juniper area. All of the customers in the Juniper area are unmetered, and the City anticipates converting Juniper accounts to metered accounts by the end of 2004. However, as previously described, the City incorporated Juniper into its service area as a result of legal proceedings and began operating the system in 2002. Legal proceedings for the ownership of Juniper's infrastructure and water rights, among other issues, are currently underway between seven (7) homeowner associations, irrigation district, the former owner and a school district. Despite lack of legal ownership, the City is moving forward with plans to meter all Juniper area customers by mid-2004 and the

schedule and process will be worked out through negotiations and/or the legal process now underway.

Hydrant Meter Program The current hydrant permit system is essentially a flat rate fee system that allows unlimited volumes of water to be drawn from hydrants when a permit is issued. Typically, these permits are obtained by contractors for construction purposes, dust control and temporary irrigation for revegetation or hydroseeding in construction zones. Hydrant use is the last major unmetered use within the City. The City plans to study the use of regionalized fill stations around Bend and will work with local contractors to determine the best locations in various quadrants of town. Also, creation of portable metered hydrant stations will be available for jobsites and is included in the benchmarks.

Meter Calibration and Replacement Since 1990 the City has contracted with Oregon Meter Repair to maintain all commercial meters 3-inch and larger. Each meter in this category is checked/calibrated every two years. The contractor repairs any meters found to need servicing. Smaller commercial meters are checked through computer analysis of customer usage each month (i.e. unusually low or high readings). When a meter is flagged for a "re-read," suspect meters are replaced. In addition, the City tests meters if requested by the customer. If a meter tested through this procedure is found to be off by 3% or more (either high or low), it is replaced.

Most of the residential meters in the City's service area are relatively new, as a result of the program to meter all residential services. Residential meters are typically replaced on a 15 to 20 year basis according to guidelines of the American Water Works Association (AWWA). The City anticipates replacing meters by zones to stagger the workload. This will be done at the same time batteries are replaced[2] on the Automated Meter Reading (AMR) transponders, or on an as-needed basis.

Source Meters Verification of source meters is accomplished at the same time reservoirs are drained and filled each year. Flow rates, pump curve data and fill rates are used in calculations to verify source meter accuracy. Accuracy of source meters is also critical for chlorine disinfection calculations; this provides a built-in source of detecting meter inaccuracy. Chlorine is tested daily throughout the distribution system. In addition, if the source meters fail or read incorrectly, chlorination can stop or be reduced due to no-flow conditions from the failed meter. This in turn triggers the inlet chlorine analyzer alarm which pages on-call staff to find the problem and correct it. Highly trained staff and extensive records of long-term water use provide additional checks on meter accuracy.

[2] The AMR transponder batteries have a 12 to 15 year lifetime.

Table 3-3 identifies benchmarks for the City's metering program.

Table 3-3
City of Bend
Metering Benchmarks for 2004-2008

Benchmark	Start Date	Frequency or Completion
Fully meter Juniper system customers	Fall 2004	Dec. 31, 2004
Periodic verification of all commercial meters over 3-inch size	Ongoing	Every 2 years
Replace all small meters on a rolling 15-20 year cycle, or as needed based on billing data indicating inaccuracies. Automated Meter Reading batteries have a 12 to 15 year life, and will tie to the meter replacement schedule for operational efficiency.	Ongoing	15-20 year rolling replacement schedule
Periodic verification of all source meters (models that Bend purchases are not designed for field adjustments)	Ongoing	Every 2 years or as needed
Install permanent metered fill stations and develop portable metered hydrant program.	Spring 2005	June 30, 2006

3.4.2 Annual Water Audit (Div. 86-0150[4a])

It has not been feasible to do a thorough audit of water system production and use until very recently, since a large portion of demand was in the unmetered residential class. However, with the installation of water meters, this has changed. This WMCP documents an initial water audit based on data available for year 2002. The audit demonstrates that non-revenue water is on the order of ten percent. This falls within the normal range of non-revenue water among water systems statewide.

With all services now metered apart from the limited Juniper system, the City will perform a water audit annually as required by the Division 86 Rules. In order to provide data for this audit, the City's water system operations staff will estimate known uses and losses on a monthly basis and maintain records of these elements. For example, this will include estimating quantities of water used for flushing water mains; estimating water lost from major water main leaks that are identified and repaired; and estimating water used under hydrant use permits. In addition, the City will put in place a system to track use of hydrants by firefighting units in fighting fires and training exercises. Table 3-4 lists the benchmark for water auditing.

Table 3-4
City of Bend
Water Audit Benchmarks for 2004-2008

Benchmark	Start Date	Frequency or Completion
Perform water audit accounting for uses and potential losses of water	2003 (using 2002 data)	Annual

3.4.3 Leak Detection Program (Div. 86-0150[4e])

Due to the rapid growth that has occurred in Bend, most of the distribution system water mains are relatively new, ductile iron pipe with little potential for excessive leakage. In fact, Bend's water audit for 2003 showed non-revenue water (for which leaks were a large portion, likely) at 8.5% and the previous two years showed 7.1% (2002) and 7.5% (2001). Bolstering these water audit calculations is the results of leak detection studies. The City commissioned leak detection surveys in 1994, 1995, 1997 and 2000, focusing on older parts of the system that have iron and cast iron piping. These surveys showed that even the older parts of the distribution system are relatively sound. For example, the 1997 leak detection survey found leaks totaling only 6,480 gallons per day in 20 miles of piping (approximately 0.07 percent of average day production). The 2000 survey of 37 miles found leakage of only 2,160 gallons per day (approximately 0.02 percent). Frequent leak detection surveys do not appear warranted given these findings. However, the City will continue to carry out occasional leak detection surveys to monitor any changes in pipe integrity over time.

Leak detection is an ongoing process in the growth of the distribution system in our process of accepting new water mains constructed by the development community. For example, when a new subdivision is approved the construction contractor begins to put in the necessary infrastructure to provide water service and fire protection to the homes in the subdivision. The new pipe is laid and bedded into the ditch, inspected for proper construction practices and quality of materials by City of Bend Inspectors. The pipe is then subjected to a pressure test, which requires a 180 pounds per square inch, minimum for a time period of not less than two hours. If the newly laid pipe does not meet strict specifications, the contractor is obligated to make the necessary repairs and the test is repeated until the specifications are met.

There are several pressure testing firms in the community and all have passed both written exams and field exams conducted by the City of Bend Water Division staff. Other communities in the Deschutes Basin utilize these pressure testing firms and the results have been satisfactory over time. Over the past few years the footage of new main laid in the City distribution system has ranged from 9 to 15 miles per year. Using a average of 12 miles per year the City has pressure tested 60 miles of water main over the past half decade, which is approximately 16% of the entire system.

Over the past decade we have utilized professional leak detection services to examine the older sections near the center of the City and along the path of the Bend Parkway, which was build in the early to mid 1990's and traverses the entire length of the distribution system. Results of these leak detection services showed a very low leak rate. There are several factors which relate to the low rate of leaks in the system. First, most of the distribution system has been constructed with ductile and cast iron pipe using copper service lines over the past quarter century. Ductile iron pipe has an expected service life of at least 100 years. Second, the soils in the Deschutes Basin are not aggressive due to the geologic setting. Third, the water quality of the City of Bend system is very neutral in terms of pH and associated corrosion parameters. Fourth, the City of Bend has had an active old line replacement program for decades. This program replaces and

upgrades distribution lines to increase fire flows, improved system flow patterns and lowers maintenance activities.

The City will continue to contract for leak detection surveys on the remaining portions of the system that have not been examined over the course of this WMCP. Budgets may be altered to provide funding for hydrant/truck filling stations to provide metering and document this type of use.

Service line leaks have been discovered in both the leak detection and metering processes. The water department has worked cooperatively with customers when leaks have been discovered on the customer side of the meter, typically in the older galvanized service lines.

Leaks that occur on customer premises are not a direct responsibility of the City, but are a potential source of losses. The City plans to develop a brochure for customers using their water meter to detect leaks in their own plumbing systems. These will be mailed out once a year and will also be available on request. In addition, the City plans to distribute toilet tank leak detection dye tablets.

The City captures Bridge Creek unfiltered surface water at the intake facility using a 1925 rolled steel 14 inch line and a 1955 rolled steel 16 inch pipeline as transmission infrastructure. The system was designed in 1925 and is engineered to remain at full flow conditions for some 9 plus miles and about 1,000 feet of elevation drop until the transmission pipelines terminate at the Outback Site. At this location, a overflow tower was constructed to reduce pressure in the pipe to atmosphere at an elevation of 4010 feet. The purpose of this tower is to provide source water to the receiving reservoirs or, if the reservoirs are full, to spill the water via the overflow structure back into Tumalo Creek so that the transmission lines always are operating as full flow conditions to utilize the friction loss to control pressures (See picture of tower in appendix D).

During annual cleaning/maintenance operations of the receiving reservoir, the valves are closed to the receiving reservoir and all of the water spills out of the tower and returns to Tumalo Creek. By recording the elevation of the intake pond and taking measurements of the depth of the water flowing over the lip of the overflow tower and comparing the numbers over time, any change in the flow amounts generated by a leak can be determined. In addition, flow recorders constantly monitor the gallons of water into the distribution system. This flow data is critical to the disinfection process and any change in surface water source flows would be immediately apparent.

Water Division crews also walk and drive the length of the transmission looking for wet spots, greener than background vegetation, depressions in the native soil or any other indicators of leaks.

Leak detection benchmarks are shown in Table 3-5.

Table 3-5
City of Bend
Leak Detection Benchmarks for 2004-2008

Benchmark	Start Date	Frequency or Completion
Periodic leak detection surveys – at least 10 miles of water mains	2005	Every five years
Provide brochure to customers on using meters for leak detection; and distribute toilet tank leak detection dye tablets.	2004	Annually
Perform flow audit calculations to verify inflows match outflows, for each Bridge Creek transmission line.	2004	Annually

3.4.4 Leak Repair or Line Replacement Program (Div. 86-0150[6a])

Based on results of the leak detection program described above and water audit calculations, system leakage is below the 15 percent threshold specified in Div. 86-0150[5, 6]. Therefore, State Rules do not require a system-wide leak repair or line replacement program.

Major leaks in the City's water lines are infrequent, but are repaired when they do occur. In addition, as part of the overall operations and maintenance program, the City does have a program to replace older water mains. The City has implemented replacement of high-maintenance and undersized mains in older parts of City's service area (e.g. 1920s and 1930s), combining benefits for conservation, operation and reliability. The City has spent $1.6 M to replace over 9,000 lineal feet of water line since 1998. This program will continue over the next five years.

Since State Rules do not require action in this area for a system like Bend's with minimal leakage, no benchmarks are identified. However, the City anticipates continuing replacement of old lines on an as-needed basis annually.

3.4.5 Rate Structure (Div. 86-0150[4d, 6d])

Requirement for Rate Structure Based on Quantity of Water Used The Division 86 Rules require Bend to have a rate structure that bases water bills, in part, on the quantity of water metered. The City has had a rate structure that meets this requirement for all metered customers for many years. Currently, metered customers pay a fixed meter charge that is based on the size of the meter, as well as a volume rate for all consumption over 600 cubic feet. For Fiscal Year 2003-04 the volume rate is $0.81 per hundred cubic feet (CCF) for customers inside city limits, and $0.94 per CCF for customers outside city limits. With the recent completion of the City's meter conversion program, this rate structure can now be applied to all of the City's customers[3].

[3] Note previous discussion of newly acquired Juniper system, where customer meters will need to be installed.

Related Elements that Support and Encourage Conservation An additional requirement of the Division 86 Rules (86-0150[6d]) is that Bend must consider rate structures, billing schedules and related programs that "support and encourage water conservation."

With the conversion of over 6,000 residential accounts from the flat rate structure to the volume-based rate structure (see above), Bend has taken a significant step to improve the link between rates and water consumption. The City will consider additional changes to its rate structure to further encourage efficient use of water and to improve availability of data on water uses in different customer classes. However, the City needs to proceed cautiously in this area in order to cushion impacts on former flat-rate customers, make structured changes in its billing software and practices, and avoid abrupt changes in revenue needed to operate the water system.

The City will explore expansion of its water rate classes to accommodate additional categories. Currently, customers are categorized in one of three classes: residential, commercial or schools. The billing rate per ccf is currently the same for all water rate classes, with the only increase for those customers outside City limits. Development of additional categories could improve analysis of customer use patterns, thereby allowing better design of water conservation programs. In addition, an expanded list of customer classes can support a more advanced rate structure that employs cost-of-service techniques to ensure the burden of costs are equitably shared based on water consumption patterns.

As part of the work plan requirement from the 1998 WMCP, the City has completed a rate study to explore "cost-of-service" rates and/or tiered rates. The rate study results are presented in Appendix C and explains the various rate options presented for policy consideration choices by the Bend City Council. Analysis of revenue and rate class impacts can be improved in the future with full metering and more finely detailed rate classes. Again, any changes need to be phased in slowly over time and be implemented in conjunction with water conservation measures to assist customers in controlling their water bills.

With regard to billing schedules, the City reads meters and issues bills on a monthly basis. This supports water conservation by minimizing the time between water consumption and receipt of a water bill. By keeping the price signal as close to time of use as possible, customers can adjust their water use behavior. This is "state of the art" in the water utility field, since many water systems only issue bills on a bi-monthly or quarterly basis.

Finally, in order to facilitate more regular communication to customers, the finance department switched from postcard sized bills with no customer message field and no capability to insert bill stuffers, to a full 8.5 X 11 inch customer bill, full message area on printed bill, as well as a defined method to design, print and insert bill stuffers each month. For example, in 2003 this new capability was used in partnership with Bend Garbage and Recycling to encourage use of compost and other soil improvements. In addition, the City's twelve tips for water conservation were also sent out to all water customers using this channel. This approach helps to reinforce the linkage between the customer's bill and their attention to water use efficiency measures they can take. This capability will be even more fully utilized during the 2004 and subsequent irrigation seasons. Rate structure benchmarks are shown in Table 3-6.

Table 3-6 City of Bend Rate Structure Benchmarks for 2004-2008		
Benchmark	**Start Date**	**Frequency or Completion**
Continue to expand and refine water use data collection and analysis, and expand breakdown of customer classes.	2003	June 30, 2006
City Council decision on whether/how to modify rate structure. Based on review of options for cost-of-service rate structure, including differing rates for different customer classes; and/or tiered rates, seasonal differential, or other approaches.	2003	June 30, 2006
Continue to utilize customer bills to communicate water conservation messages and incentive programs	2003	At least four times per year; with focus on irrigation season.

3.4.6 Public Education Program (Div. 86-0150[4f])

Currently the entire water conversation effort has been brought under the name of "City of Bend WaterWise Program", and is concentrating on a few key areas. Bend's current programs have focused on increasing the efficiency and effectiveness of outdoor watering. A new effort will now be added to address indoor conservation efforts beginning with leak detection related to indoor plumbing systems on customer premises, a feasibility study of creating toilet retrofit program, and adding indoor conservation tips and links to the upgraded web page. The WaterWise program has been in a "capacity building" mode since 2000 when the first full time staff person was hired. Currently the effort has consisted of developing materials, strategic partnerships and building capacity to deliver future programs while the water metering contract is completed. This program mode has been successful in raising water awareness throughout the community and region. The following is a list of existing WaterWise Program Components related to public education for both indoor and outdoor conservation efforts, many with energy conservation benefits as well. For indoor conservation , please note the partnerships with Earth Advantage, Palmer Homes and the Oregon Department of Energy for indoor conservation. It should also be noted that because of our work with the Earth Advantage home certification program, they now have added water conservation "points" in their certification checklist, for both indoor and outdoor uses.

- **Marketing Study and Advertising Campaign**
  - ***Marketing Study*:** the City contracted with Ralston Group advertising agency to conduct research consisting of two focus groups, and an on-line survey of over 400 customers which was designed to explore and understand the following customer issues:
    - Current knowledge, attitudes and behaviors regarding water use and outdoor water conservation
    - Motivators for water conservation
    - The kinds of water conservation information customers want and need
    - Recall of attitudes toward the four *"Signs You Might be Wasting Water"* ads that ran as a test at the end of the summer of 2002.

- ***Print Advertising***: For the 2003 irrigation season the Ralston contract created an ad campaign of *"Signs You Might be Wasting Water."* They began with four ads that incorporated practical, easy to implement watering tips with expected behavior outcomes. The tips list began with four and expanded to include a total of 12 signs and tips. These ads ran all irrigation season in all the local print media in various sections and sizes. This campaign won two awards – "Special Achievement in Water Conservation" and "Excellence in Communication"— from the Pacific Northwest Section of the American Water Works Association (AWWA) in 2003.
- ***Radio Advertising***: Ralston produced 4 radio ads that lent themselves to radio, using the best "Signs" theme – entertaining, compelling and effective.
- ***Television Advertising:*** The City contracted with Z-21, the Local NBC affiliate, to produce and run Public Service Announcements for 3 months during the late summer of 2003. These featured tips from the "*Signs You Might be Wasting Water*" campaign.

- **Regional Awards**
  - 2003 American Water Works Association – Pacific Northwest Section – Special Achievement Award – "Signs You Might Be Wasting Water" Campaign
  - 2003 American Water Works Association – Pacific Northwest Section – Excellence in Communication – "Signs You Might Be Wasting Water"
  - 2004 American Water Works Association – Pacific Northwest Section – Excellence in Communication – "Consumer Confidence Report category: "Best of Show Award"
  - 2004 American Water Works Association – Pacific Northwest Section – Excellence in Communication – category: Consumer Confidence Report
  - 2004 American Water Works Association – Pacific Northwest Section – Excellence in Communication – Medium Utility – Best Radio and TV Broadcast Spot
  - 2004 Drake Awards – Advertising Federation of Central Oregon (4 category winner): Best Campaign – Black and White, Best Newspaper Campaign, Best Mixed Media Campaign, Best Radio Spot

- **Web Site Development**
  - The City of Bend has a Web site (www.ci.bend.or.us) that is in the process of being upgraded so that all the handouts, radio ads, reports and information will be available at all times in standardized formats. This will include class offerings, links to partner programs, and links to all the other conservation tips and information that pertains to our program.

- **WaterWise Program Information**
  - *Lawn Watering Guide* and Free Rain Gauge – Four-color, tri-fold document that outlines how to measure lawn water use in conjunction with the lawn watering gauge.
  - *Signs You Might be Wasting Water Tip Brochure* – 2 color tri-fold brochure with 12 useful tips on how to conserve water, focusing on outdoor watering.

- List of drought tolerant plants and various native plants that thrive in Central Oregon
- *The Deschutes River Basin – Opportunities for Restoration* – color handout with the "Blue Whale" graphic displaying the basin's water balance.
- *Conservation "FAQ's"* – Frequently asked questions about conserving water in Bend.
- *Annual Consumer Confidence Report*: an annual report about water quality in our system which goes to all citizens of Bend. Bend has added conservation tips and facts within this four-color, 12 page brochure.
- Development of charts and graphs to display water-related data for Bend and the Deschutes Basin, for use in public presentations.
- *Table Top Display*: The City purchased a table top display with signage about outdoor water use, for use at indoor and outdoor events. Bend purchased the same type as the City of Redmond and the two units are combined into a larger unit to maximize regional exposure at shared events such as the Home and Garden show. Bend and Redmond also share various components of the signage and rain gauge purchases.
- The City's public speaking effort has been significantly ramped up since 2000 when the first full time FTE was hired to run the conservation program. Hundreds of presentations have been made on a variety of water topics. High quality powerpoint presentations and handouts have been developed. Presentations are made at public events, and to local boards, college classes, school groups, Rotary and other service cubs, elected officials and others.
- Brochure and Information Distribution: conservation information is provided by the Customer Field Representative and is available at multiple locations including City Hall, Engineering, Public Works and several Fire Stations and uses displays of free rain gauges and instructional brochures. These are refilled weekly by the Customer Field Rep or as needed.
- The City offers school visits and tours of the watershed and intake buildings
- The City has hired a Communications Manager to help disseminate news-releases, do a cable TV monthly show as well as the "Our City" quarterly newsletter. Conservation information is one type of information disseminated through this approach.
- In order to facilitate more regular communication to customers, the finance department switched from bills sent on postcards (not using an envelope or return envelope) to a larger bill format, with a full message area on the printed bill, as well as a method to design, print and insert bill stuffers each month. For further description, see above.

- **Customer Field Representative:**
  - The City of Bend hires a full time seasonal position annually to help educate residents about the watering hours and even/odd watering days. The field representative distributes water conservation information such as the lawn watering guide and provides a pro-active way to handle watering complaint calls and violations that may occur. This position does have authority to fine violators as a last resort. The field representative contacted over 500 customers during the

summer of 2003 as a result of observed poor watering practices or violation or watering rules or complaint calls.

- **Annual Events:**
  - Bend participates in a number of local and regional events that reach a wide spectrum of the public. Participation in these events typically includes activities such as paid sponsorship, contribution of articles for newspaper inserts and other promotional literature, display booths and availability of water conservation staff to talk to the public, presentations, tours of City water system facilities, and distribution of conservation brochures, rain gauges and other items. These events include:
    - Riverfest: multi-day event each May sponsored by the Upper Deschutes Watershed Council sponsors and highlighting the Deschutes River. Includes an insert magazine that reaches over 20,000 citizens.
    - Earth Day Fair: The City is one of many annual sponsors for the Central Oregon Environmental Center each year when they put on this one day festival.
    - Salmon Run: Another Central Oregon Environmental Center Event that we sponsor. This run attracts 300-500 local runners every year and the money raised goes toward river restoration and education grants.
    - Paddle Day –a local day of river sporting gear demonstrations.
    - Home and Garden Show: a Spring and Fall event held at the Deschutes County Fairgrounds.
    - Fall Festival and Green Building Fair: This new event has joined with the annual Bend Fall Festival and Solar Home tour to bring in even more attendees. In 2003 Bend partnered in staffing the booth with Sustainable Landscapes, a local non-profit group that promotes native landscaping.

Public education benchmarks are shown in Table 3-7.

Table 3-7
City of Bend
Public Education Benchmarks for 2004-2008

Benchmark	Start Date	Frequency or Completion
Upgrade Web site to more fully convey the City's WaterWise program	2004	Annual
Continue sponsorship and participation in approximately three to five annual events attended by the public	Ongoing	Annual
Print and radio advertising, with focus on irrigation season	Ongoing	Annual
School tours and speakers bureau	Ongoing	Annual
Periodically review and upgrade printed handouts and related materials	Ongoing	At least every other year
Continue funding Customer Field Representative position, to provide customer outreach and enforce irrigation restrictions.	Ongoing	Annual, during irrigation season

3.4.7 Technical and Financial Assistance (Div. 86-0150[6b])

In keeping with the City's overall objective of reducing outdoor watering, Bend's major technical and financial assistance program focuses on providing a full FTE position for working with large irrigation customers in its service area in addition to assisting with City landscaping projects. In addition, the City works actively with various trade groups to promote water-efficient landscape design and installation. These activities are described as follows.

City of Bend Large Landscape Program

The Large Landscape Program is the key part of our Technical and Financial Assistance program and is one part of the WaterWise program. The City of Bend has hired a full time irrigation and landscape specialist to meet the program goals of working with large scale turf irrigators to reduce water use and promote the use of weather based central control systems. Key parts of this program include:

City of Bend Landscapes – the City must begin to walk its own talk in regard to water use within its own landscapes. The basis for the large landscape program began with the City installation of a weather-based central control system (Rainbird Maxicom) for a local private cemetery which is managed by the City under contract. The funding for the improvements came from using the avoided cost dollars that would have been needed to install an expensive siphon road crossing under the new Highway 20 realignment. Instead, by working with the Arnold Irrigation District and Oregon Department of Transportation (ODOT), in cooperation with the landowner, we were able to replace an antiquated, hand-operated valve system with a state of the art irrigation and computerized central control system. This project also resulted in 0.3 cfs of Arnold Irrigation water being put back instream and moving the cemetery source supply to pressurized City water. This 12-acre site previously diverted over 15 acre-feet of water for each acre of irrigated ground. The new irrigation system's "main brain" control unit, owned and operated by the City, will be able to run the contract cemetery and up to 200 additional stand-alone sites. The City is now in a position to add many other City landscaped sites to the Rainbird Maxicom Central Control system.

Additional elements of the changes within City landscape operations include:

- ***City-Owned Landscape Irrigation*** - The City plans to complete an inventory of all landscapes managed by the City of Bend with the inventory becoming the basis of a management plan for all sites. The City will then develop a capital improvement plan for each site with special attention focused on water wasting due to poor or antiquated irrigation systems, plant choices or both. Analysis will also include use of the new Maxicom Central Control system where it is cost justified.
- ***Standards and Specifications*** - Completion of new Standards and Specifications promoting and encouraging native plants and low water and maintenance planting within City of Bend right-of-way (ROW) projects. As part of the ROW specification review, new inspection and review process procedures will also be included to complete water audits of all new irrigated areas included in any contract as part of the inspection and approval process, and the audit results must pass standards as set by the Irrigation

Association per their Certified Landscape Irrigation Auditor training certification program. The new specifications are expected to be through the engineer review process and come out in the revised specifications book in early 2004.

- ***Bureau of Reclamation Agrimet Program –*** A state-of-the-art satellite telemetry weather station with web access to archival weather data and evapotranspiration records was installed for the City through a contract with the Bureau of Reclamation. The Web site is found at: http://www.usbr.gov/pn/agrimet/agrimetmap/bewoda.html. The standard Bureau of Reclamation weather station contract was upgraded to go beyond the normal web access and includes two extra capabilities. 1) Phone dial-up to a second data logger with capabilities for access by City and other partners weather based watering control computers, and 2) Provided a real-time Radio Telemetry Unit (RTU) connection to the water system's System Control and Data Acquisition (SCADA) system. With this, the City can track weather data for day-to-day water system operation as part of the information system for more efficient use of surface water, wells and storage capabilities. This weather station and related parts will assist the public through its web link, and increase education about evapotranspiration and tie directly to adjusting watering habits based on the weather, rather than random run times. This weather station will become the backbone for new weather-based central control timer technology in the region. This site is in addition to a National Interagency Remote Automated Weather Station (RAWS) which operates in the City's watershed in partnership with the U.S. Forest Service (USFS).

Partners in the Large Landscape Program:

Bend Metro Parks and Recreation District – We partner with this special district to help support water conservation in a variety of ways. This district was the first large turf manager to convert to a central control system, and as such led the way for demonstrating the water and labor saving benefits. We continue to provide staff support to them and are including them in forming a local users group to enhance the on-going education and trouble-shooting capacity of regional users of this technology.

Bend-La Pine School District – The Bend-La Pine School district was named in our previous WMCP as one of our biggest cumulative water-using customers due to managing over 130 acres of turf at over 25 separate sites. After performing some site audits, we proposed a three way partnership between the City of Bend, the Oregon Department of Energy (ODE) and the Bend-La Pine School District to promote the installation and use of a Rainbird Maxicom, weather based central control system. In agreement for the district budgeting to convert school sites to this system beginning with new school sites and retrofitting older sites, we provided the School District with $15,000 from the ODE to purchase the software and computer to run the system. This includes one week of training for two employees and ongoing site assistance. The City of Bend provides use of a weather station (mentioned above) that provides real time daily weather and provides our staff as technical help to assist with the program. This phased approach is expected to have dramatic savings of water over the long term as sites are converted to the system and will bring additional savings in labor by automating irrigation at their various school sites throughout Deschutes County. Site audits will be used to inform each conversion and we

are also working with the school district to include audits in their landscape contract specifications.

Oregon State Parks (OSP): Pilot Butte State Park – The City has signed an agreement to deliver water and partner in upgrading a large turf site for Pilot Butte State Park. OSP has agreed to upgrade the irrigation system and the City will add the central control components and provide operation of the system with a Central Control Software as well as provide ongoing technical assistance at this site and possibly other sites as well. An audit of the system will be included.

Other City of Bend Weather-Based Irrigation Activities

- WeatherTrak Case Study: partnered with HydroPoint to install and test a WeatherTrak weather based irrigation controller on City's Public Works Building. Test is ongoing.
- The City is participating in a Market Transformation study for "smart" controllers being led by the Irrigation Association in partnership with the Conservation Committee of the American Water Works Association (AWWA) Pacific Northwest Section. Research and reports from this group will be used to inform technical and incentive based measures in the future for this technology that can save up to 20 to 50 percent of a customer's typical outdoor irrigation use.

Irrigation Hours – The City has had restrictions on the day and time of irrigation for many years. Under the current ordinance, watering is allowed between the hours of 5 am - 10 am and from 4 pm to 10 pm, on an even and odd schedule based on the customer address. The time of day restriction is in effect between April 15 and October 15, with even and odd restrictions in place all year. The even/odd restriction has had the unintended consequence of training customers to water every other day whether they need to or not. With adoption of weather-based watering systems at parks, schools and other sites, we will need to allow daily watering at the hottest part of the season when evapotranspiration data shows daily water needs of up to .32 of an inch. The even and odd restriction does spread out the demand, and therefore, before removing or modifying restriction we will need to carefully analyze with system modeling how our fully metered system will be affected by just having time-of-day restrictions. The analysis must include a look at fireflow capability as well as any impacts on meeting peak hourly flows, especially in regard to how our storage and distribution system capabilities have been enhanced significantly since the even/odd policy was put in place many decades ago.

WaterWise Partnerships – Various Categories of Partnerships, include Planning, Educational and Regulatory:

- **Oregon Department of Energy**: distribute information and promote tax credits for using low water use appliances for the Residential Energy Tax Credit (RETC) program and promote tax credits and low interest loans for Business Energy Tax Credits (BETC). Central Oregon is a leading region for these programs which has resulted in large water and energy savings.
- **Local Area Water Network (LAWN):** partnership with local water providers including City of Bend Franchisees to promote conservation and efficient use of water (Avion, Roats, City of Redmond, Agate-Apache, OSU Extension). The City provides rain gauges

and lawn-watering guides for free to participating groups and shares in-kind support for staffing events and distributing the information.

- **Palmer Homes**: supply and distribute water conservation information and low water using plant lists to their new home customers and to the landscape contractors they use in building their homes.
- **Earth Advantage:** a home certification program that has become established in our region, beginning with several builders. Through direct influence from our water department staff and with added refinements through a workgroup within the Pacific Northwest Chapter of AWWA Conservation Committee, the Earth Advantage program has added significant water conservation criteria, including outdoor use measures, to their total home certification criteria that promote wise use of energy, water and materials.
- **High Desert Green Industry Conference:** this annual event with over 200 attendees each year is put on by the Oregon Extension and Oregon Forestry Department and focuses on continuing education for landscape professionals. 2002 featured Bend's Patrick Griffiths as the keynote speaker and he discussed water conservation and an update on the Deschutes Basin water issues. The City of Bend and Redmond regularly do a joint presentation on the latest in conservation updates.
- **Bend Metro Parks and Recreation District**: in addition to partnering with them in the technical turf irrigation support, we also partner with this special district to help support water conservation in park related land use planning initiatives and support them in presenting water and water conservation information to parks-related conferences or meetings with staff and board as needed.
- **Upper Deschutes Watershed Council**: education partner and the City is an annual sponsor of River Fest their annual event. City of Bend water staff participates on their Communication Committee. Tumalo Creek Restoration Project with $150,000 contribution by the City of Bend in a stream reach project below our surface water diversion. Water Quality Monitoring Project with $90,000 funding to track water quality above, within and below Bend to assist in understanding potential TMDL and flow related impacts with the Urban Growth Boundary.
- **American Water Works Association:** currently City of Bend staff are active members of the conservation committee and hold program co-chair positions, including working on a regional market transformation project for weather based watering technology.
- **Building Green Council and 3E Strategies**: working with local home builders to promote better water conservation strategies both indoor and outdoors (See Palmer Homes). Looking to increase or create more WaterWise Partners through this group.
- **Central Oregon Builders Association**: Bend is a member of this group and exhibits annually at their Home and Garden shows. The City also provides speakers to member meetings as requested to update them on water conservation issues and general water issues for our region.
- **ReSource**: education and sustainability partner. ReSource is a non-profit that promotes sustainable behavior in a variety of ways including contacting over 5,000 students in Deschutes County to promote wise resource use, recycling, composting and more. The City of Bend has been a key speaker at events they have sponsored aimed at business and commercial users.

- **Rebuild America**: The City of Bend is the Deschutes County contact partner for this Department of Energy sponsored program. Through Rebuild America, hundreds of communities and businesses are saving energy dollars and reinvesting in their communities by improving buildings and stimulating the local economy. Partnerships are not limiting themselves to the renovation of existing buildings. Many are addressing new construction, while others are expanding to include elements of land use planning, alternative fuels and vehicles, water and wastewater treatment and the impacts of electric utility restructuring. Our focus to date has been the water and energy connection and has also branched into the City of Bend's Sustainability Efforts.
- **OSU Extension**: partner on various programs and classes, including Xeriscape presentations and landscape professional trainings. They are a cosponsor of the annual High Desert Green Industry Conference.
- **Central Oregon Community College (COCC):** The City of Bend sponsors and teaches a very popular series on native and low water use landscaping for the region. This class was the largest attended class in their adult education offerings for 2003. This will be an annual series.
- **Bend Garbage and Deschutes County**: partners in promoting use of compost and soil improvements. City used bill-stuffer capability to send out over 15,000 County flyers offering compost incentive. Over 100 customers participated.
- **Oregon Landscape Contractors Association (OLCA):** promoting certifications and education for the landscape industry. Monthly meetings and updates regarding water, conservation and new incentives being considered. OLCA provided comments during the development of right-of-way specification.
- **Irrigation Districts**: Partnered with local irrigation districts, on educational events, water conservation projects and basin wide water planning. Bend has entered into a Memorandum of Understanding which will include conservation projects and other projects that will benefit the Deschutes Basin.
- **Central Oregon Cities Organization (COCO):** partner on water issues with Redmond, Madras, Sisters, Prineville and Culver. A stated goal of this group is to increase the availability of information about water, water conservation and sound water policy for the Deschutes Basin for the long term.
- **Other Partnerships, Memberships or Board Appointments:** Bend also participates in Deschutes Coordinating Group (member), Deschutes Resource Conservancy (member of communication committee), Oregon Association of Water Utilities (member and annual speaker at regional conference), Oregon Water Utility Council (member), and the Groundwater Foundation (member) as well as members of other trade associations.

Benchmarks for technical and financial assistance are shown in Table 3-8.

Table 3-8
City of Bend
Technical and Financial Assistance Benchmarks for 2004-2008

Benchmark	Start Date	Frequency or Completion
Review odd-even day irrigation restrictions and determine whether/how to modify. Possible exemption for those sites using weather-based irrigation systems.	2004	Dec. 31, 2005
City-managed Greenwood Cemetery: Install with Maxicom irrigation control system	2003	Dec. 31, 2004
City Landscape Retrofit Project: Budget for replacement of landscape irrigation system at one site per year	2003	Annually
City Landscape Sites: Complete maintenance and management plan	2003	Dec. 31, 2004
Bend-La Pine School District Irrigation Agreement: Partner with school district to provide technical assistance to implement weather-based watering control at all new and existing sites	2003	Ongoing
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	2003	Ongoing
Water audits for selected large customers. Audits of turf fields will be completed as part of partnership described above.	2004	4 large site audits per year to 2008
Irrigation audits will also become part of standard contracts for City-funded irrigation improvement projects. Contracts will include performance standards and correction actions.	2004	As projects occur
Continue to expand waterwise partnerships using weather-based irrigation technology, including new large landscape partners.	2003	Add one new site per year to 2008

3.4.8 Retrofit/Replacement of Inefficient Fixtures (Div. 86-0150[6c])

In past years the City distributed homeowner conservation kits that included shower heads, toilet tank leak and flow modification equipment, and faucet aerators. However, with further development of the City's WaterWise program, the emphasis has shifted instead to outdoor uses of water. Consequently, the indoor-oriented kits are no longer distributed. Instead, the City has developed the outdoor-oriented packet containing WaterWise program handouts and rain gauges, as described above.

The City has considered programs to replace older tank toilets with high-efficiency models, but has opted to focus its efforts on outdoor water uses at this time. Due to the rapid pace of growth in the city, many homes and businesses have been built since 1994, and are subject to national standards mandating high-efficiency, 1.6 gallon per flush toilets, reducing the need for a separate City-sponsored program in this regard. However, as part of its overall conservation planning program, the City will undertake a feasibility survey with respect to toilet retrofits.

The benchmark for fixture retrofit/replacement is shown in Table 3-9. For discussion of measures to reduce leakage from toilets and other equipment on customer premises, see section on the Leak Detection Program, above. This survey will focus on determining the number of older toilets and the most efficient and effective method of delivering a toilet retrofit program.

Table 3-9 City of Bend Fixture Retrofit/Replacement Benchmarks for 2004-2008		
Benchmark	**Start Date**	**Frequency or Completion**
Toilet retrofit program feasibility survey	2004	Dec. 31, 2008

3.4.9 Reuse, Recycling and Non-Potable Opportunities (Div. 86-0150[6e])

An important consideration for reclamation and reuse of wastewater associated with the City's wastewater treatment plant is its location. Our treated wastewater does not flow back directly into the Deschutes River. All wastewater must flow approximately eight miles northeast (downhill) to the treatment plant's location near the Bend Airport. After treatment, the effluent is sent to evaporation / percolation ponds to seep back into the regional aquifer. In order to carry out reclamation/reuse to reduce water usage within the City's water service area, the City would need to install a new transmission pipeline eight miles long to return the reclaimed water to the city, as well as local distribution lines to reach customer sites. In addition, all reclaimed water would need to be pumped uphill. At this time, delivery of reclaimed water to customers within the City's water service area is not considered practical due to the costs involved. Therefore, at this time the City does not have plans to convey and deliver reclaimed water within its water service area. This option will be reconsidered from time to time, in the context of overall water resource needs.

The City has assessed opportunities for reclamation and reuse outside of its service area directly related to the location of the City's wastewater treatment plant. One major opportunity has been identified and implemented. This is delivery of Level 4 effluent to the Resort at Pronghorn. Pronghorn is not located within the City's water service area, receiving potable water instead from Avion Water Company. However, Pronghorn is located downhill from the City's wastewater treatment plan. In addition, this is a new development, and conveyance pipes were installed concurrently with needed wastewater lines needed, rendering this program cost-effective for the private developer. Pronghorn has contracted to purchase two MGD of Level 4 effluent and installed the conveyance pipeline in the same trench as their wastewater lines. The effluent is used on two golf courses during the irrigation season.

The City will consider further opportunities to expand water reclamation, by delivering treated water into an irrigation canal system that passes near the wastewater treatment plant. This could potentially be part of a mitigation exchange of surface water rights for ground water rights that could be transferred to the City for use within its water service area. A feasibility study will be performed to explore this option. This action is shown as a benchmark in Table 3-10.

Table 3-10 City of Bend Reuse, Recycling, Non-Potable Benchmarks for 2004-2008		
Benchmark	**Start Date**	**Frequency or Completion**
Perform 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.	2004	Dec. 31, 2006

3.4.10 Conservation Program Staffing

The City has made a considerable investment in staffing to carry out conservation activities since the previous WMCP was submitted. The City has added positions to meet this need, and now has three positions staffing water conservation services:

- Customer Field Representative: this position has been hired on a full time seasonal basis since the early 1990's (see above)
- Water Conservation Staff Person: From 1998 till 2000, staffing was less than 0.2 FTE and was done on an as needed basin by other water department staff. In 2000 the first 0.5 FTE with water conservation in the job description was hired as part of a conservation/cross-connection position. As of 2001, one FTE became full time on water conservation efforts.
- Large Landscape Specialist: In 2003 the City added an FTE position for the large landscape program, to support and expand the weather-based watering program and installation and use of a central irrigation control system by the City, Bend-La Pine School District, Bend Metro Park Districts, and state parks. In addition, this position supports and develops the irrigation and landscape specifications, and will develop an irrigation management plan for City lands.

3.4.11 Water Use Measurement and Reporting (Div. 86-0150[2])

OAR 690-085 requires governmental entities holding water rights to submit a report of water use by December 31 of each year. The reporting must provide information from each month of the year for each water right. The City of Bend complies with this requirement, by reporting monthly diversions from its surface water sources and monthly pumping from its ground water wells. Bend's measurement program meets the accuracy requirements of the State Rule. The most recent report was submitted December 22, 2003

3.5 Anticipated Water Savings

As shown in the previous sections, the City of Bend is in the midst of a substantial effort to reduce water consumption, with a primary focus on outdoor water use in the irrigation months. Since 2000, the City has been building capacity to deliver conservation programs, including

adding staff; performing research on customer attitudes and response to conservation messages; developing outreach materials, specifications and other materials; developing the large-landscape program; and building partnerships to leverage resources.

Ultimately, the effectiveness of the City's conservation effort will require not only actions on the part of the city government, but also change in water-using behaviors by the City's customers. This is especially important in the area of outdoor water use. The City's efforts to induce changes in customer behavior include conversion to full metering, development of rates tied to metered consumption, and public information and outreach campaigns delivered through a variety of media. These approaches are well founded in the literature on water conservation nationwide, and are supported by the new Division 86 Rules.

Because of the reliance on customer behavior across a wide spectrum of customer types and water saving measures, it is very difficult to develop accurate predictions of water savings. For purposes of the WMCP, a prediction of water savings was developed by using available data on aggregate uses of water in the Bend service area, coupled with results of studies from the literature of water conservation.

3.5.1 Seasonal Breakdown of Water Usage

Since the primary focus of Bend's conservation program will continue to be outdoor water usage, it is helpful to examine recent data to estimate the quantity of seasonal water use. This data can then be used to estimate potential water savings.

Table 3-11 displays water production for years 2000, 2001, 2002, and 2003 broken into two seasonal components: irrigation season (April – October) and non-irrigation season (remaining months from late fall through early spring). The table shows that average daily production during the non-irrigation season averages 5.1 MGD. This can be considered the "base usage" since it represents primarily indoor water uses that occur throughout the year. Average daily production increases to 15.4 MGD during the irrigation season. The difference between these values, 10.3 MGD, represents the additional water usage on an average daily basis throughout the irrigation season[4].

[4] This comparison between base usage and irrigation season usage involves a different calculation from the peaking factor used in the demand forecast. The peaking factor compares the maximum day demand on the single highest water-use day of the year, to the year-round average day demand. The peaking factor is used to project peak day demands for purposes of sizing distribution and storage infrastructure.

Table 3-11 City of Bend Water Production by Season					
Full Year	**2000**	**2001**	**2002**	**2003**	**4 Yr. Ave.**
Total Production over 12 months (mg)	3,919	3,866	4,205	4,184	4,044
Avg. daily production (MGD)	10.7	10.6	11.5	11.5	11.1
Irrigation Season (April -Oct.)					
Total Production over 7 irrigation months (mg)	3,146	3,124	3,442	3,425	3,284
Avg. Daily Production. (MGD)	14.7	14.6	16.1	16.0	15.4
Non-Irrigation Season (Jan - Mar. plus Nov. - Dec.)					
Total production over 5 non-irrig. months (mg)	773	743	763	759	760
Avg. Daily Production (MGD)	5.1	4.9	5.1	5.1	5.1
Difference between Irrigation and Non-Irrigation Seasons					
Difference in Avg. Daily Production (MGD)	9.6	9.7	11.0	10.9	10.3

It should be noted the additional seasonal quantity of 10.3 MGD may not be due entirely to irrigation and other outdoor uses. Bend's population fluctuates somewhat seasonally, due to the influence of tourism in the local economy. The impact of these fluctuations has not been analyzed in detail for this WMCP. This characteristic of the City of Bend, as well as other factors, may affect the seasonal needs for water in ways that are not well defined at this time. However, as data collection from the meter installation program improves and the customer classification system is updated, Bend will be able to gain a better understanding of demand characteristics.

3.5.2 Predicted Reduction in Irrigation Season Usage

Various studies have reported figures for reduction in outdoor usage that can be obtained through changes in behavior and improvements in irrigation equipment and scheduling. In a review of several such studies, Vickers (2001) reports that individual properties converting to water-efficient landscaping can realize savings of twenty to fifty percent. She provides examples from Austin, Texas; Oakland, California; and Phoenix, Arizona. These savings occurred only on the individual properties where water-efficient landscaping was installed, however, and do not represent savings across the entire community. In any community, some customers may fully convert to water-efficient practices; others may change their practices to a limited degree; and some customers may not change at all. For a community-wide program, water savings will be averaged across all of these customers.

The U.S. Environmental Protection Agency (1998) reports "benchmarks" derived from a variety of sources for water savings in the outdoor sector. These range from 7.5 to 25 percent savings, for measures such as low water use plants, distribution of lawn watering guides, and large landscape management.

As these figures demonstrate, estimates of water savings from outdoor measures vary widely, depending on the specific activity that is measured, and whether estimates apply to a single

customer implementing a water-efficiency measure, or an entire community or region where some customers will participate while others will not.

For purposes of this WMCP, the City will use the assumption that an average reduction of ten percent in non-base usage per account can be achieved during the irrigation season. At the current estimated level of average outdoor water use of 10.3 MGD during the irrigation season (see above), this is approximately 1.0 MGD in savings during the irrigation season. Given a seven month season (214 days), this amounts to 214 million gallons per year. It is important to note that conservation savings can vary greatly depending upon the weather as discussed in Section 3.5.4.

Averaging this total across the entire, 365-day year, this is equivalent to 586,000 gallons per day (gpd). Given total production averaging 11.1 million gallons per day (MGD) across the entire year (see Table 3-11), this is equivalent to 5.3 percent of total average day water usage.

3.5.3 Predicted Reduction in Base Usage

Some additional savings will occur in base water usage that is not captured in this figure. For example, the conversion of unmetered residential accounts to meters, and use of a commodity-based rate structure for these customers is expected to affect base water usage throughout the year. The City plans to implement a program to assist customers in methods to identify and correct leaks on customer premises. Therefore, a separate estimate is needed for savings in base water usage. Reductions in base usage will occur year-round.

The savings in base water usage are expected to be less than the savings in outdoor uses. This is because the City's conservation program emphasizes reduction in outdoor water uses, both in terms of behavioral measures and support for improved equipment. In addition, base water usage throughout the year is less discretionary, compared with outdoor water use. For example, water used for bathing, showering, flushing toilets, cooking, laundering and other indoor uses is less susceptible to reduction through behavioral change. While equipment changes can reduce these types of uses, retrofitting of equipment throughout the community is far more expensive in comparison with the behavioral changes in outdoor water use that are emphasized in the City of Bend's conservation program. Even if it is assumed that customers themselves will invest in water-saving equipment in response to changes in rates, this effect will take many years to play out across the entire service area, as older equipment is gradually replaced with new, more efficient equipment.

In addition, it should be recognized that the meter conversion program and associated change in customer billings to a commodity-based rate will affect the residential sector rather than other sectors. This is because the unmetered accounts were solely in the single-family residential sector (all other customers were already metered and paid a commodity-based rate). During the four-year period from 2000 to 2003, residential demand averaged 5.6 MGD. During these years, the demand in this sector was a composite of metered and unmetered customers. The demand forecast prepared for this WMCP *already incorporates water savings from metering* in the residential category. This is done by projecting that in the future *all* customers in the residential

class will consume water based on recent data for water use by *metered* customers. Therefore, a separate estimate of savings from this source is not presented here.

In view of these points, the City will assume that additional savings in base water usage will amount to 2.5 percent of base usage. In volumetric terms, this is approximately 125,000 gpd, year round (2.5% of 5 MGD).

3.5.4 Total Water Savings

Adding the base usage savings of 125,000 gpd to the year-round average day demand savings of 586,000 gpd from the irrigation season programs, results in total projected water savings of approximately 710,000 gpd. In percentage terms, this is 6.4 percent of average day demand over the four-year period shown in Table 3-11. This percentage will be used for purposes of adjusting the demand forecast in the WMCP.

For purposes of the WMCP, it is assumed that these savings will be achieved in stages over a ten-year period beginning in 2004 (i.e. full savings of 6.4 percent achieved by year 2013). For the five year period ending in 2008, the goal will be to achieve one-half of this percentage. When evaluating effectiveness of the program retrospectively (e.g. in 2008), population growth will also need to be factored in to the calculation.

It should be recognized that considerable uncertainty will remain regarding water savings. In particular, weather conditions can have a large impact on customer behavior and ultimately water savings as described in Section 2.5.2 and shown in Figure 2-2. The figure is intended to show that production can vary greatly from week to week and that most of this variation is due to changing customer demand of water for irrigation as a result of changes in the evapotranspiration (ET) rate. ET is a measure of water lost from the surface of soils and plants through evaporation and transpiration, respectively.

The City will revisit the savings projections periodically, as conservation activities (benchmarks) are implemented and actual results of the conservation program are evaluated. As discussed previously, the City plans to develop new customer billing categories and improve capabilities in the area of gathering and analyzing data on water use. This will improve the City's ability to track consumption and estimate water savings by customer category over the next several years.

Section 4

Municipal Water Curtailment Element

4.1 Introduction

Preparation of a municipal water curtailment plan is required under OAR 690-086-0160 (Division 86 Rules). The purpose of this plan is to prepare the City for supply management in the event of a loss of source or lack of delivery capacity over a defined period of time or condition. Examples include an emergency event, extreme weather conditions, or catastrophe that would limit the city's ability to meet ongoing demand. Bend is well suited to meet most supply deficiencies to a limited degree given its ability to use its two primary sources of water—ground and surface water—concurrently (in varying ratios) or exclusively. However, unforeseen events resulting from natural disasters, source contamination, drought, or other circumstances may trigger a supply deficiency or compromise Bend's ability to maintain delivery to its customers. The following Municipal Water Curtailment Element describes the most likely scenarios to impact Bend and documents Bend's planned response to curtail demand under these scenarios.

4.2 Supply Deficiencies (Div. 86-0160[1]))

As discussed in the Water Supplier Element, Bend has three sources of water: ground water, surface water, and small interconnections with Roats Water System, and Avion Water Company. Over the last 10 years, Bend has not experienced any deficiencies with these sources as a result of natural disasters or source contamination. Regulation of shared water rights with Tumalo Irrigation District during the droughts over the last 10 years have curtailed Bend's use of some of its surface water rights during peak-season. However Bend has adjusted its use of its supply options to account for these annual restrictions.[1] See Section 2 Municipal Water Supplier Element. Although Bend has not experienced deficiencies brought on by disaster or contamination, Bend is aware that there is a potential for such events to occur. Of the multitude of supply deficiency scenarios, Bend believes that a wildfire in the Bridge Creek watershed, a system-wide power outage, and a major drought are most likely to impact Bend's ability to maintain delivery of water to its customers.

4.2.1 Bridge Creek Watershed Wildfire

The first scenario which could significantly impact Bend's ability to meet customer demand is a major wildfire in the Bridge Creek watershed. Though human activity in the watershed is strictly regulated, fires have historically been an element in the watershed (the last major fire occurred in

[1] Of Bend's 36.1 CFS surface water rights, 15 CFS is available winter-time only, 15.1 CFS is based on the variable flows of Tumalo Creek, and 6 CFS is unrestricted. These restrictions were discussed in detail in the Water Supplier Element.

1979) and could occur at any time. The likelihood such a fire will occur in the future is high considering the fact that the watershed currently has a significant fuel build-up inaccessible to harvest. Such a fire would lead to elevated turbidity levels in the creek beyond water quality standards which will elevate contaminant levels in the surface water supply beyond federal drinking water regulations without capital intensive treatment. In this scenario, Bend's ground water points of appropriation (not including the unexercised Lava Island rights) could provide for 23.6 MGD or (36.5 CFS). This amount could meet winter demand, but could not meet peak demand.

By listing only three scenarios capable of significantly reducing Bend's ability to meet demand, this discussion is not meant to imply that Bend's water system is not vulnerable to other disasters, such as earthquakes or mechanical. If, in fact, one of these scenarios did occur, Bend's dual source and built-in redundancies with multiple wells provide flexibility, such a system allows for Bend to change or mix the use of sources and move water to specific areas from various locations. In some cases, dual sources and redundancy may not be enough to meet demand and Bend therefore Bend would need to invoke its curtailment plan.

Since ground water would not be impacted by a Bridge Creek watershed wildfire and, as discussed above, Bend's ground water is less vulnerable to drought, Bend believes ground water should be its primary source in the future. As such, Bend will continue to pursue expansion of existing ground water rights and/or new ground water rights.

4.2.2 System-Wide Power Outage

The second scenario with a potential to affect Bend's ability to supply water to its customers is a power outage, a concern for any water supplier which relies on electricity to drive ground water pumps. A power outage would not necessarily last as long as a drought, but there is potential for an outage to last long enough to warrant an emergency response. Outages which occur in limited areas within the water system are less problematic for Bend as a system-wide outage since Bend's water system has been designed such that wells and pumps are located throughout the service area. This dispersed distribution of source water infrastructure along with build-in system redundancy would enable Bend to meet demand from a variety of production locations.

In the event of a system-wide power outage which temporarily halts ground water supply production entirely, Bend would rely on several diesel generators to operate the chlorination and telemetry system for both surface water and ground water and the generators would also provide power to pump several wells. Surface water is gravity-fed to the entire service area except a portion of Pressure Zone 1 in northwest Bend, though Bend's generator at the Awbrey reservoir pump station well site will supply power to produce up to 1.6 MGD for this area. Other ground water well production can be assisted by Bend's large V-8 generator at the Outback site. This generator will allow for production of 3.2 MGD at Outback wells 3 and 4. Outback Wells 1 and 2 can produce 2.4 MGD when run by the portable generators owned by the City for total ground water production of 5.6 MGD.[2] Assuming Avion Water Company could convey water through

[2] Bend's wells located at Rock Bluff also are capable of running off of a diesel generator and therefore can produce water. However, the generator would have to be rented. Since no generators are present at this site, the additional supply from the Rock Bluff wells was not factored into the calculation of total available supply.

their interconnection with Bend and are not impacted by the power outage, Bend would gain an additional 1 MGD as well for a total production of approximately of 14.2 MGD.

Coupled with surface water rates of 7.6 MGD (surface water can supply up to 10.6 MGD, however for planning purposes, Bend sets the rate to a more reliable number), Bend can meet demand of 14.2 MGD which is about 3 MGD *higher* than Bend's average day demand of 11.4 in 2003. For a system-wide power outage in the winter, Bend could meet demand using surface water and groundwater.

With the rate of 14.2 MGD, Bend could meet a little more than half of the maximum day demand (26.0 MGD in 2003) during peak season. Imposition of the curtailment plan described below would be necessary for a summer-time system-wide power outage.

4.2.3 Regional Drought

History has shown that during droughts, Bend's ground water source remained fully available. Should a major drought occur in the future, Bend anticipates continued use of its ground water source. Though this source alone can meet demands during off-peak season, it must be supplemented with surface water to meet peak season demand. However, a drought could significantly reduce the surface water rates of diversion. Therefore, it is likely that drought-like conditions during the winter would not impact Bend's ability to meet demand, but a drought during the peak season, when demand is at its highest, would likely require the use of the curtailment plan.

As a side note, obtaining approval for a point of appropriation transfer for Bend's unused ground water right at Lava Island would provide an additional 5.0 MGD or (7.75 CFS) of ground water available during a drought. This would enhance reliability, since ground water is not affected measurably by temporary drought conditions. See the Water Supplier Element for further discussion of this transfer.

Ground water is less vulnerable to drought and natural disasters. Therefore, Bend sees ground water as its primary future source to meet demand. In addition, use of groundwater has less impact on environmental resources of the Deschutes Basin, compared with use of surface water.

4.3 Curtailment Plan

Recognizing that the City's water supply system is potentially vulnerable to loss of supply, the City has prepared a basic curtailment plan focused on three stages of alert: Mild, Moderate, and Severe. For each stage a triggering event is defined and curtailment measures are listed. Also, a goal for each set of curtailment measures is given. In general, the curtailment measures are intended to be easy to describe and easy to convey to the general public from one stage to the next. They were designed to be easily understood by the public and at the same time are practical enough to reap water savings.

The Mild stage is triggered if supply capacity is diminished to 100% of demand. The measures identified in this stage are intended to reduce demand by 10% and are voluntary for Bend's

customers. Bend will make public service announcements indicating, among other information, the severity of the water supply shortage and provide the specific voluntary measures customers can implement to reduce demand.

The second stage of alert, called Moderate, will be instituted when supply capacity is diminished to 80% of demand and the primary goal is to reduce demand by 20%. The curtailment measures for this stage of alert are the same as those listed in the Mild Stage, however the measures associated with the Moderate stage are mandatory and not voluntary. By keeping the measures the same, it will be easier for the public to remember the measures. Another difference between the Mild and Moderate stages of alert is that the conservation patrol shift will be given the capability to enforce the mandatory restrictions.

The third and final stage of alert called Severe is triggered when less than 80% of the demand can be met with available supplies. The measures associated with the Severe stage are intended to enable the City to protect the remaining water capacity for basic needs and health and safety concerns. The measures include Moderate stage of alert measures as well as additional measures, such as a rationing of water. If successful, the measures will reduce demand by 40%.

The development of this plan is done not only to comply with the provisions under Div. 86-0160 but to also provide the customers of Bend's water with a basic level of management for properly dealing with unanticipated events or conditions that would lead to loss of supply or lack of ability to meet full, on-going demand.

Table 4-1 City of Bend Curtailment Plan Matrix			
Stage	**Trigger**	**Goal**	**Implementation Measures**
Mild	Supply capacity diminished from 91 -100% of demand	Reduce demand by 10%	■ Public service announcements (PSAs) via the radio and local newspapers announcing voluntary restrictions. ■ A conservation patrol shift will circulate throughout the service area educating customers about voluntary restrictions. ■ Voluntary restrictions to prohibit the following: o residential and commercial irrigation from 8 AM to 6 PM o cleaning all types of permanent, outdoor hard surfaces (horizontal and vertical) with water o washing of any type of motorized vehicle except at commercial washing facilities o filling or refilling of any public or private swimming pools or Jacuzzi pools or indoor or outdoor ponds or fountains used for aesthetic or scenic purposes o using hydrants for non-fire fighting activities o flushing of the distribution system o the use of potable water for dust control.
Moderate	Supply capacity diminished to 81-90% of demand	Reduce demand by 20%	■ Voluntary restrictions in the Mild stage of alert become mandatory ■ Increase PSAs, message to emphasize mandatory restrictions ■ A patrol shift will have enforcement capabilities
Severe	Supply capacity diminished to < 80% of demand	Reduce demand by 40%	■ PSAs maintained as above, message strengthened ■ Patrol shift expanded and operates 24 hours per day ■ In addition to the "Moderate" stage implementation measures, further restrictions include: o All outdoor uses of water banned unless exempted by the city manager o Commercial car washes closed o Indoor residential (single family and multi-family) dwelling units restricted to a pre-determined volume of water per day. Volume calculated by City based on available supply. o Require non-essential commercial and industrial operations to reduce consumption by 50% from previous year's annual average

Section 5

Municipal Water Supply Element

5.1 Introduction

The final element of the WMCP is a long-range water supply plan, as prescribed under OAR 690-086-170 (Division 86 Rules). Over the past three decades the City has worked under master plans developed between consulting firms and City staff as a part of meeting the Oregon Drinking Water Program regulations. These master plans were based on utilizing the abundant groundwater resources in the Deschutes Basin (2.4 billion gallons per day or 3800 cfs of recharge). Groundwater has several advantages to the community including, high quality water, no treatment costs, sources can be placed next to storage reservoirs or high demand areas and the facilities can be shut down for most of the year due to the short time span they need to operate to meet summer demand.

Groundwater can also be used to supply the community with source water in the event that surface water supplies cannot meet water quality regulations or maintenance activities preclude surface water production. This reliability of having dual sources of water is a very positive aspect of providing the community with essential water service. By having diesel generators at well sites, the community can always have enough water for basic human activity of cleaning, cooking and medical facilities in times of power failure or wildfire in the Bridge Creek watershed.

Customer demand for water within the Urban Growth Boundary over that past decade and half have been met with following current Master Plans and the expenditure of significant capital to develop groundwater sources and the attendant yard piping, distribution and transmission main installation and disinfection systems. Groundwater rights, including Lava Island, have always been considered to be the optimal choice for the community and the Deschutes Basin.

Among other required topics, this section focuses on comparing projected demand with available supply, identifying alternative sources of supply to serve the projected demand, and comparing the costs of the preferred source alternative (ground water under the Lava Island water right) with the costs of additional conservation measures. This section builds on information that was presented in Section 2 regarding population and demand data and incorporates information found in Section 3, the Water Conservation Element.

5.2 Future Population Projection (Div. 86-0170[1])

Bend's water service area encompasses a large portion of city limits; however population projections, performed and published by Deschutes County, address population for the entire city. Therefore, a separate forecast of future population had to be developed based on a

translation of the County's existing data. This future population forecast of Bend's service area is the basis for the water demand forecast described later in this section.

The County's forecast results used in this WMCP were submitted to the Planning Commission in draft form on May 13, 2004 in the "Deschutes County Coordinated Population Forecast for 2000 to 2025". A final adopted version was not available at the time Bend's demand forecast was developed. The County study did not project population beyond 2025, ten years earlier than the anticipated build-out of the UGB, and research revealed that up-to-date forecasts to 2035 were not available. Therefore, the growth rate for the period 2025 to 2035 was assumed to be same growth rate forecast in the County's report from 2020 to 2025.

In the County's forecast, the results show a 107% increase in population within the Urban Growth Boundary (UGB) from 2000 to 2025. Much of this growth was forecast to occur early in this 25 year period: From 2000 to 2005, an annualized growth rate of about 5.6% was predicted whereas between 2020 and 2025 an annualized growth rate of approximately 1.7% was forecast. It was assumed that such growth translated to Bend's service area population growth as well.

Table 5-1 shows Bend's population in 2000, obtained from the County study, as well as a forecasted population every five years starting in 2005 and extending through 2035. The table also shows the estimated number of people in Bend's water service area in 2000 and future population in the later years. The 2000 year estimate of the number of people in Bend's service area was calculated based on estimates of single family account information as described in Section 2 of this WMCP.

The estimated number of people to be served by Bend for purposes of this report was calculated by assuming that 70% of all future growth within the UGB as noted in the County forecast would occur within Bend's service area. The current and future service area populations are listed in Table 5-1. This percentage can be verified when the residential land use study is completed and should be included in the next update of this report.

Table 5-1
City of Bend
Population from 2000 to 2035

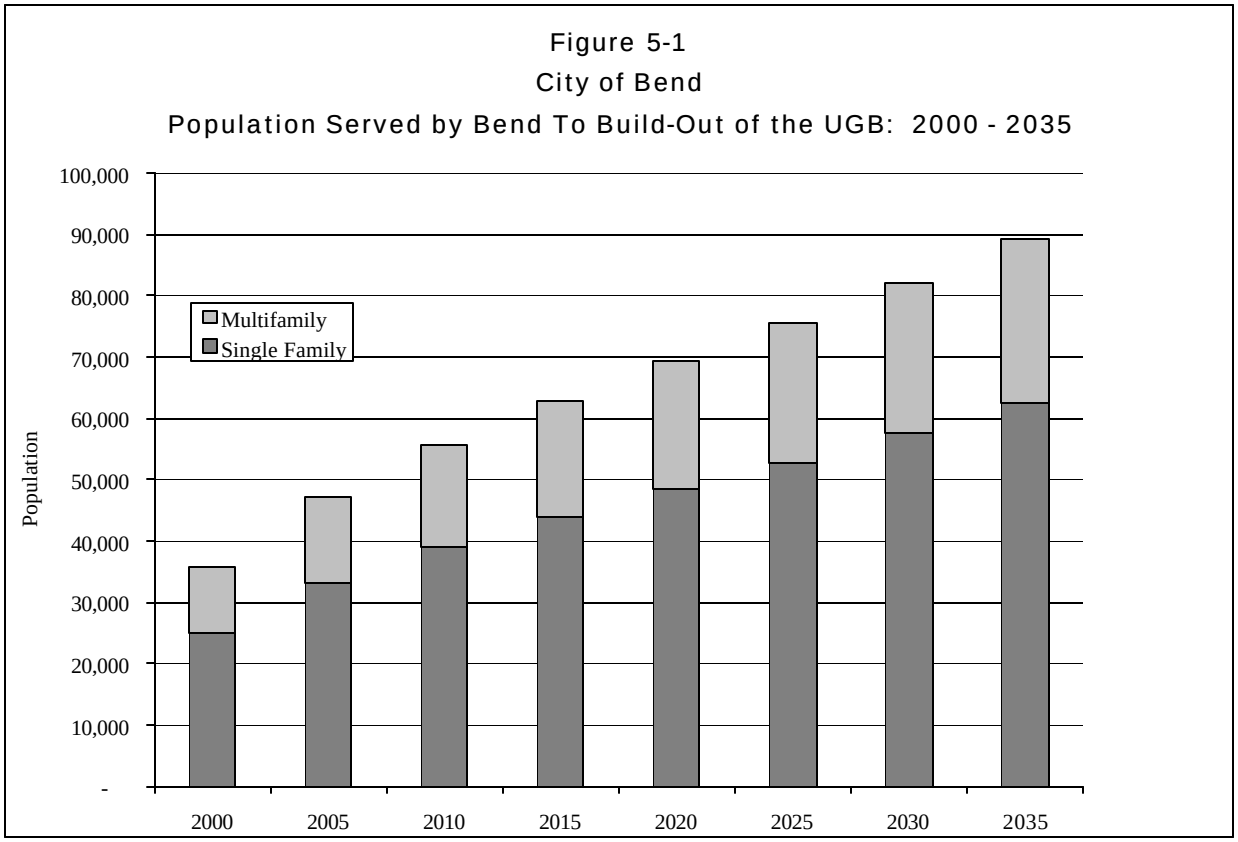
	Bend UGB Population Estimate From County Report	70% of Increase of UGB Population	Bend Service Area Population (1)	Annual Growth Rate (2)	Portion of Service Area Population: *Single Family*	Portion of Service Area Population: *Multifamily*
2000	52,800		35,904		25,133	10,771
2005	69,004	11,343	47,247	5.6%	33,073	14,174
2010	81,242	8,567	55,813	3.4%	39,069	16,744
2015	91,158	6,941	62,755	2.4%	43,928	18,826
2020	100,646	6,642	69,396	2.0%	48,577	20,819
2025	109,389	6,120	75,516	1.7%	52,861	22,655
2030	118,891	6,652	82,168	1.7%	57,518	24,650
2035	129,219	7,230	89,398	1.7%	62,578	26,819

(1) Year 2000 population was calculated by assuming 70% of the total city population fell within Bend's service area.

The population forecast was refined to obtain the number of single family households. To estimate the number of single family households in 2000 and beyond, Bend assumed 70% of the population lived in single family homes and the remaining portion lived in multifamily units.

The ratio of 70/30 was a compromise between data found in construction records from 2000 to 2003 which suggested a 75/25 split and results from the Census 2000 which suggested a 63/37 split. Figure 5-1 graphically depicts the growth of single family and multifamily populations shown in Table 5-1. The County's prediction of a greater increase in population from 2000 to 2005 than in future periods is evident in this figure upon close inspection.

Figure 5-1
City of Bend
Population Served by Bend To Build-Out of the UGB: 2000 - 2035



Based on an analysis of the number of single family houses constructed between 2000 and November 2003, the County's forecast between 2000 and 2005 appears low. Using the County's forecast, an increase in service area population is estimated at 18% over the three year period from 2000 to 2003, whereas, the City's construction records suggest a 25% increase in the number of single family houses during the same three year period. This 25% increase does not include the construction of apartment units from 2000 through 2003 because construction records do not provide a count of total units. During this time period, 439 multifamily housing structures were constructed. Table 5-2 shows the annual single family housing construction count, the assumed number of residents, and the County estimates for 2000 through 2003, inclusive.

Table 5-2
City of Bend
Annual Housing Construction Count

	New Single Family Homes per Construction Records	Service Area Population Using Construction Records [1]	Service Area Population Using County Source[4]
2000	910	35,904[2]	35,904
2001	1,020	38,434	37,931
2002	1,380	41,856	40,071
2003	1,273[3]	45,013	42,333
	Percent Change (2000 to 2003)	25%	18%

(1) Assumes 2.48 persons per single family house as estimated in Census 2000.
(2) The County estimates of population for 2000 are shown as the base year from which future population increases were added.
(3) As of November 2003.
(4) See Table 5-1 for 2000; 2001-2003 interpolated using 2000 and 2005 estimates.

The discrepancy in growth and how Bend has chosen to address this discrepancy in the water demand projections is discussed in Section 5.3.7.

5.3 Water Demand Projections (Div. 86-0170[3])

Bend's demand projections are a combination of the future demands of the Residential, Commercial, and Schools customer classes; water loss; conservation savings; and a demand buffer. Demand for these classes are described below. Not described is the projected demand of the Juniper area. Juniper area demand is relatively small and was not included within the forecast because: 1) its potable demands are met by wells devoted to this area and by an interconnection with the Roats Water System and 2) its irrigation demands are met entirely through an interconnection with the Arnold Irrigation District (using a separate irrigation right) and supplemented by area wells as necessary.

5.3.1 Residential

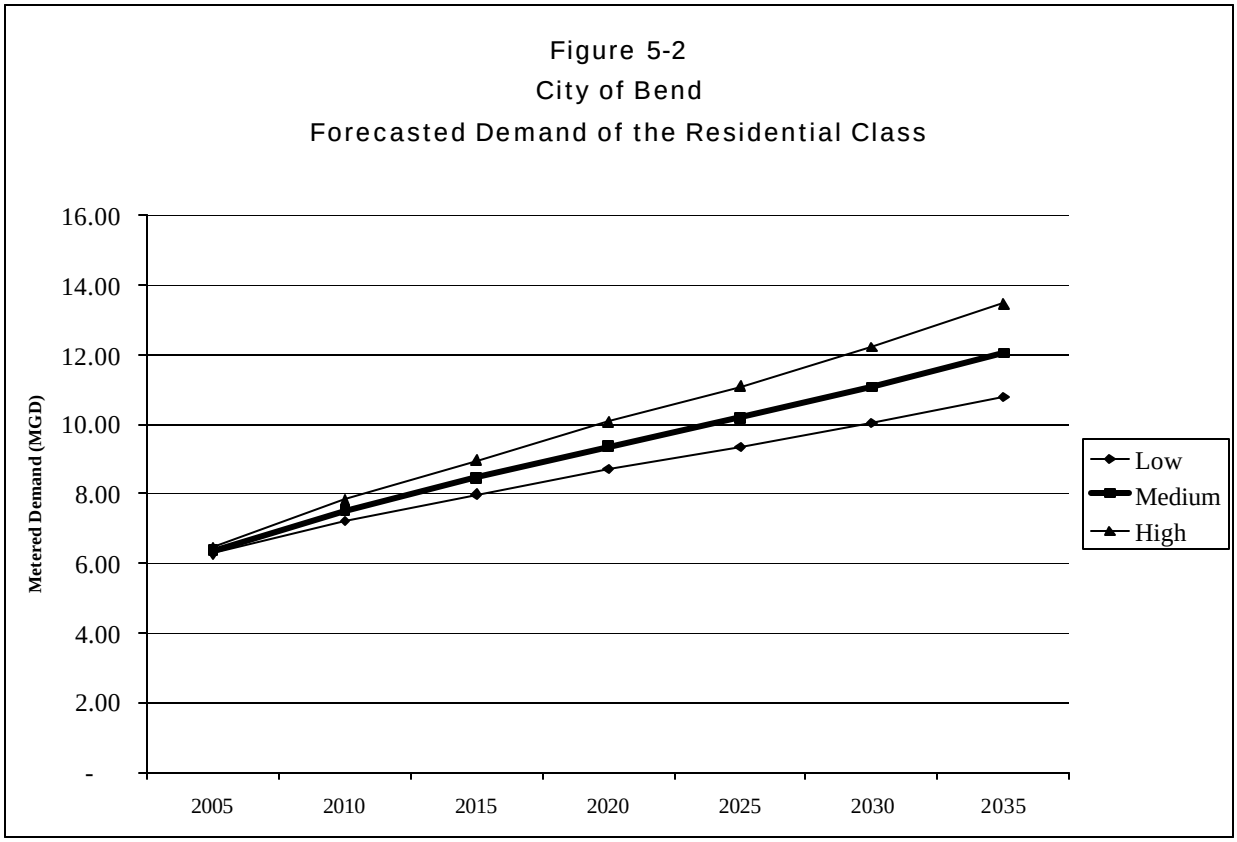
Based on the County's forecast, population is projected to increase as shown in Table 5-1. Specifically, the single family residential population is anticipated to more than double from 25,133 in 2000 to 62,578 by 2035. This continued population growth will spur an increase in Residential demand. (Multifamily demand is a component of Commercial demand which is discussed in the following subsection.) To forecast demand of the Residential class starting in 2000, it was assumed that demand would grow at a rate equal to the growth of the residential population forecasted to be served by Bend. The rate of growth can be seen in Table 5-3. It should be noted that the effect of conservation on demand was calculated separately, as discussed in Section 5.3.5.

Table 5-3 City of Bend Demand Forecast Calculations of the Residential (Single Family) Class			
	Annual Percentage Change of Service Area Population (1)	**ADD** (2)	
2003		5.71	(Observed)
2005	5.6	6.37	(Forecast)
2010	3.4	7.53	(Forecast)
2015	2.4	8.46	(Forecast)
2020	2.0	9.36	(Forecast)
2025	1.7	10.19	(Forecast)
2030	1.7	11.08	(Forecast)
2035	1.7	12.06	(Forecast)

(1) See Table 5-1.
(2) See Appendix A, Table A-2.

As with all forecasts of this kind, there is a given degree of uncertainty in the estimates driven by imperfect knowledge of the future including changes to demographic data, water efficiency technology, customer usage patterns, and other factors. Therefore, the uncertainty surrounding the future is modeled in the forecast by increasing and decreasing the rate of growth in demand by 15% higher and 15% lower than the medium forecasted demand. Figure 5-2 shows the forecasted demand from 2005 to 2035 with the high and low forecast bands.

Figure 5-2
City of Bend
Forecasted Demand of the Residential Class



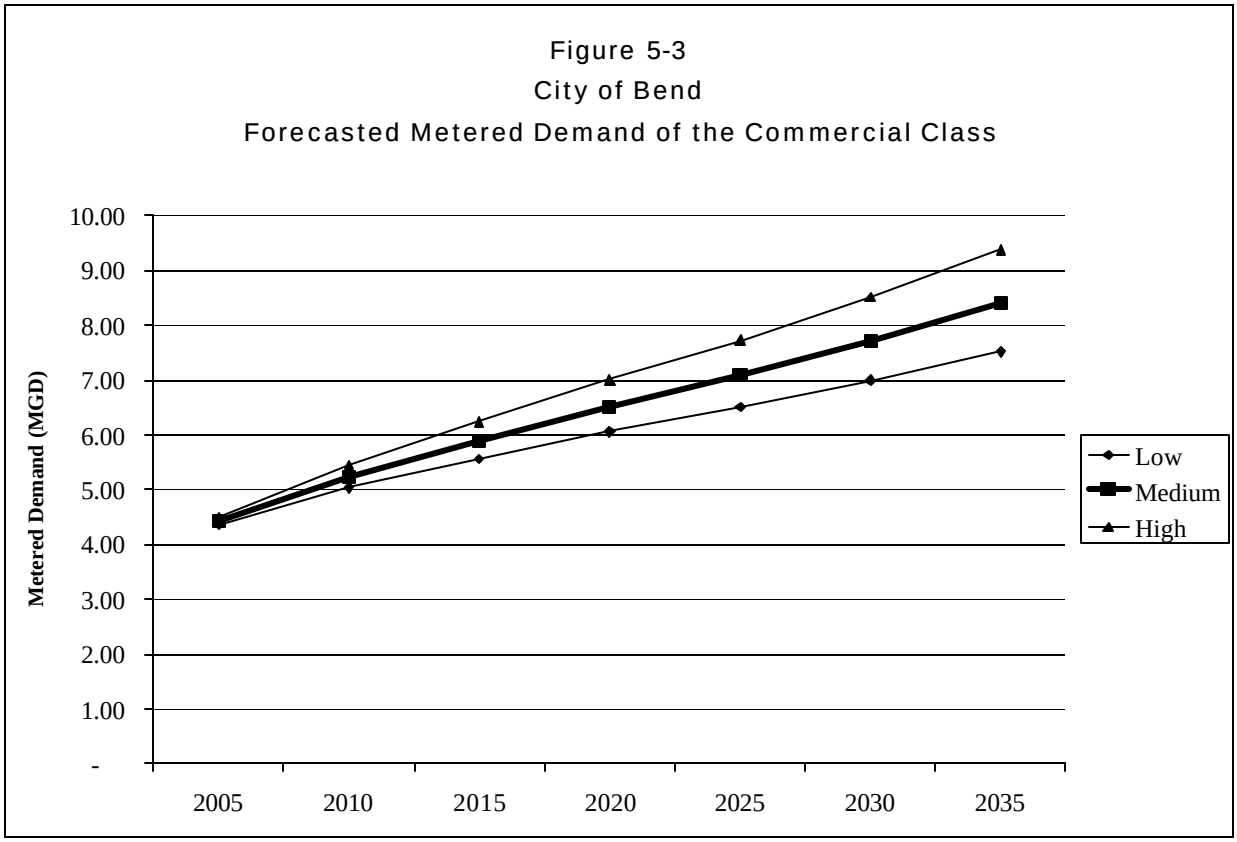
The small difference between the low and high demands in the early time periods is indicative of greater certainty, in part due to the fact that detailed demographic data was available for this time period. The larger difference between the low and high demands in the latter time period is due to greater uncertainty of the forecast's ability to predict the future. For additional information, refer to Appendix A which lists the low, medium, and high percentage changes by year and which provides historic and forecasted average day demands from 1998 to 2035 in tabular format.

5.3.2 Commercial

In order to forecast demand for this class, it was assumed that demand would grow at a rate equal to the growth of the residential population forecasted to be served by Bend, the same method used to calculate residential demand described previously. The rate of growth can be seen in Table 5-1. In addition to a medium rate of growth, a high and low demand was forecast for the Commercial class. Reasons for a range of demand are described in the previous subsection. The forecasted demand for this customer class is presented in Figure 5-3. Refer to Appendix A which lists the low, medium, and high growth rate by year and which combines historic and forecasted average day demands from 1998 to 2035 in tabular format.

The City has designated approximately 800 acres called Juniper Ridge for future industrial development. The area is located immediately northeast of the city and is bordered by the City UGB and URA on its southern boundary (see Exhibit 2-1). Half of this area's water demands are slated to be served by the City while the other half will be served by Avion. Significant future development which will require considerable water demand is anticipated to occur in the area which the City will serve. The timing and magnitude of such development is unknown at this time. The City's demand forecast for these future customers is reflected in assumption of future demand from the Commercial class as described herein.

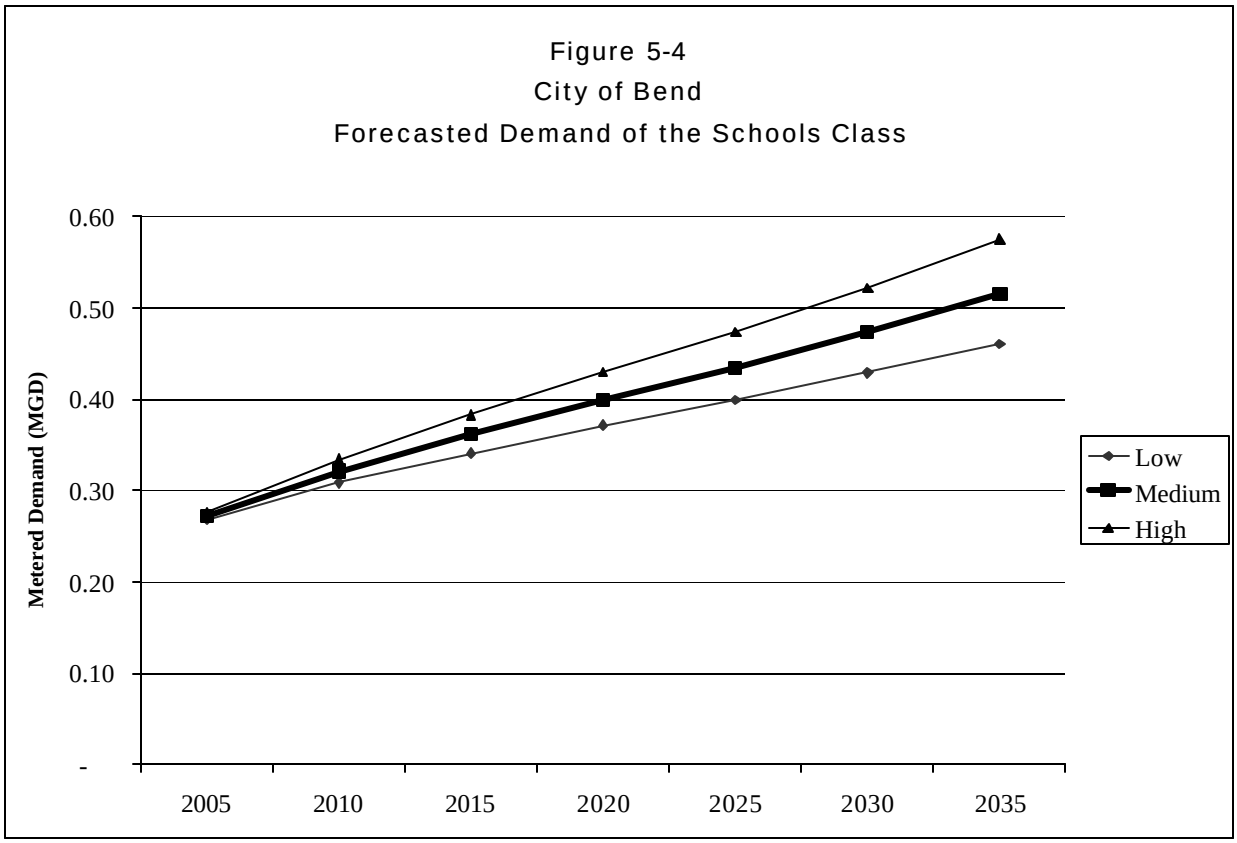
Figure 5-3
City of Bend
Forecasted Metered Demand of the Commercial Class



5.3.3 Schools

Just as the Commercial demand forecast was based on the growth of the population served by Bend, the Schools class was also forecast using this basis. And similarly, a high and low demand was forecast for each year. Future demand of this class can be seen in Figure 5-4.

Figure 5-4
City of Bend
Forecasted Demand of the Schools Class



For reference, the Schools demand in 2005 is projected to be approximately 4.2% of the Residential demand. Refer to Appendix A for demand figures.

5.3.4 Non-Revenue Water

In projecting future non-revenue volumes, estimates can be calculated as a percent of metered demand. Calculating a water audit for 1998 to 2002 reveals the historic average non-revenue water at 11.9% of customer demand. Table 5-4 shows this calculation. This percentage is used to forecast non-revenue water from 2005 to 2035; it was assumed for the forecast that this percentage will remain constant from 2005 through 2035.

Table 5-4 City of Bend Non-revenue Water Calculation				
	Production (MG)	Metered and Unmetered Sales (MG) (1)	Non-revenue Water (MG) (2)	Non-revenue Water As Percent of Metered & Unmetered Sales
	Production	Minus Sales	Equals Non-vevenue water	
1998	3,142	2,801	342	12.2%
1999	3,733	3,057	676	22.1%
2000	3,919	3,481	438	12.6%
2001	3,866	3,557	310	8.7%
2002	4,205	3,889	316	8.1%
2003	4,184	3,810	374	9.8%
Totals and Average Percent		**20,594**	**2,455**	**11.9%**

(1) See the columns titled "Metered Sales" and "Unmetered Sales" in Table 2-9 for the base data.

(2) A portion of non-revenue water volumes are attributable to main flushing, street cleaning, fire fighting and training, reservoir maintenance, and major breaks (a total of approximately 20 MG in 2003) as shown in Table 2-9 found in the Water Supplier Element. The remaining volume in this column is considered water lost.

5.3.5 Conservation (Div. 86-0170[5a])

For the demand forecast, a staged reduction of up to 6.4% of metered demand by 2013 (and held constant at 6.4% thereafter) was calculated as an estimate of the savings gained from Bend's future conservation measures. The calculation for these savings can be found in Section 3.5. It was assumed that this reduction would continue for the duration of the forecast period. The savings reaped from these conservation measures represent an additional savings above and beyond any savings gained from existing conservation measures.

5.3.6 Demand Buffer

In order to help protect Bend from unforeseen events, Bend has added a demand buffer on top of the maximum day demand as part of their total system demand forecast. This buffer "is based on ten percent of the peak demand…allowing up to three inoperative wells at one time" as described in Bend's report titled "Initial Assessment of Water Supply and Mitigation Alternatives" (p. 17, Table 7 Notes). Unforeseen events may include exceptionally high peaks as a result of unseasonably hot weather, major line breaks, or exceptional unanticipated growth.

The inclusion of this element allows for a modest accounting for extreme events that would potentially stress demands or limit capacity.

5.3.7 Total System Demand

Total system demand is calculated by combining: 1) the forecasted demand from the three metered customer classes (Residential, Commercial, and Schools), 2) the results of the water audit for non-revenue water, 3) conservation measures, and 4) the demand buffer. Table 5-5 shows an expected trend of increasing average and maximum day demands over time; these are driven by increases in population. Average day demand is the sum of metered demand, non-

revenue water, and conservation. Maximum day demand is calculated by multiplying average day demand by 2.26 (the peaking factor) and then is increased by an additional 10% to represent the demand buffer.

In Section 5.2, the forecasted population growth, a discrepancy was discussed between the service area population growth rate calculated using the Deschutes County population forecast versus the population rate calculated using the City's construction records. Specifically, the service area population growth was calculated at 18% using County data for the years 2000 to 2003 whereas the growth was calculated at 25% using construction records. (See Table 5-2). The construction records represent a more definitive measure of growth than the County's forecast. However, since an exact count of population increases is not possible given the lack of new multifamily unit construction data, the City did not want to alter the County forecast and therefore the County forecasts are still the basis for these water demand projections. Bend believes that the high end of the range of demand presented in Table 5-5 and Figure 5-5 presented later in this section is a more realistic representation of future demand than the medium forecast. Accordingly, the City believe it should be prepared to met that higher demand and will be monitoring growth in demand closely over the next five years or until the next submittal of a revised WMCP.

Table 5-5
City of Bend
Total System Demand to Build-Out of the UGB (MGD)

Demand Categories	2003	2005 Forecast			2015 Forecast			2025 Forecast			2035 Forecast		
	Actual	Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High
Metered Residential (1)	5.71	6.27	6.37	6.48	7.99	8.46	8.97	9.35	10.19	11.09	10.79	12.06	13.47
Commercial	3.98	4.37	4.44	4.51	5.56	5.89	6.25	6.51	7.09	7.72	7.52	8.40	9.38
Schools	0.24	0.27	0.27	0.28	0.34	0.36	0.38	0.40	0.43	0.47	0.46	0.51	0.57
Mtr. Demand Sub-Total	9.93	10.91	11.08	11.26	13.89	14.72	15.60	16.26	17.71	19.29	18.77	20.97	23.42
Non-revenue water (2)	0.97	1.30	1.32	1.34	1.66	1.75	1.86	1.94	2.11	2.30	2.24	2.50	2.79
Conservation Savings (3)		(0.30)	(0.35)	(0.41)	(0.80)	(0.94)	(1.08)	(0.96)	(1.13)	(1.30)	(1.14)	(1.34)	(1.54)
AVERAGE DAY DEMAND (4)	11.45	11.90	12.05	12.20	14.74	15.53	16.37	17.23	18.69	20.29	19.87	22.13	24.67
Demand Buffer (10%) (5)		2.69	2.72	2.76	3.33	3.51	3.70	3.89	4.22	4.59	4.49	5.00	5.57
MAXIMUM DAY DEMAND (6)	26.05	29.59	29.95	30.32	36.65	38.62	40.70	42.84	46.47	50.44	49.39	55.01	61.32

(1) Includes metered and unmetered Residential demand.
(2) In 2003, non-revenue water was 9.8% of metered demand (see Table 5-4) and in future years it was calculated at 11.9% of metered demand.
(3) Conservation savings for 2003 not calculated. For the method used to calculate future savings, see Section 3, Water Conservation Element.
(4) The sum of demand in 2003 does not equate to actual ADD or MDD figures because unmetered Residential demand was not incorporated into Residential demands.
(5) A demand buffer represents 10% of maximum day demand. A demand buffer was not a component of total system demand in 2003.
(6) A peaking factor of 2.26 was used to forecast MDD in 2005 to 2035. The peaking factor was not applied to the demand buffer, though the demand buffer is a component of MDD.

5.4 Comparison of Available Supply to Future Demand (Div. 86-0170[4])

5.4.1 Calculating Available Supply

Not including Bend's Lava Island right, Bend's ground water rights allow for the production of up to 23.6 MGD (36.5 CFS). These are unrestricted and available. Bend's surface water rights in the winter amount to 23.3 MGD (36.1 CFS) but drop in the summer due to seasonal constraints placed upon one of the rights and changing flows of Tumalo Creek.[1] For planning purposes, the City assumes flows for Tumalo Creek at 40 CFS which would allow for a maximum diversion of 7.6 MGD (11.72 CFS). The sum total of available surface and ground water supply during the low-flow season is 31.2 MGD (48.2 CFS).

As an aside, there are also sources associated with Bend's Juniper area. These sources, however, are dedicated to serving the local needs of the Juniper service area. The Roats Water Company serves the drinking water needs to a small portion of the Juniper area and drinking water is supplied to the remaining area from three wells in the Juniper area which Bend operates. (Bend does not own the wells nor the water rights associated with the wells.) Irrigation water is purchased from the Arnold Irrigation District to meet Juniper customers' irrigation demands. Combined, these sources entirely meet the needs of the Juniper service area in this dual piped system.

Juniper well production and customer demand are difficult to calculate because of limited records on well production and the lack of customer metering by the former operator of Juniper's system. In addition, Bend purchases a set amount of irrigation water annually to meet peak season needs in the Juniper area, but some of the water is unused. In the future, Bend does not anticipate increases in demand in Juniper. Therefore, the supplies available to the Juniper area and customer demands were eliminated from the comparison of available supply to future demand described below.

5.4.2 Comparison of Supply and Future Demand

Using an available supply of 31.2 MGD (48.2 CFS) and future demands listed in Table 5-5, Bend is predicted to be in a supply deficit given maximum day demands forecasted as early as 2006 or late as 2007. Figure 5-5 graphically depicts this comparison. Should unforeseen events occur—like an unusually hot, dry summer or mechanical failure of ground water pump—Bend may be required to execute their water curtailment plan. Note that as a safety factor, Bend's demand forecast does include a 10% demand buffer to account for unusual weather conditions, as explained in Section 5.3.5.

To temporarily make up this deficit, Bend is requesting immediate amendment of its "Lava Island" permit to allow for additional points of appropriation for the maximum rate of diversion

[1] See the Section 2 Municipal Water Supplier Element for further information about Bend's surface water rights and associated restrictions.

of 5 MGD (7.75 CFS)—if approved, Bend will be able to fully exercise this right at two other locations. The amendment will free up this water to meet short term deficiencies brought on by the anticipated growth in demand.

5.5 Water Rights Schedule of Use (Div. 86-0170[2])

Currently, all of Bend's surface water rights are certificated or decreed and one of their ground water rights is partially perfected. With regard to the other ground water rights, excluding the Lava Island requests, Bend is prepared to move forward with final proof surveys for each of its rights immediately following approval of this WMCP. Furthermore, Bend showed in the previous subsection titled "Comparison of Future Supply to Available Demand" that it will have utilized all its available supply—not including the Lava Island right, but including all its ground water rights—in 2006 at the earliest and 2007 at the latest.

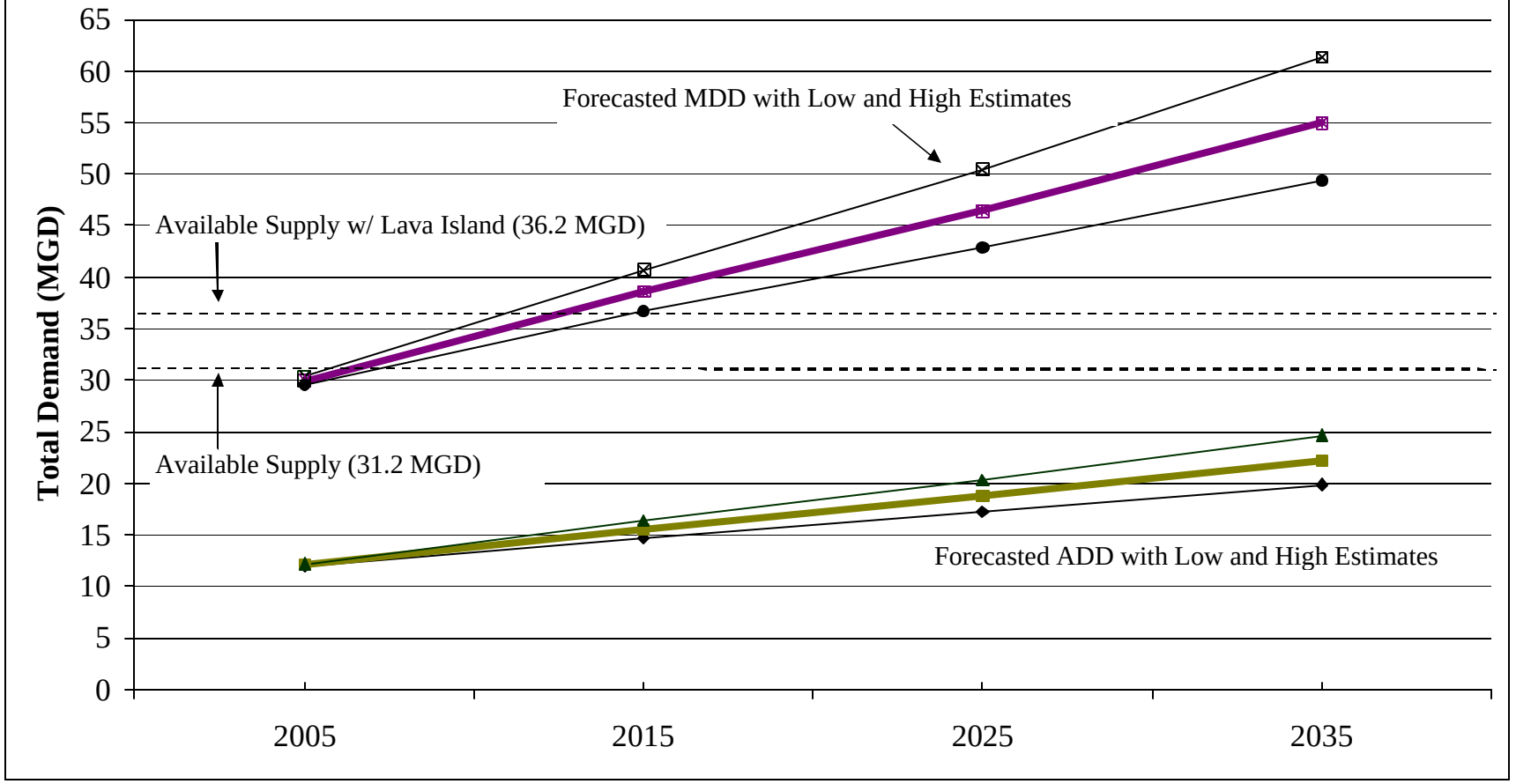
Regarding the Lava Island right, if the Water Resources Department issues a final order for permit extension and approves Bend's application for a permit amendment for additional points of appropriation, Bend expects to fully exercise this right by 2013. Using the low and high range, Bend will exercise this right by 2011 or 2015, respectively. This range of dates was calculated by adding Lava Island supply of 5.0 MGD to existing supplies of 31.2 MGD and comparing the result to the future range of demands (high, medium and low forecasts). As described in Section 5.3.7, Bend considers that the "high" range shown in Figure 5.5 is a more accurate representation of future demand given that future growth rates identified in the County population forecast appear too low. Therefore Bend's customers are likely to utilize this additional amount closer to 2011 than 2015.

5.6 Quantification of Maximum Diversion/Production (Div. 86-0170[6])

Division 86 Rules require that the maximum rate and monthly volume of water be quantified for any expansion or initial diversions. Table 2-5 in Section 2 of this WMCP notes that Bend's maximum rates of diversion for its ground water rights except for the Lava Island right are currently at or near total permitted rates. For those permits in which the maximum rate of diversion has not been fully met (permit application file numbers G-8695 and G-11942), these will be fully exercised in 2006 or 2007, the same date in which Bend has shown in Section 5.4 that all the ground water rights, excluding the Lava Island right, will be fully exercised. At that time, applications of certification for those ground water rights which are not certificated will be submitted.

In addition, Bend's Lava Island right will allow Bend to meet additional demand by 2013, though 2011 if the high range of demand is observed and 2015 if the low range is observed. In other words, Bend expects to fully exercise its Lava Island rights of 5 MGD (7.75 CFS) some time between 2011 to 2015, depending upon how quickly demand continues to grow.

Figure 5-5
City of Bend
Total System Demand By Build-Out of the UGB



In sum, the maximum rate of diversion for *ground water* will be 28.6 MGD (44.24 CFS) by 2013 (within 2011 and 2015) and the maximum monthly amount at that time will be 995.4 CF (643.3 MG) calculated by multiplying the daily volume by 30 days and reducing production by 75% to account for the fact that the wells will probably not produce at the maximum daily rate for a full month due to drops in production if all wells were operating, capacity limitations, and fluctuating demand patterns.

Regarding *surface water* rights, all these rights have been perfected or the right was allocated to Bend by decree. Therefore, maximum diversion rates and monthly maximum rates are not given.

5.7 Analysis of Alternative Sources of Supply (Div. 86-0170[5])

The analysis of alternative sources includes an examination of potential interconnections, additional conservation measures, and other alternatives to meet demand instead of pursuing development of the Lava Island right. These alternatives are discussed in their respective subsections below.

5.7.1 Interconnections (Div. 86-0170[5b])

Bend considered the potential to interconnect with Avion Water Company, the City of Redmond, and Roats Water System as sources of regular water supply to avoid development of the Lava Island right. Bend determined that these interconnections are infeasible and unavailable. Specifically, Avion is already pursuing additional water rights to meet its own needs, which demonstrates that they do not have excess capacity or rights to offer on a regular basis. Moreover, Redmond is located about 15 miles north of Bend. Land between the two cities is owned by the federal Bureau of Land Management (BLM) and will not be developed. Therefore the two cities will not grow towards each other and the existing distance is too great to make an interconnection feasible. Finally, because of its small water rights, Roats could not produce enough water to meet the needs of Bend. Because these interconnections are infeasible and unavailable, this plan does not address the issue of reliability of these supplies.

Interconnections have little to no direct impact upon the environment, but the impacts of increased production or diversion upon the sources used by the wholesale supplier may be indirect. If Bend chooses to pursue any of these alternatives in the future, the environmental impact will be reviewed and weighed carefully.

5.7.2 Additional Conservation Measures (Div. 86-0170[5c])

In the Water Conservation Element, Bend listed many conservation measures it intends on implementing within the next five years. These measures show Bend's commitment to conservation in order to reduce its need for additional supply. Some of these measures are required by the state per Division 86 Rules, while others go above and beyond the required minimum conservation efforts required of municipal suppliers. Following the new rules, Bend

also has considered other conservation measures and compared the costs for these measures to the cost to develop the Lava Island right. These measures are listed in Table 5-6.

Conservation Costs For each of the additional conservation measures, Bend outlined the expected effort and costs associated with implementation, including the cost for labor (such as administration of the measure), marketing of the program, and the incentive to encourage customer participation. Once implemented, the measures will reap conservation savings and these savings are based on assumed participation rates minus free riders, annual savings, and each individual measure's lifetime savings. Free riders represent a percentage of total participants who would have implemented the conservation measure anyway regardless of the City's efforts. Lifetime savings represent the total savings anticipated over the life of the measure. To obtain the financial cost to Bend on a per unit of water basis, program expenses were divided by lifetime conservation savings. These costs are shown in Table 5-6.

Table 5-6
City of Bend
Costs of Additional Conservation Options

Additional Conservation Options	Description	Utility Cost per Million Gallons Saved
Institutional Laundry Machine Incentives	Provides financial incentives for institutional customers to purchase efficient machines.	$1,015
Toilet Replacement	Provides a rebate for low-flow toilets.	$1,085
Hotel and Motel Program	Provides methods and supplies to hotels to reduce water consumption by guests.	$1,096
Conversion from Single Pass Cooling	Provides technical expertise to encourage businesses with single pass cooling systems to install re-circulating equipment.	$2,547
Pre-rinse Spray Nozzle Distribution	Distributes low-flow spray nozzles to restaurants and institutions with commercial dishwashers.	$2,817
Front Loading Washing Machine Rebate	A residential program which offers a rebate for the purchase of a front-loading washing machine.	$3,399

All conservation savings and expenses were estimated and based on studies in the field of water conservation, such as those by the California Urban Water Conservation Commission, or based on professional experience of Bend's and EES' conservation staff. The calculations of savings and costs can be found in Appendix B. The conservation measure calculations require various assumptions about program incentives, participation rates, etc., and changes to these assumptions can alter the final costs and savings of the measures. For example, programs may be bundled with other, similar measures in order to leverage expenditures or program costs may be distributed among other participating utilities, such as an energy utility which benefits from conservation measure implementation. As such, the costs and savings presented may vary depending on overall program design.

Source Cost The financial costs to Bend for each of the six conservation measures were compared to the cost to develop the Lava Island right. Developing this right would entail the

construction of four wells, along with the planning and engineering work associated with this construction. Once functional, these wells would require operation and maintenance and the water produced would require simple disinfection. For this comparative analysis, the cost for well construction was annualized over the lifetime of the well and added to the operation and maintenance costs on a per unit of water basis. The costs were estimated and based on recent experience constructing, operating, and maintaining wells of similar capacity and an assumed depth of 1,000 feet. The combined cost was estimated at $1,141 per million gallons. The calculations of construction, operation, and maintenance can be found in Appendix B.

As shown, the cost to develop the Lava Island right is more than the cost to implement the additional conservation measures called "Institutional Laundry Machine Incentives", "Hotel and Motel Program", and "Toilet Replacement". Due to the fact the City does not have refined customer classes that would enable us to estimate the total volume of water available from each of these conservation measures, and due to the fact that indoor water uses are remaining flat as compared to outdoor use which is growing at a significant rate (see Figure 2-1). The City will look more closely at these indoor measures for future implementation. The choice to continue to focus on outdoor landscapes, beginning with the large landscapes will better address the increasing rate of outdoor water use as seen in Table 2-1 which is nearing our peak water supply capacity at the time of this writing. The substantial volume of the outdoor use also justifies the bias for outdoor conservation efforts at this time in the development of the conservation program, as indoor conservation remains an important component of water use reduction over the long term. Again, with better water use data refinement coming with our customer class delineations, better estimates of savings from various conservation measures can be better estimated as to both costs and potential volumes of water that can be conserved in the future.

Additional Considerations Additional ground water capacity offers benefits to the City that are not offered by water conservation measures. Development of additional ground water capacity lessens Bend's reliance on the Bridge Creek surface water source; the Bridge Creek watershed is considered highly vulnerable to wildfires, which could compromise water quality on a long-term basis. Reducing reliance on surface water would also potentially free up flows for Bridge Creek which would help improve the existing flows in the distressed middle section of the Deschutes River. Finally, it is important to note that not all additional water rights may be used as a primary source of supply, but may be held in reserve and only for use in the event of an emergency. Therefore, development of expanded ground water capacity improves overall system reliability.

5.8 Other Source Alternatives (Div. 86-0170[5])

Bend documented its consideration of various other sources of supply in the report titled "Initial Assessment of Water Supply and Mitigation Alternatives" (Public Review Draft, September 2003) prepared by Newton Consultants, Inc and Deschutes Resources Conservancy [DRC]). That report has been provided to WRD. Alternatives considered in this report include:

- New Groundwater Permits
- Reallocation of Surface Water Rights
    - Deschutes River: Municipal-Industrial Water Reservation

    - Bridge Creek & Tumalo Creek: Tumalo Irrigation District
- Substituting Irrigation District Water and Wastewater for City Supply
    - Non-potable water: Irrigation District Water
    - Effluent Reuse
    - Dual System Piping

These alternatives are described below. The descriptions were adapted from the report.

5.8.1 New Groundwater Permits

The City recognized its needs for additional water in the early 1990's and submitted two applications for groundwater permits in 1992 for an additional combined appropriation rate of 15.5 MGD (24 CFS). Delays in application processing and, ultimately, a protest of the application by Water Watch in 1995 ensued. Eventually all pending groundwater applications in the Deschutes Groundwater Study Area were placed "on hold" pending new groundwater mitigation rules for the basin. The Oregon Water Resources Commission adopted mitigation rules on September 13, 2002.

The availability, reliability, feasibility (including cost) and environmental impacts of this source of supply depend largely on the nature and extent of mitigation requirements for new ground water rights. The Newton/DRC report provides additional discussion of mitigation requirements. However, at this time, the City perceives a high degree of uncertainty in regards to mitigation that would be required. Therefore, the City has decided not to conduct further analysis of the new ground water rights alternative in the context of this WMCP. Further discussion will be reserved for the City's next WMCP update. In the meantime, the City will continue to work with WRD and other regional participants in addressing ground water mitigation issues.

5.8.2 Reallocation of Surface Water Rights

Surface water in Tumalo Creek and the Deschutes River are generally over allocated, however, the City could still meet its needs by acquiring additional water rights through a reallocation of existing rights or by substituting the use of existing water rights or wastewater for a portion of its needs.

Deschutes River: Municipal-Industrial Water Reservation The Duffy Decree adjudicating water rights to the Deschutes River established a reservation of 200 CFS based on a 1921 Order by the State Water Board. The reservation has a priority date of 1913. The decree initially allocated water under this decree to two lumber mills, but indicated that lumber company rights would terminate when lumber manufacturing ceased, and the water would then "revert to the public and be subject to reallotment by the State Engineer." The last lumber operation ceased in 1994.

Uncertainty surrounds the reservation, including the purpose (whether limited to municipal and industrial or including instream uses), the reach affected (whether to North Dam or Steelhead Falls), the continued validity of the reservation (since more than 80 years have passed),

environmental impacts if the right were put to beneficial use, and the impact of this reservation upon water storage rights of local irrigation districts (the priority dates of which are more recent that the reservation).

In addition, the reservation has limited appeal for Bend due to the over-allocation of natural flow in the Deschutes below Bend during the irrigation season thereby leaving little water for diversion when Bend needs water the most. In general, municipal water reservation is unlikely to provide an effective or timely solution to the City's water supply needs.

Bridge Creek and Tumalo Creek: Tumalo Irrigation District Acquisition of new surface water supplies, a transfer from irrigation to municipal use from the Bridge Creek-Tumalo Creek system, or the acquisition of irrigation water rights would require the expense associated with enlarging the existing 10.6 MGD transmission pipeline. Bend has determined this is not an effective solution in consideration of the facts that 1) no surface water is available in these creeks for appropriation, 2) the expense of infrastructure upgrade is too great, and 3) such actions would increase the City's consumption of surface water in place of groundwater, thus further contributing to the pressure on this already over-allocated resource. In particular, given the high priority placed on improving streamflow in Tumalo Creek by the Irrigation District and its conservation partners, reallocation to the City might be counterproductive to the City's intent to support the overall restoration of the Deschutes Basin.

The advantages and disadvantages of these actions are covered in more detail under mitigation alternatives discussed in the Newton/DRC report. Suffice it to say, that if the City were able to work with Tumalo Irrigation District, there would be a limited ability to acquire surface water directly from the District without going through the mitigation process. Due to the high degree of uncertainty regarding mitigation requirements in the region, this alternative does not appear feasible for meeting the City's immediate, short-term needs for water supply.

In addition, the watershed is vulnerable to wildfire in the Bridge Creek watershed which would degrade water quality due to post-fire erosion conditions and make the supply unusable for drinking water without expensive treatment. Such vulnerability adds to the City's concern about acquiring new rights in the creek.

5.8.3 Substituting Irrigation Water and Wastewater for City Supply

Under this alternative, large City water customers could be encouraged (or required) to substitute to non-potable water sources from potable sources (the City) for landscape irrigation. Non-potable water for existing or future developments or play/ball fields could be supplied by irrigation districts or through the use of level 4 treated municipal effluent.

Regarding irrigation district water, the only steps necessary to implement this alternative would be to transfer irrigation water rights to the large water users' properties. However, the contribution that this alternative could make would be proportional to the extent of large acreages within the City's service area serviceable from existing District infrastructure. In all likelihood this would be a useful but marginal contribution relative to City needs. And, as with other alternatives that rely on surface water sources, this alternative does not improve

streamflow conditions in the Deschutes River or Tumalo Creek. However, as this alternative effectively reallocates surface water rights it is at least neutral with respect to these conditions.

Recently, the City entered into an agreement with the new Pronghorn Resort to supply 2 MGD or just less than half of its current supply of effluent to the resort for landscape irrigation. Future agreements with other customers to use effluent from the City's wastewater treatment plant (WWTP) are also possible and represent an excellent opportunity to decrease the City's demands on its existing sources. Furthermore, reliability of this source is very high. However, the amount of available effluent is limited in quantity and also in terms of its potential distribution area. The City has determined effluent re-use could fulfill only a small portion of the City's needs. Based on the Pronghorn agreement for 2 MGD of effluent, approximately 2.2 to 2.7 MGD remains for other potential irrigation reuse projects. Other factors such as feasibility of design cost, fixed cost and recurring costs of implementation would need further examination. These are discussed in detail in the Newton/DRC report.

Non-potable sources such as irrigation district water or WWTP could allow for the development of a dual system piping system in Bend. With such a system, urban lands or lots are served by two separate underground piped water systems delivering potable supply and non-potable supply. The major purpose of such systems is to reduce the overall cost of providing water by using cheaper, untreated water for irrigation and preserving higher quality water for drinking. Dual piping systems can help the City meet its water supply needs and can help irrigation districts protect their assessment base. Irrigation districts that supply water to lands within the UGB are at risk of losing assessments as these lands are developed and no longer in need of district water. Dual piping provides partnering opportunities for the City and the districts to resolve water supply and assessment issues.

A downside of dual piping is, however, the need to operate and maintain two independent systems and the expense to Bend's customers of constructing a dual pipe system throughout the city. In addition, there will be additional complications and additional costs associated with rights of way. Other issues such as the timeliness of developing a large infrastructure and source availability and associated agreements would have to be assessed. Finally, it should be noted that water systems are sized to meet fire flow demands which are much greater rates than peak day demands, so existing system infrastructure would not necessarily be able to be sized smaller for reduced maintenance and operating costs. The Newton/DRC report discusses these issues in detail.

5.9 Mitigation Actions (Div. 86-0170[7])

The Division 86 Rules require that a WMCP describe mitigation actions the water supplier is taking to comply with legal requirements "including but not limited to the Endangered Species Act, Clean Water Act, [and] Safe Drinking Water Act…." For purposes of this WMCP, the only existing City permit that is proposed for development is the Lava Island ground water permit (Permit G-4435). The City has reviewed the status of this permit and is aware of no legal requirement for mitigation under the three laws listed above or other laws. Therefore, mitigation actions are not identified for the Lava Island water right. However, the City remains willing to continue participating in on-going regional discussions about supply and mitigation and remains

interested in working with regional partners to develop a coordinated plan for the basin with the goal of being able to access further ground water in the future.

Appendices

Appendix A
Demand Forecast Supplemental Data

Appendix A-1 Annualized Growth Rate in Demand Used to Forecast Low, Medium and High Average Day Metered Demands							
	2003-2005 (1)	**2005-2010**	**2010-2015**	**2015-2020**	**2020-2025**	**2025-2030**	**2030-2035**
Residential, Commercial, and Schools							
Low	4.8%	2.9%	2.0%	1.7%	1.4%	1.4%	1.4%
Medium	5.6%	3.4%	2.4%	2.0%	1.7%	1.7%	1.7%
High	6.5%	3.9%	2.7%	2.3%	2.0%	2.0%	2.0%

Appendix A-2 Forecasted Average Day Demand for Customer Classes									
	Residential ADD (MGD)			**Commercial ADD (MGD)**			**School ADD (MGD)**		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
1998	-	4.12	-	-	2.91	-	-	0.14	-
1999	-	4.56	-	-	3.16	-	-	0.16	-
2000	-	5.55	-	-	3.29	-	-	0.20	-
2001	-	5.43	-	-	3.63	-	-	0.19	-
2002	-	6.01	-	-	3.87	-	-	0.28	-
2003	-	5.71	-	-	3.98	-	-	0.24	-
2005	6.27	6.37	6.47	4.37	4.44	4.51	0.27	0.27	0.28
2010	7.22	7.53	7.83	5.03	5.24	5.46	0.31	0.32	0.33
2015	7.98	8.46	8.96	5.56	5.89	6.25	0.34	0.36	0.38
2020	8.70	9.36	10.06	6.06	6.52	7.01	0.37	0.40	0.43
2025	9.34	10.19	11.09	6.51	7.09	7.72	0.40	0.43	0.47
2030	10.04	11.08	12.22	7.00	7.72	8.51	0.43	0.47	0.52
2035	10.79	12.06	13.46	7.52	8.40	9.38	0.46	0.51	0.57

Note: 2005 is the first year forecast. The 2005 forecast is based on year 2003 as the base year and applies growth rates from Appendix A-1, above.

Appendix B
Costs Associated with New Source Development and Conservation Measures Implementation

Estimated Cost of Developing a New Source

Develop New Source

Lava Island Source Development

Capital Costs			
No. of Wells to produce 5 MGD		4	
Cost per well		$500,000	
Cost for 4 wells		$2,000,000	
Annualized to 10 years at %5 financing	$	259,009	
Operation and Maintenance			
Present cost per million gallons		370	Includes electricity, disinfection, etc.
Cost per million gallons in 30 years		776	Assumes O & M costs increases 2.5% annually
Average cost per million gal. over 30 years		573	
Production per year			
Average % of production capacity used		25%	
Production (MGD)		1.25	= 5MGD * 25%
MG/Yr.		456	
Capital Costs per Million Gallons		$568	
Operation and Maintenance Cost per Million Gal		$573	
Total Cost per Million Gallons		**$1,141**	

Appendix C - 2003 Water and Sewer Rate Study

Report

2003 Water and Sewer Rate Study

Prepared by

Galardi Consulting, LLC

Executive Summary

Introduction

In the fall of 2001, the City of Bend (the City), authorized Galardi Consulting, LLC to conduct a comprehensive water and sewer rate study. The purpose of the study was to develop financial plans and rates that:

- Provide adequate revenue to meet the projected capital and operation and maintenance (O&M) costs of the systems,
- Equitably distribute costs among different types of system users,
- Encourage efficient use of resources,
- Are relatively simple to administer and understand, and are consistent with industry standard practices

The rate study followed three tracks of analysis:

1. Financial planning – Five-year financial plans were developed to determine overall revenue needs for each system.
2. Cost of Service Analysis – Annual revenue requirements are analyzed to determine how costs are incurred to serve various customer classes.
3. Rate Design – Rate structure options were developed to recover the required annual revenues, and address the City's policy objectives.

Financial Plans

For this analysis, system revenue requirements were developed under the cash basis approach, which is typically used for publicly owned utilities. Under this approach, annual revenue requirements consist of O&M and capital expenditures. Capital expenditures include debt service and current revenue funded or pay-as-you-go (PAYG) capital, as well as transfers to reserves for future capital expenditures. Data used in developing the revenue requirements were obtained from the City's financial statements, budgets, and other information provided by the City.

For rate setting purposes, revenue requirements are developed separately for the water and wastewater systems. Tables ES-1 and ES-2 present the water and wastewater revenue requirements for each system individually. To determine the amount of revenue that rates must generate each year, the total system revenue requirements are reduced by nonrate or other system revenues (e.g., interest income, and revenues from SDCs and other fees and charges). The City also uses fund balances to stabilize rates and "smooth" rate increases over the study period. Under a rate smoothing approach, revenue will exceed cash outlays in some years, leading to an accumulation of fund balance (shown as an addition to reserves

in Tables ES-1 and ES-2). In other years, these reserves are programmed as revenue requirement off-sets, decreasing the annual requirements from rates.

Table ES-1
City of Bend
Water and Sewer Rate Study
Water System Projected Requirements from Rates

Item	FY 2002-03	FY 2003-04	FY 2004-05	FY 2005-06	FY 2006-07
Revenue Requirements					
Operation and Maintenance	$5,474,335	$6,012,580	$6,517,181	$6,919,842	$7,558,636
Capital Costs					
Debt Service	822,941	1,100,237	1,532,109	1,817,551	2,053,808
Cash-Funded Improvements	6,068,180	2,946,650	2,472,295	4,372,602	2,196,824
Subtotal	$6,891,121	$4,046,887	$4,004,404	$6,190,153	$4,250,633
Total Requirements	$12,365,456	$10,059,467	$10,521,585	$13,109,995	$11,809,269
Less Nonrate Revenue:					
Miscellaneous	$25,300	$26,628	$28,026	$29,498	$31,046
Interest Income	130,000	172,549	188,335	153,060	113,525
Other Fees and Charges	35,259	37,110	39,058	41,109	43,267
SDCs	1,880,000	1,897,206	1,935,150	1,973,853	2,013,330
Meter Installation	-	-	-	50,000	50,000
Reimbursements -- Meter Install	832,623	1,248,495	455,395	-	-
Subtotal	$2,903,181	$3,381,987	$2,645,964	$2,247,519	$2,251,168
Uses of (Additions to) Reserves	$3,221,175	($180,043)	$281,283	$2,419,535	$411,400
Requirements from Rates	$6,241,100	$6,857,523	$7,594,338	$8,442,941	$9,146,701
Adjustment for partial year rate increase					
Projected Water Sales Revenue	$6,241,100	$6,857,523	$7,594,338	$8,442,941	$9,146,701
Revenue Increase		9.88%	10.74%	11.17%	8.34%
Rate Increase		7.75%	7.75%	7.75%	5.00%

In fiscal year (FY) 2003/04, total water system revenue requirements are forecast to be $10.0 million. Nonrate revenue is estimated to be $3.4 million. In addition $0.2 million will be added to reserves to off-set future year requirements, resulting in annual revenue requirements from rates of $6.9 million. Annual requirements from rates are projected to increase at an average annual rate of about 9 percent during the study period. Based on projected growth in water sales and customers, the required rate increases during the period are 7.75 percent per year through FY2005/06, and 5.00 percent in FY2006/07.

For the sewer system in FY2003/04, total requirements are projected to be $9.5 million and requirements from rates are $6.7. Annual requirements from rates are projected to increase at an average annual rate of about 10.4 percent during the study period. Based on projected growth in customers and billed volumes, the required rate increases during the period are 6.00 percent per year through FY2006/07.

Table ES-2
City of Bend
Water and Sewer Rate Study
Sewer System Requirements from Rates

Item	FY 2002-03	FY 2003-04	FY 2004-05	FY 2005-06	FY 2006-07
Revenue Requirements					
Operation and Maintenance	5,309,921	5,751,765	6,007,605	6,516,293	7,345,192
Capital					
Costs					
Debt Service	1,553,436	1,418,229	1,412,726	1,416,307	1,413,465
Cash-Funded Improvements	5,079,320	2,304,440	2,688,140	2,605,553	3,970,514
Subtotal	6,632,756	3,722,668	4,100,866	4,021,860	5,383,979
Total Requirements	11,942,677	9,474,433	10,108,471	10,538,153	12,729,171
Less Nonrate Revenue:					
Miscellaneous	25,260	25,765	26,280	26,806	27,342
Interest Income	100,000	115,654	92,404	97,417	87,981
SDC Revenue -- Reimbursement	736,420	751,148	766,171	781,494	797,124
SDCs -- Improvement	570,647	511,992	521,285	530,764	540,432
Transfers From Other Funds	2,280,540	1,193,513	1,229,318	1,266,197	1,304,183
Loan Repayments	45,600	397,800	9,200	9,000	9,000
Subtotal	$3,758,466	$2,995,872	$2,644,658	$2,711,678	$2,766,063
Uses of (Additions to) Reserves	$2,357,186	($201,089)	$67,677	($359,159)	$907,797
Requirements from Rates	$5,827,025	$6,679,650	$7,396,136	$8,185,634	$9,055,312
Projected Sewer Sales Revenue	5,827,025	6,679,650	7,396,136	8,185,634	9,055,312
Revenue Increase	6.47%	14.63%	10.73%	10.67%	10.62%
Rate Increase		6.0%	6.0%	6.0%	6.0%

User Characteristics

An equitable allocation of revenue requirements to water and wastewater system users begins with an analysis of user characteristics. Customers are classified into relatively homogeneous groups with similar usage characteristics, and costs are then allocated in proportion to these usage characteristics. Costs are allocated to water customers based on their average and peak water demands, and to wastewater customers based on their estimated wastewater flows and strengths. Historical data were used to project user characteristics for the five-year rate-setting period FY2002/03 through FY2006/07.

Water System

Customers and Meters. The water system currently serves about 16,800 customers, including customers previously served by the Juniper Utility. All customers are metered, with the exception of about 3,000 residential customers who will be converted to meter use by 2004. Juniper Utility customers are also currently not metered.

Water Use. Projections of average annual and peak day and hour demands were developed for each customer class. Total estimated water use for FY2002/03 is 5.3 million hundred cubic feet, with residential customers representing about 60 percent of total use. Peaking factors were developed that estimate the maximum-day and maximum-hour rates of use of each class. Residential customers and schools have higher peaking factors than commercial due primarily to summer irrigation.

Wastewater System

Customers and Bills. The wastewater system currently serves approximately 18,300 customers, including 1,300 from the Juniper Utility area. Customer account growth is forecast at 3.25 percent annually throughout the study period. Additionally, the City expects to add approximately 300 customers per year through septic tank conversions.

Wastewater Flows and Strengths. Wastewater flows and strengths were estimated for each customer class. Winter average water use served as the basis for estimating wastewater flows for residential and commercial customers. Treatment plant influent data were analyzed to estimate wastewater strengths by class. Commercial customers were estimated to have higher strengths on average than residential customers, reflecting the discharge from restaurants, bakeries, and other high strength businesses.

Cost-of-Service Analysis

A fundamental principle for developing an equitable rate structure is to ensure that all users pay for their share of the total costs imposed on the system. O&M expenditures and normal capital expenditures should be paid through user charges. Some of these expenditures are a function of water usage or sewage flow; others are a function of peak demands placed on the system. Some costs are associated with serving customers regardless of the volume of usage or discharge.

The cost allocation processes follow standard industry practices and are based on staff and consultant reviews of the systems. The allocation of O&M costs generally considers operations criteria, while capital costs consider facility design. The user characteristic analysis serves as the basis for the allocation of costs to customer classes.

Rate Design

Rate design involves determining systems of charges for each class of customers that will generate a desired level of revenue. The water and wastewater rates developed in this study are designed to recover revenue requirements and generate revenues by class that approximately equal the allocated cost responsibility of each class.

Existing Rates

This report includes data as of January 2003. "Existing rates," for the purposes of this report, refer to rates set on July 1, 2002, which were in effect through June 30, 2003. These rates are shown in Tables ES-3 and ES-4. (Subsequent to the analysis undertaken for this report, new rates were implemented, on July 1, 2003, to reflect the financial plan recommendations).

The City's existing water rate schedule is provided in Table ES-3. The existing rates for metered customers include two main elements: (1) a fixed monthly service charge, and (2) a commodity or volumetric rate. The monthly service charges vary by meter size, and include a quantity allowance of 600 cubic feet (cf) for all customers. Monthly charges range from $7.78 for a 5/8" meter to $1,156.00 for a 10" meter. Commodity charges are the same per

unit of consumption for all customers and apply to metered consumption year-round (i.e., there are no seasonal variations). The volume charge is $0.75 per 100 cf.

TABLE ES-3
City of Bend
Water Rate Schedule (effective July 1, 2002)

Metered Water Rates	
Meter Charge ($/Meter/Month)	
5/8"x3/4"	$7.78
5/8"	$7.78
3/4"	$11.92
1"	$17.96
1 1/2"	$34.93
2"	$64.66
3"	$184.56
4"	$284.70
6"	$553.54
8"	$813.39
10"	$1,156.00
Volume Rate ($/100 cf)*	$0.75
*In excess of first 600 cf water consumption	
Flat Rates	
First Unit Service (Tap-Bath-Sink-Toilet)	$12.91
Additional Services:	
Each additional unit service	$12.91
Each additional tap	$9.92
Each additional bath	$1.03
Each additional sink	$0.58
Each additional toilet	$1.36
Irrigation**	
First 1,500 sq. ft. irrigated area	$13.04
Next 1,000 sq. ft. (per 100 sq. ft)	$0.75
Excess over 2,500 sq. ft. (per 100 sq. ft.)	$0.33
**Applies only to months April through September	

Flat rate customers pay a fixed amount per month based on the number of service units (e.g., tap, bath, sink, toilet). The charge for the first unit service (defined as any combination of tap, bath, sink, and toilet) is $12.91. Additional service costs range from $0.58 for an additional sink, to $9.92 for each additional tap. Separate irrigation charges may also apply during the summer months (April through September), based on the size of the irrigation area.

Sewer System

The City's existing sewer rates are shown in Table ES-4. Sewer rates for single-family residential customers are based on a flat monthly charge of $19.38 per customer. Multifamily customers may be charged based on the residential or nonresidential rate schedule. Nonresidential rates consist of a monthly service charge and a volumetric charge.

The monthly service charge is $19.38 and includes the first 1,000 cf of water used. The volumetric rate is $1.51 per 100 cf for volumes in excess of the 1,000 cf. Volumetric rates are applied to winter average water use when part of a customer's water use is for summer irrigation.

The existing sewer rates also include extra strength charges for users whose discharge is significantly above domestic strengths.

TABLE ES-4
City of Bend
Sewer Rate Schedule (effective July 1, 2002)

Residential ($/Month/ERU)(1)	
General Service Charge	$19.38
Nonresidential	
First 1,000 cubic feet of water use (2)	$19.38
Excess over 1,000 cubic feet ($/100 cf)	$1.51
Extra-Strength Customer Charges	
First 1,000 cubic feet of water use	$19.38
Excess over 1,000 cubic feet ($/100 cf)	(3)

(1) Multifamily customers may choose to be charged as nonresidential
(2) Based on winter average water use
(3) 1.46+.0062433 [COD mg/l x (0.2 x $1.06 + SS mg/l x (0.2 x $1.06)]
ERU = Equivalent Residential Unit

Rate Design Options

Policy Issues

There are a number of potential rate structure options the City may wish to consider to address equity, conservation, and affordability goals. Because the City is under a mandate to meter all customers by July 2004, the focus of this study is on rate structures for metered customers. When considering different rate structure options, there are a number of policy questions to address, including:

1. Should a quantity allowance continue to be included in the fixed charges for water rates (all customers) and sewer rates (nonresidential customers)?
2. Should the fixed charge for residential water customers be uniform or vary by meter size?
3. Should the City continue to assess water and sewer volume rates uniformly across different customer types or adopt customer class-specific rates based on estimated usage characteristics?
4. Is the City interested in implementing conservation-oriented water rate structures?
5. Is the City interested in implementing volume-based sewer rates for residential customers?

Rate Options

Three rate design options are presented for the water and the sewer systems, that address some of the policy issues identified. Further information on rate design options may be found in Appendix C (wheeling rates, such as for Juniper Golf Course), and Appendix D (effluent re-use rates).

Water System

Table ES-5 presents the existing water rate structure along with three options for consideration. The options differ in terms of whether or not a quantity allowance is included in the fixed charge and how the volume charge is applied (uniformly across all customers, or different rates by class.)

Table ES-5
City of Bend
Water and Sewer Rate Study
Existing and Alternative Water Rate Design Options

	FY2002/03		FY2003/04	
Customer Class	**Existing**	**Option 1**	**Option 2**	**Option 3**
Quantity Allowance (100 cf/mo./meter)	6	0	6	0
Volume Charge ($/100 cf above Qty Allowance)				
Residential	$0.75	$1.04	$1.27	$0.95
Nonresidential	$0.75	$0.80	$1.27	$0.95
Schools	$0.75	$1.20	$1.27	$0.95
Billing Charge ($/mo./account)				
Residential	na	$2.95	$2.95	$2.95
Nonresidential	na	$2.37	$2.37	$2.37
Meter Charge ($/mo./meter)				
5/8"	$7.78	$4.07	$4.07	$4.07
3/4"	$11.92	$4.07	$4.07	$4.07
1"	$17.96	$6.92	$6.92	$6.92
1 1/2"	$34.93	$18.29	$18.29	$18.29
2"	$64.66	$33.85	$33.85	$33.85
3"	$184.56	$96.61	$96.61	$96.61
4"	$284.70	$149.02	$149.02	$149.02
6"	$553.54	$289.75	$289.75	$289.75
8"	$813.39	$425.77	$425.77	$425.77
10"	$1,156.00	$605.10	$605.10	$605.10

The three options include identical changes to the meter charge, with the proposed charges aligned with the cost-of-service of each meter size, resulting in a decreased meter charge across the board. The three options also include a billing charge - a new fee component - which, based on the cost-of-service analysis - would be $2.95 per month for residential customers and $2.37 per month for nonresidential customers. The higher cost for residential customers reflects recovery of cross connection control costs through the billing charge for these customers only.

Only Option 2 retains the 600 cf quantity allowance; in this case, the water is provided through the fixed charge, at no extra cost.

All three options include higher volume rates, reflecting the findings of the cost-of-service analysis. Options 2 and 3 include a uniform system-wide volume rate. Option 2, which retains the current quantity allowance of 600 cf per month, includes a volume rate of $1.27 per 100 cf – a 69 percent increase over the existing volume charge. Option 3, which does not retain a quantity allowance, includes a volume rate of $0.95 per 100 cf – 27 percent more than existing rates. Option 1, like Option 3, does not retain the quantity allowance, but includes volume rates that differ by customer class, with the lowest volume rate for nonresidential ($.80 per 100 cf), followed by residential ($1.04), followed by schools ($1.20) – reflecting the results of the cost-of-service analysis findings concerning water use/peaking.

Sample Water Bills

While all three options would recover the costs of service, they burden customer classes/groups differently, as is shown in Table ES-6. As the table indicates, high volume water users would be most greatly impacted by Option 2 (due to the relatively higher volume rates).

Table ES-6
City of Bend
Water and Sewer Rate Study
Sample Water Bills by Customer Class and Rate Design Option

Customer Class	Meter Size	Monthly Use (100cf)	FY2002/03 Existing	FY2003/04 Option 1	FY2003/04 Option 2	FY2003/04 Option 3
Quantity Allowance (100 cf)			*6*	*0*	*6*	*0*
				Monthly Bill		
Residential	5/8x3/4"	2	$7.78	$9.11	$7.02	$8.92
Residential	3/4"	5	$11.92	$12.24	$7.02	$11.78
Residential (Avg)	3/4"	18	$20.92	$25.83	$22.24	$24.15
Residential	1"	25	$32.21	$35.99	$33.97	$33.67
Residential	11/2"	70	$82.93	$94.38	$102.42	$87.87
Nonresidential	3/4"	10	$14.92	$14.47	$11.52	$15.96
Nonresidential (Avg)	1"	53	$53.21	$51.83	$68.92	$59.75
Nonresidential	3"	400	$480.06	$419.99	$598.82	$479.77
Schools (Avg)	3"	256	$372.06	$403.33	$416.14	$342.68
				Percent Increase over existing		
Residential				17%	-10%	15%
Residential				3%	-41%	-1%
Residential (Avg)				23%	6%	15%
Residential				12%	5%	5%
Residential				14%	24%	6%
Nonresidential				-3%	-23%	7%
Nonresidential (Avg)				-3%	30%	12%
Nonresidential				-13%	25%	0%
Schools (Avg)				8%	12%	-8%

Under Option 2, residential and nonresidential customers who use low quantities of water would experience a significant decline in their monthly water bills, whereas those that use large quantities of water (or average, for nonresidential customers) would experience large increases in water bill. The impact of Option 1, with class-specific volume rates, would impact residential customers most significantly; nonresidential customers would generally experience a decline in water bills, reflecting the large decrease in fixed charges. Option 3 would create the least dramatic change in bills overall.

Sewer System

Table ES-7 presents the existing sewer rate structure along with three options for modification associated with the quantity allowance, customer charge, and volume charge.

Table ES-7
City of Bend
Water and Sewer Rate Study
Existing and Alternative Sewer Rate Design Options

Customer Class	FY2002/03 Existing	Option 1	FY2003/04 Option 2	Option 3
*Quantity Allowance (100cf/mo./meter)**	10	0	7	9.5
Volume Charge ($/100 cf above Qty Allowance)				
Residential	n/a	n/a	n/a	n/a
Nonresidential	$1.51	$2.35	$2.14	$1.75
Customer Charge ($/mo./account)				
Residential	$19.38	$15.37	$16.56	$18.76
Nonresidential	$19.38	$1.13	$16.56	$18.76

*Applies to Nonresidential Only

The three rate options all maintain a fixed charge only for residential customer; however, the charge is reduced based on current estimates of sewage flows and strengths per account. Residential rates under Options 1 and 2 are based on the 700 cf estimated flow per account. Option 3 is based on 950 cf per month use, to provide an option for the City to gradually move from 1,000 cf to 700 cf over a multiyear period.

For nonresidential customers, Option 1 assumes elimination of the quantity allowance, limiting the fixed charge only to billing related costs. Options 2 and 3 include a quantity allowance – set at 700 cf in Option 2, and 950 cf in Option 3.

Each option shown in Table ES-7, shows an increase in the volume charges to nonresidential customers (as the fixed charges decrease in each option). Option 1, with the lowest fixed rate, includes the highest volume rate at $2.35 per 100 cf (36 percent increase), followed by Option 2 at $2.14 per 100 cf (29 percent increase), followed by Option 1 – which had the most modest decrease in fixed charges – at $1.75 per 100 cf (14 percent increase). The shift towards a higher volume rate and lower fixed charge, particularly in Options 1 and 2, reflects the results of the cost of service analysis which indicates a general shift in costs from residential to commercial (due to estimated sewage flows and strengths), and within the commercial class from fixed costs to volume rates.

Sample Sewer Bills

While all three options would recover the costs of service, they burden customer classes/groups differently, as is shown in Table ES-8. All three options would reduce residential sewer rates, with Option 1 having the most significant impact (21 percent reduction), followed by Options 2 and 3 (15 percent and 3 percent reductions, respectively). While all three options would reduce the bills of the lowest quantity nonresidential customers, the bills of nonresidential customers would increase progressively with each option, as use increases. As the table shows, nonresidential customers with monthly use of 20,000 cf would see a 54 percent increase in their sewer bill with Option 1, followed by an increase of 40 percent with Option 2, and an increase of 15 percent with Option 3.

Table ES-8
City of Bend
Water and Sewer Rate Study
Sample Water Bills by Customer Class and Rate Design Option

Customer Class	Monthly Use (100cf)	FY2002/03 Existing	Option 1	FY2003/04 Option 2	Option 3
*Quantity Allowance (100cf)**		*10*	*0*	*7*	*9.5*
		Monthly Bill			
Residential	Na	$19.38	$15.37	$16.56	$18.76
Nonresidential	5	$19.38	$13.01	$16.56	$18.76
Nonresidential (Avg)	34	$55.62	$81.25	$74.06	$60.79
Nonresidential	75	$117.53	$177.73	$161.87	$132.60
Nonresidential	200	$306.28	$471.87	$429.58	$351.51
		Percent Increase over existing			
Residential			-21%	-15%	-3%
Nonresidential			-33%	-15%	-3%
Nonresidential (Avg)			46%	33%	9%
Nonresidential			51%	38%	13%
Nonresidential			54%	40%	15%

*Applies to Nonresidential Only

Implementation

The technical approaches used in this study are based on industry standard methods and principles, and that the implementation of the resulting rates and charges will help to ensure the continuation of high-quality water and wastewater service to the customers of the City's systems, at fair and equitable prices. However, the City must balance equity objectives, with other important criteria, including administrative feasibility, affordability, and customer understanding and acceptance. In light of these considerations, a number of recommendations are provided related to the implementation of the various findings, for the City's consideration.

- **Financial Plan.** We recommend that the City review its utility financial plans annually and update rate levels as needed. Significant changes in the sizing or timing of capital projects will have an impact on the revenue requirements. Also, the City will need to monitor billing units to ensure adequate revenue is being generated.

- **Resource Efficiency Pricing.** The alternative rate structures developed in this study provide incentives to customers to use resources efficiently through the elimination of the quantity allowances, shift in revenue recovery from fixed charges to volume rates, and the development of customer class-specific rates. The City may wish to consider stronger price incentives in the future, as the residential metering program is completed, and additional usage data is available.

- **Subclasses of Commercial Customers for the Wastewater System.** We recommend that as soon as is practically possible, the City implement strength-based subclasses of commercial customers. To the extent that the City can augment data from other communities with a limited local wastewater sampling program, the defensibility of the rates may be enhanced. The City should also develop an appeals program at the time the subclass rates are implemented, for those customers who want to challenge their classification.

- **Volume-based rates for residential.** The primary advantage of including a volume component in the wastewater rate structure is that it allows for recognition of different levels of service among customers. Customers have greater control over their bills, and may therefore be able to make their bills more affordable by controlling their water use. The primary hurdle for the City is that approximately 40 percent of sewer customers are served by other water suppliers. The implementation of a volume-based charge for residential would require initial data collection and billing system adjustments, along with on-going coordination with the water service providers. An intermediate step to potentially enhancing the equity of the sewer rates would be to revise the rate structure to reflect the current average winter month use of 700 cubic feet.

- **System Development Charges**. The City currently charges SDCs at rates below the 'maximum allowable', as defined by a previous methodology. To enhance the overall equity of its utility pricing system, the City may want to consider potential changes to the SDCs, to reflect recent capital improvement plans, as well as changes in Oregon SDC legislation. The rate analysis provides an opportunity for the City to address equity issues among existing users; the SDC analysis will address potential equity issues between existing and new customers.

Appendix B
Cost for Additional Conservation Measure Implementation

Institutional, Commercial, Industrial Measure			**Assumptions/Notes**
Single Pass Cooling			
Measure Cost			
Labor	$	16,000	1FTE at $50/hr. for 320 hrs.
Marketing	$	2,000	Brochures, advertising, etc.
Incentive: Engineering Audit	$	10,000	$2,000 for each, performed by professional ICI auditor.
Total Up-Front Cost	$	28,000	No on-going costs assumed upon program completion.
Measure Savings			
Eligible of the top 50 Commer. customers		5	
Participation		2	For 2 customers, cost savings realized within 3 years, therefore these customers decide to implement the measure.
Annual savings (gal.)	$	549,760	40% of the median annual water consumption of top 50 Commercial customers in 2002 * 2 customers
Lifetime Savings (gal.)		10,995,200	Over 20 years
Utility cost per mill. gal. saved	**$**	**2,547**	

Institutional, Commercial, Industrial Measure			**Assumptions/Notes**
Pre-rinse Nozzle Retrofit			
Measure Cost			
Labor	$	16,000	1FTE at $50/hr. for 320 hrs
Marketing		$2,000	Brochures, advertising, etc.
Incentive: Give-away	$	12,500	250 nozzles distributed at $50 ea. Actual cost is $70, but assume bulk purchase discount.
Total Capital Cost	$	30,500	No on-going costs assumed upon program completion
Measure Savings			
Eligibility	$	300	10% of total 3,000 commer. cust. can use an efficient nozzle.
Participation		250	250 choose to participate.
Participation w/o free riders		225	
Annual savings (gal)	$	2,165,625	9,625 gal/yr saved per site*225 sites (1).
Lifetime Savings (gal)		10,828,125	5 year lifetime of nozzle
Utility cost per million gal. saved	**$**	**2,817**	

Notes
(1) Savings based on the evaluation of a pre-rinse spray valve installation program performed by the California Urban Water Conservation Council in 2003.

Appendix B
Cost for Additional Conservation Measure Implementation

Institutional, Commercial, Industrial Measure			**Assumptions/Notes**
Laundry Units at Institutional Facilities			
Measure Cost			
Labor	$	16,000	1FTE at $50/hr. for 320 hrs.
Marketing	$	2,000	Brochures, advertising, etc.
Incentive--Rebate	$	3,000	$1000 per machine performed by professional ICI auditor.
Total Capital Cost	$	21,000	No on-going costs assumed upon program completion
Measure Savings			
No. of eligible customers		15	Large hotels, commercial washing facilities, college, etc.
Participation		3	For 3 customers, cost savings realized within 3 years, therefore these customers decided to implement the measure.
Gal. Per day saved per participant		1890	Based on analysis of Shelton, WA prison's washing facility.
Annual savings (gal.)		2,069,550	= 1,890 g/d * 3 participants * 365 days.
Lifetime Savings (gal.)		20,695,500	10 years
Utility cost per million gal. saved	**$**	**1,015**	

Institutional, Commercial, Industrial Measure			**Assumptions/Notes**
Linen and Towel Reuse Measure for Hotels			
Measure Cost			
Labor	$	8,000	1FTE at $50/hr. for 160 hrs
Marketing	$	2,000	Brochures, advertising, etc.
Incentive: Give-away	$	15,000	50 Project Planet Co. kits for hotels with no more than 50 rooms at $300 ea.
Total Up-front Cost	$	25,000	No on-going costs assumed upon program completion
Measure Savings			
No. of hotels participating		50	
Rooms		1250	Each hotel with an average of 25 rooms ea.
Gallons per day per room pre-measure		100	Per SPU study "Hotel Water Conservation" (2002)
% savings per room post-measure		10%	Per SPU study "Hotel Water Conservation" (2002)
Annual savings (gal.)		4,562,500	= 1,250*100*10%*365
Lifetime Savings (gal.)		22,812,500	5 year lifetime
Utility cost per million gal. saved	**$**	**1,096**	

Appendix B
Cost for Additional Conservation Measure Implementation

Residential Measure			**Assumptions/Notes**
Rebated for front loading machines			
Measure Cost			
Labor		$16,000	FTE at $50/hr. for 320 hrs.
Marketing		$2,000	Brochures, advertising, etc.
Incentive - Rebate		$37,500	$75 per rebate * 500 participants
Total Capital Cost		$55,500	
Measure Savings			
Participation		500	500 Residential households
Non-free riders		375	75% of participants
Savings per day (gal.)		13	= 40 gal.- 27 gal. (top load use - front load use)
Loads per person per day		0.37	Per AWWARF REUW Study (2)
Annual savings (gal.)		1,632,755	= 375 * 13*.037*2.48 persons per house*375*365
Lifetime Savings (gal.)		16,327,545	10 year lifetime of machine
Utility Cost per million gal. saved	**$**	**3,399**	

(2) Residential End Uses of Water Study (REUWS) published by American Water Works Association Research Foundation (1999).

Residential Measure			**Assumptions/Notes**
Toilet Replacement Voucher Program			
Measure Cost			
Labor	$	8,000	FTE at $50/hr. for 160 hrs.
Marketing	$	2,000	Brochures, advertising, etc.
Incentive - Rebate	$	25,000	$50 per toilet at 500 toilets (5% of homes w/ 3.5 gpf toilets)
Total Up-front Cost	$	35,000	
Measure Savings			
Participation		500	
Non-free riders		375	75% of participants
Savings per flush		2	= Older toilets (3.5 gpf) - Efficient toilet (1.6 gpf)
Flushes per person per day		5	See footnote (2)
Total flushes per day (gal.)		4,650	= 375 * 5 * 2.48 persons per house
Total annual savings		3,224,775	=5580*1.9*365
Lifetime Savings (gal.)		32,247,750	10 year savings
Utility Cost per million gal. Saved	**$**	**1,085**	

Appendix D

Avion/Bend Interconnect – Chlorine Injection Building, Valve is in Vault

Bridge Creek Diversion and Intake Building – Built 1926

Source Spring Diversion Dam, Tumalo Creek to Bridge Creek
Originally Built 1955

Bridge Creek Intake Building From Above

CT Basin Overflow Tower
Originally Built - 1926