September 2000

Municipal Water Management In Oregon Coastal Communities:
Surmounting the "Conservation Paradox"

Coastal Oregon
Marine Experiment Station
Oregon State University

Municipal Water Management in Oregon Coastal Communities: Surmounting the "Conservation Paradox"

Kate Quigley
Graduate Research Assistant
Department of Agricultural and Resource Economics
Oregon State University

Gilbert Sylvia
Marine Resources Economist and Superintendent
Coastal Oregon Marine Experiment Station

September 2000

Prepared for:

Coastal Oregon Marine Experiment Station (COMES)
Hatfield Marine Science Center
2030 Marine Science Drive
Newport, OR 97365
541-867-0230

Oregon Sea Grant
Oregon State University
500 Kerr Administration Building
Corvallis, OR 97331-2131
541-737-2714

This report was prepared by the authors with funding from the Coastal Oregon Marine Experiment Station (COMES) and Oregon Sea Grant. The views and opinions of the authors do not necessarily reflect the views or opinions of COMES or Oregon Sea Grant.

Municipal Water Management in Coastal Communities: Surmounting the "Conservation Paradox"

EXECUTIVE SUMMARY

The opportunities for expanding water supplies in Oregon coastal municipalities are becoming increasingly limited. New water quantity and quality regulations, particularly those designed to protect and rebuild salmon runs, constrain water supply options. At the same time, however, demand for water is increasing. Coastal communities continue to grow in population and are targeted as tourist destinations. In addition, water supplies are at their lowest levels during the summer months when demand is greatest. Although the coast receives more rain than other areas in Oregon, the majority of the precipitation is received between October and March. The uneven distribution of rainfall creates periodic scarcity and an increasing likelihood that summer and fall demand for water cannot be met.

The municipalities of Newport, Garibaldi, and Port Orford serve as case studies to illustrate a range of coastal municipal water issues. Each study discusses the characteristics of the municipal population, water management goals and objectives, the types and amounts of water supplies, problems associated with expanding water supplies, and opportunities for conservation. Together the case studies are used to determine the common problems and issues. These include:

- Decreasing options for additional raw water supplies
- Peak demand during summer months
- Difficulty in covering operational costs
- Increasing importance of domestic consumers in designing of new rate structures
- Tendency to avoid implementing conservation strategies until absolutely necessary
- Management "conundrums" resulting from the "Conservation Paradox"

Although the three municipalities suffer from decreasing water supplies and peak demand, the municipalities do not plan to incorporate demand-side or water pricing strategies into current water management. Newport and Garibaldi have decreasing water rate structures while Port Orford has a uniform rate structure. These rate structures do not inform water consumers about the scarcity of water supplies and the increasing opportunity costs associated with delivering those supplies.

Integrating conservation strategies into municipal water system management and pricing is opposed by many communities. The disincentives for water utilities to invest in demand-side methods of water management result from four interrelated issues: 1) traditional rate structures are incompatible with demand management; 2) demand management options can reduce municipal revenues; 3) demand management options can increase uncertainty about expected water use and compromise profitability; and 4) implementing higher priced rate structures is politically unpopular.

Unless a municipal water agency is experiencing maximum demand capacity, conserving water will decrease revenues under traditional pricing methods. In addition, many coastal municipal water systems service large water users such as seafood processing plants. Successful and significant water savings will involve these firms. However, the water needs of seafood processing plants can be highly variable, with peak use during the summer months. Unless municipalities can guarantee seafood processing plants their water needs during peak periods, seafood firms have little incentive to conserve. These problems are collectively referred to as the "conservation paradox" and are the focus for a discussion of alternative conservation strategies for coastal municipalities. Several types of strategies are discussed:

- Increasing rate structures
- Marginal cost and revenue neutral pricing
- Non-pricing, voluntary, or command and control conservation approaches for residential and industrial consumers
- Conservation education

Collectively, these conservation strategies provide a range of approaches for addressing the problems facing coastal municipalities.

Municipalities experiencing peak demand problems and decreasing options for additional water supplies significantly benefitted from adopting seasonal rate structures. Seattle has been successful in reducing peak demand by almost one-third through seasonal rates and other demand-related strategies. Seattle's rate over the four summer months is 1.5 to 2.6 times more costly than rates during the remainder of the year (depending on consumer classification). (In 1997, Newport's peak water demand was, on average, almost 2 times greater than average use over the rest of the year; Port Orford's peak demand was 1.5 times and Garibaldi's 3 times greater than the average annual demand.) Other utilities use average winter use as a baseline and create a surcharge for consumers who exceed the baseline during the summer months. Seasonal rate structures such as these require citizens to readjust their needs each summer. Some U.S. municipalities also use a marginal cost pricing strategy, which is considered the most efficient approach for pricing water.

There are numerous other methods of promoting conservation besides pricing rate structures. Leak detection and improvements in the water distribution system are examples. The use of incentives to encourage conservation is popular in many large cities throughout the U.S. Incentives to encourage low water-use appliances have been successful through Seattle's Home Water Saver Apartment/Condominium Program. Incentives are used in Corvallis, Oregon where citizens participate in the WashWise program and receive discounts from the city for purchases of low water use clothes washers. Municipalities with smaller budgets encourage conservation by distributing water saving kits and, via water bill inserts, information about water saving measures for the home. Incentives can also be successful when applied to commercial conservation.

State policy addressing conservation and efficient water use states, "the elimination of waste and improving the efficiency of water use are high priorities." The Oregon Water Resources Department implemented this policy by conditioning new municipal water rights on development of a *Water Management and Conservation Plan. Water Management and Conservation Plans*, once approved, are enforced by the Oregon Water Resources Department (OAR 690-86-929).

In March 1999, two species of salmon in the Northwest were listed as endangered and seven more listed as threatened - the largest implementation of the Endangered Species Act to date. Any action that degrades the water quality of rivers and streams that provide habitat for these protected salmon or steelhead will be subject to federal regulation. Agriculture, timber companies, urban industry, and municipalities will experience increasing limits on water use. Municipalities will be required to withdraw water in ways consistent with supporting healthy fish populations. For example, Portland will develop programs to limit homeowner damage to fish-bearing rivers and streams. Restrictions on car-washing and pesticide and fertilizer use are being considered. Clark and Clackamas counties are spending millions of dollars to prepare for compliance with the listings by replacing culverts and developing fish passage projects.

Solutions being considered by municipalities to increase supplies while protecting salmonids will become increasingly difficult to implement. Attempts to mitigate the effects of dams and reservoirs on one stream through decreased pressure on other rivers and streams might not be approved under the Endangered Species Act. Other solutions will need to be identified that spread current water supplies over greater numbers of individuals and uses. Conservation of existing water supplies will become an increasingly important strategy, and for some Oregon coastal municipalities, possibly the only viable strategy.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

ACKNOWLEDGMENTS

We would like to thank the entire Advisory Board of the Coastal Oregon Marine Experiment Station (COMES) for their encouragement and leadership in this project. The importance of water conservation issues to coastal communities was first discussed at a meeting of COMES in the spring of 1998. Board member Joe Easley, Director of the Oregon Trawl Commission, led the discussion by arguing that there were negative consequences to municipal water dependent coastal communities and industries if conservation problems were not addressed. Captain Barry Fisher, Chair of the COMES Advisory Board, together with other board members, enjoined COMES faculty to provide intellectual leadership on this issue. Although COMES has no expertise in municipal water management, faculty and board members agreed that COMES, together with other University partners including Oregon Sea Grant, could act as facilitators to stimulate research and education in coastal municipal water conservation. As an important complement to our primary research and education responsibilities, this decision reemphasized the mission of COMES as intellectual facilitator and leader for marine costal resource issues.

In particular, we would like to acknowledge Jay Rasmussen, Associate Director of Oregon Sea Grant, for his ideas in structuring the case studies.

We would also like to thank the city managers, planners, and water utility managers of Newport, Port Orford, and Garibaldi for their patience and contribution of time and knowledge. This project benefited greatly from the assistance of water utility managers John Van Dyver, Dennis Sheldon, and Jerry McNurlin. We would also like to thank the managers of seafood processing facilities for their frank discussions, especially Smith's Pacific Shrimp and Premium Pacific Processors.

Greg Nelson of the Water Resources Department also contributed significantly to the success of this report by providing us with several contacts, documents, books, and maps. In addition, we would like to recognize the Oregon Department of Fish & Wildlife, Fuller and Morris Consulting, and the National Regulatory Research Institute for their generous donations of literature and data.

Any errors are the sole responsibility of the authors.

Section I: Overview

Organization of the Study

This study is organized in five sections. This section briefly discusses study objectives, organization, and methods. Section II presents a broad state perspective on water use and water conservation. Particular emphasis is placed on the Water Resources Department, the agency responsible for water allocation and management in Oregon. Section III develops coastal perspectives and issues relating to water supply (as influenced by regional geology, geography, and climate) and water demand as influenced by major coastal industries. Section IV presents the results of the case studies. The results include existing water rights, municipal water management objectives, current water use, future demand, and future management plans. Section V summarizes commonalities and discusses alternative options for water conservation using revised rate structures and non-pricing conservation approaches.

The importance of other water users and issues are acknowledged but are not addressed within this limited report. These uses include instream, hydroelectric, irrigation, agricultural, and industrial uses. The authors acknowledge that these uses are inextricably linked to current and future municipal water availability.

Methods

For the purposes of this report, three case studies were chosen to illustrate some of the water issues confronting coastal communities. Municipalities were chosen to represent a wide range of diverse water management problems. Each municipality is located in a different coastal basin and has different populations, growth expectations, water user demographics, raw water supply limitations, and funding possibilities.

For each case study, information about water rights was obtained from the Oregon Water Resources Department. Information about community objectives, water use, and future plans were obtained through interviews with city managers, city planners, water plant managers and staff, Water Management Plans, and data collected through each city's water billing office. With this information, forecasts of "best" and "worst" case scenarios of future water needs were estimated based on basic population forecast methods. Although relatively simple, these methods are often used for generating long term forecasts.

Through comparison of information collected from each municipality, common issues and problems were identified for discussion. The "Conservation Paradox" was chosen as the focus of a literature review for discussion of alternative solutions to water conservation and addressing revenue related objectives that discourage beneficial conservation efforts. This is significant because conservation can be an important part of any plan to help communities solve primary water supply issues including peak demand, raw water supply limitations, high operational costs, and a tendency to avoid implementation of politically difficult conservation techniques until absolutely necessary.

Section II: State Perspectives on Municipal Water Management

Allocation of Water Resources

Oregon water law is based on the Oregon Water Code adopted in 1909 by the state legislature. The law established four general principles:

- Water belongs to the public.
- Any right to use water is assigned by the state through a permit system.
- Water use under that permit system follows the "prior appropriation doctrine."[1]
- Permits may be issued only for "beneficial"[2] use without "waste"[3] (Bastasch, 1998).

With some exceptions, cities, farmers, factory owners and other users must obtain a permit or water right from the Oregon Water Resources Department (OWRD) to gain access to additional sources of water. The OWRD is the state agency that administers the laws governing surface and ground water resources. The Oregon Water Resources Commission sets water policy for the state and oversees activities of the Oregon Water Resources Department in accordance with state law.

Application for water rights involves two stages: the "issue" stage and the "perfection" stage. During the issue stage, the OWRD issues the municipality a water use permit on a specific water source following submission of an application and an application review. During the perfection stage, the municipality develops this right by applying it to a beneficial use. Once the water right has been beneficially used or perfected, the municipality receives a water certificate allowing the

---

[1]The "prior appropriation doctrine" prioritizes the rights for older water uses over newer water uses.

[2]A definition of a "beneficial" use is not provided in law. However, ORS 536.300 offers examples of beneficial uses.

[3]The term "waste" is not defined in law. It is "inferred to be the quantity of water in excess of the minimum needed to support a beneficial use authorized in a water right" (Bastasch, 1998).

municipality permanent use of water from the specified source. In addition, with Water Resources Department approval, the entity can permanently or temporarily transfer place of use, nature of use, and type of use.

Municipalities enjoy preferential treatment with respect to the rules governing use of water rights.[4] This is called the "growing communities doctrine." The preferences allow communities to reserve water for future growth and hold rights to surplus water that can help cities successfully compete in attracting new industries.

In some instances, OWRD does not consider these undeveloped rights when calculating water availability, creating the potential for over-appropriation of water resources. For example, if a new user diverted water from a source already allocated through an undeveloped permit, a new user will find that when the undeveloped rights are finally used, water might be unavailable. In other cases, the community might be using only a fraction of its permitted right, but the water availability calculations factor into the whole right; this fully appropriates the source and closes it to any additional uses (Greg Nelson, personal communication; Bastasch, 1998).

Water Conservation

Policy and Principles

Chapter 690, Division 410 of Oregon Administrative Rules specify policy and principles for state groundwater management, hydroelectric power development, instream flow protection, interstate cooperation, water resources protection on public riparian lands, conservation and efficient water use, and water allocation.

State policy addressing conservation and efficient water use states, "the elimination of waste and improving the efficiency of water use are high priorities" (Statewide Water Resource

---

[4]Rules for municipal water right use differ from rules applying to other users in that: 1) municipalities are not required to begin construction of surface water diversion work within one year of obtaining the permit; 2) municipalities are not subject to permit cancellation and forfeiture of the right through non-use except for water storage purposes; 3) a municipality can obtain a water right certificate for a portion of its permit and hold the remainder in permit status; and 4) municipal uses can take preference over a senior instream water rights if the OWRD determines that this would be in the public interest (Bastasch, 1998). Other differences exist that are not included here. See *Waters of Oregon* by Rick Bastasch for additional information.

Management, Conservation and Efficient Water Use 690-410-060). Programs to accomplish the policy are guided by certain principles including:

- Water users shall construct, operate and maintain their water systems in a manner which prevents waste and minimizes harm to the waters of the state and injury to other water rights;

- Major water users and suppliers shall prepare water management plans under the guidance of schedules, criteria and procedures which shall be adopted by rule. The plans shall evaluate opportunities for conservation and include a quantification of losses of water from the systems, an evaluation of the effectiveness and costs of alternative measures to reduce losses, and an implementation schedule for all feasible measures. During the planning process, consideration shall be given to the environmental impacts from and time needed for implementation of system modifications. The Department shall assist water users and suppliers in the preparation of the water management plans;

- The Commission shall encourage and facilitate the development of subbasin conservation plans throughout the state by local advisory committees. Subbasin conservation plans shall include measures to assist water users in eliminating waste, other methods to improve water use efficiency in the subbasin, funding proposals to implement the measures and procedures to protect water dedicated to instream uses from further diversion. Priority shall be given to development of subbasin conservation plans in serious water management problem areas, critical groundwater areas and other areas where water supplies are not sufficient to meet demands. The Commission shall adopt rules to guide formation of broad-based committees, the preparation of subbasin plans, and the submittal of plans to the Commission for approval;

- When wasteful practices are identified in water management plans and subbasin conservation plans, the Commission shall adopt rules prescribing statewide and subbasin standards and practices that ensure beneficial use without waste. The rules shall recognize that conditions vary for different parts of the state and for different uses;

- A conservation element shall be developed and included in each basin plan when a major plan review and update is performed;

- The collection, analysis and distribution of information on water use and availability are necessary to ensure that the waters of the state are managed for maximum beneficial use and to protect the public welfare, safety and health. The ability to measure water flows at authorized points of diversion is essential to the management of water and the elimination of waste;

- The Commission shall support public education programs, research and demonstration projects to increase citizen and water user awareness of water conservation issues and measures in the state; and

- The Commission shall support programs to provide economic assistance to water users to implement desired conservation measures, particularly where the benefits of implementing the measures are high.

State Efforts to Encourage Water Conservation

Water Management and Conservation Plans

In an effort to more effectively incorporate water use efficiency and conservation elements into municipal planning, Water Resources Commission policy made development of the *Water Management and Conservation Plans* a requirement for municipalities acquiring or expanding their existing water rights. Any municipality that applies for a new water use permit must develop a *Water Management and Conservation Plan.* Chapter 690 Division 86 of the Oregon Administrative Rules outlines plan provisions and standards for *Water Management and Conservation Plans*. Submitted plans must consist of:

- Description of the water system
- Water conservation element
- Water curtailment element
- Long range water supply element
- Proposal date for updating the water management and conservation plan. This would be based on the schedule for implementation plans made by the water provider of conservation measures or other activities.

The water conservation element includes:

- A progress report on conservation measures already scheduled for implementation in previous water management and conservation plans;

- A description of measurement and reporting procedures and a description of other conservation measures;
- An evaluation of the following measures to determine whether conservation measures not being implemented are feasible and appropriate for ensuring the efficient use of water and waste prevention;
    - A leak repair program to reduce leakage by 15% and if not feasible or appropriate, by 10%;
    - Programs to encourage low-water-use landscaping;
    - Programs that encourage conservation through incentives;
    - Retrofitting or replacement of existing inefficient water using fixtures;
    - Adoption of water conservation price-rate structures; and
    - Water re-use opportunities.

A description and schedule for implementation of certain conservation programs is also required. These conservation programs include:

- A water supply audit;
- A program to install meters where not already installed;
- A program for testing and maintenance of meters; and
- An efficient water use public education program;

If a water supplier does not submit a plan or does not submit a satisfactory plan as determined by the Director of the Water Resources Department, the Director can pursue of the following actions:

- Provide an additional amount of specified time for remedy;
- Determine whether the water supplier's management practices and facilities are wasteful;

- Initiate regulation of water use to eliminate waste under OAR 690-250-050;
- Recant previous approval of a water management and conservation plan; and
- Assess a civil penalty or cancel the permit if the submittal of the plan is required under a permit condition (690-86-929).

In general, the *Water Management and Conservation Plans* should identify what is appropriate and feasible for each community given differing resources, abilities, and situations. The purpose of requiring municipalities to develop a *Water Management and Conservation Plan* is part of the OWRD's attempts to encourage a more efficient use of the resource and to make it stretch farther (personal communication, Greg Nelson).

However, *Water Management and Conservation Plans* are not required for water providers that are increasing their water supplies within the limits of current permit amounts. Therefore, *Water Management and Conservation Plans* do not require conservation for users with, for example, rapidly increasing populations or water use unless they apply for additional water permits.

There are some municipalities without available water resources to apply for water permits on. However, they may benefit by considering conserving of their water resources. Other municipalities voluntarily submit *Water Management and Conservation Plans* (personal communication, Greg Nelson).

Other State Agency Involvement

Other government agencies contribute in assisting municipalities in solving water management problems. The Oregon Department of Environmental Quality (ODEQ) and the Oregon Health Division created the Environmental Partnerships for Oregon Communities Program (EPOC) to assist communities encountering numerous new and increasingly stringent state and federal regulations. The program helps small cities find solutions for local and environmental health needs while satisfying wastewater treatment, drinking water, management of solid and hazardous waste, and air quality requirements. Funding is coordinated with the ODEQ, the Oregon Economic Development Department (OEDD) and the Rural Utilities Service, formerly known as the Farmers Home Administration. Under this program, the ODEQ assists municipalities in identifying water quality problems, prioritizing, and setting up a schedule for meeting state regulations.

Other state agency programs have similar objectives. The Oregon Economic Development Department (OEDD) supplies grants to assist municipalities in planning and implementing projects to improve water quality through the OEDD's Regional Development Program. The City of Prineville received funds through OEDD to develop a system that would use excess treated effluent discharge to maintain a new 18-hole municipal golf course (OEDD, 1998).

The OEDD's Water/Wastewater Financing Program provides up to $500,000 when financed with lottery funds and $10,000,000 when funded through State Revenue Bonds for projects needed to meet state or federal water quality statutes and standards. The program also provides technical assistance grants and loans of up to $10,000 and $20,000 respectively.

The Safe Drinking Water Revolving Loan Fund offered through the OEDD assists drinking water systems in financing activities toward compliance with the Safe Drinking Water Act and to further public health protection goals of the Safe Drinking Water Act and Oregon's Drinking Water Quality Act. The department structures financing packages not to exceed $2,000,000 per project (OEDD, 1998).

Future Water Management

Future water management and administration will continue to concentrate on resource capacity and water availability, and will increase the emphasis on conservation and efficient water use.[5] The main approach is a long run strategy to: 1) become good stewards of the

---

[5] Through Senate Bill 93, increased focus was given to water supply and conservation. The bill, sponsored by Senator Veral Tarno, was passed by both the House and Senate in summer 1999 and signed by the Governor (personal communication, Veral Tarno; Oregon Legislation homepage). Senate Bill 93 created a Joint Task Force on Water Supply and Conservation that develops recommendations relating to the process of siting and funding future water supply projects. In doing so, with respect to conservation, the Task Force is required to evaluate current programs that result in conservation, identify barriers to implementation of conservation programs and recommend policies to eliminate those barriers, and evaluate informational needs for development of incentives for conservation.

resource, recognizing that there will be additional demands for water; 2) find ways to accomplish objectives in an environmentally benign way, and 3) find ways to mitigate some of the effects of water use. The OWRD is no longer just concerned with allocating water but requires that municipalities 1) identify what resources can sustain, 2) identify the effect on other resources, and 3) ensure that water resources are used wisely and efficiently (personal communication, Greg Nelson).

Section III: Coastal Perspectives and Issues

Water Supply and Demand

Water Supply

For administrative purposes, the State of Oregon recognizes 18 major river basins or watersheds. There are three coastal basins: the "North Coast," the "Mid Coast," and the "South Coast" basins. The North Coast Basin is a combination of several sub-basins. A basin, or watershed, comprises all the land that collects water and passes it on to a particular stream or river. The coastal basins comprise approximately 8% of the land in the state but produce about 34% of the state's average annual discharge of water (Bastasch, 1998).

Streamflow is influenced primarily by precipitation. Precipitation differs by region and season. Coastal regions receive large amounts of precipitation relative to eastern regions of the state. For example, average annual precipitation west of the Cascades is between 40 and 140 inches. In eastern Oregon, annual precipitation ranges from 10 to 20 inches (Bastasch, 1998). During the rainy winter months, coastal areas have plentiful surface water sources. However, usually one month of every year has no rain. A two-month period without rain usually occurs once a decade (Bastasch, 1998). Because there is no snowpack to release water over time, coastal streamflow mirrors rain patterns. Unfortunately, this means coastal streamflow is at its lowest during the summer months, when demand is highest.

In many cases, coastal municipalities must rely almost entirely on surface water. Coastal municipalities often do not have access to groundwater sources. The Coast Range has low recharge and ground water soaking capabilities due to the underlying rock consistency (tight grains) and thickness. Well yields are generally small, with low quality water containing large amounts of dissolved solids. However, sand dune formations sometimes house aquifers with relatively larger yields. These are most prevalent from Seaside to Astoria and from Heceta Head to Coos Bay (Bastasch, 1998).

Water Use

The largest use of water in Oregon is irrigation. Irrigation accounts for 81% of Oregon water use, compared to municipal and domestic water use at approximately 6%. Approximately 12% is used by commercial and industrial entities (Bastasch, 1998). Water "use"[6] is often used as a proxy for water demand.[7] Future expectations of water demand are often calculated with information about population growth rates and industry growth.

One of the fastest growing industries in Oregon coastal communities is tourism. The Oregon Tourism Commission estimates that the direct economic impacts due to tourism have increased 42% between 1991 and 1997 and from $3.3 billion to $4.7 billion statewide. In addition, state and local tax receipts have increased 46% and 65% respectively from 1991 to 1997. The tourism industry is predicted to grow 3 to 4% annually (Oregon Tourism Commission, 1998), and this growth is an important factor in determining future water needs for coastal municipalities.

The growth of the fishing industry also will influence future water demand, but seafood processing water requirements are a major consideration for municipalities in determining future water needs. Uncertainty about future harvests makes prediction of water needs difficult.

Peak Demand

Natural low-flow conditions in the summer coincide with peak demand by residents, seafood processing plants, and tourists. Figure 1 shows the monthly trends in precipitation in inches, tourism in numbers of visitors, and thousands of pounds of shrimp landed in Oregon in 1997. Shrimp landings serve as a proxy for seafood processors' water needs. The greatest difference between precipitation and tourism occurs in July and August. Seafood processing needs are highest in May when precipitation is just beginning to decline.

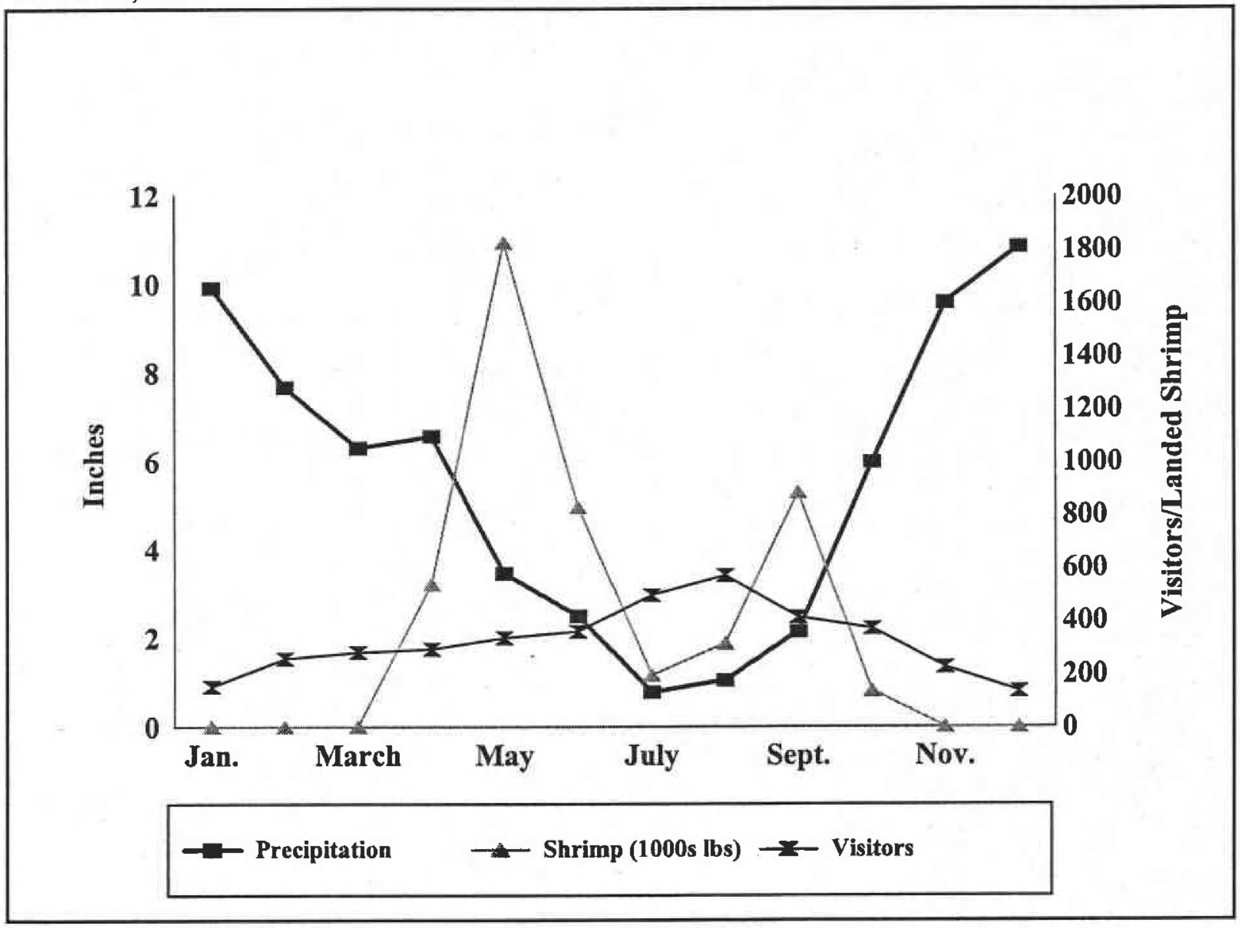
Seafood processing plant water needs are included because many coastal areas are home to seafood processing plants that can use large amounts of water. Shrimp processing, for example,

---

[6]Water use is the amount of water consumed.

[7]Water demand is the amount of water a consumer is willing to purchase at a given price.

Figure 1. Newport's Average Monthly Precipitation (1990-97), Shrimp Landings, and Tourist Visitation, 1997.



Note: Data provided by the Newport Chamber of Commerce, the Oregon Climate Service, and the Oregon Department of Fish & Wildlife.

requires up to 40 gallons of water to produce one pound of final product. Large quantities of water are used in rinsing and to produce steam used in peeling (Nielson, 1983; personal communication, Bill Shreiber).

Section IV: Case Studies

Newport

Water Rights

Newport currently has 14 water rights on several creeks, rivers and reservoirs including Big Creek, two reservoirs on Big Creek, Siletz River, Jeffries Creek, Blatner Creek, and Nye Creek (see Table 1). Newport's primary water source is Big Creek. The city has the earliest priority dates on water rights in Big Creek, amounting to 6.45 million gallons per day (MGD) from natural streamflow. Newport has several supplemental water sources. The primary supplemental water source is the Siletz River.[8] The City has water rights to 3.88 MGD from the Siletz River. Another supplemental water source used before implementation of the water pump in the Siletz is Jeffries Creek.[9] Newport has one water right for Jeffries Creek amounting to 0.26 MGD (WRIS database, 1998).

Newport has two reservoirs that store the raw water withdrawn from Big Creek. Both are located close to the Newport Water Filtration Plant located on Big Creek. Together they store 381 million gallons of water (MG). The smaller of the two, Big Creek Reservoir No. 1, has a capacity of approximately 65 million gallons. It might be phased out of use over the next 10 years due to warm water conditions in the summer months that contribute to growth of weeds and water quality problems[10] (personal communication, John Van Dyver).

---

[8]When the city pumped water from the Siletz three years ago they withdrew on average, nearly 2.1 million gallons per day. However, Newport has not needed to pump water from the Siletz in such large quantities for nearly two years. Due to pumping costs, the Siletz is a relatively expensive source compared to Big Creek.

[9]The most recent use of the Creek occurred for one month before water was first withdrawn from the Siletz River in the mid 1990s. Approximately 130,000 gallons were withdrawn per day (personal communication, John VanDyver).

[10]A kind of grass (*Brazilian Elodea* or *Egeria Densa*), commonly used in home aquaria, grows in abundance in the two reservoirs. The plant is a non-native species and has no natural predators. Newport has been able to rid the reservoirs of the plant only by emptying and dredging the reservoirs, an expensive process that increases turbidity. This makes the water difficult to clean. Without dredging, the plant will continue to degrade water quality by decreasing the

Reservoirs are useful because they can be refilled during periods of high supply (rainfall) and low demand. This ensures equalizing storage for the next day. Equalizing storage is the water needed to make up the difference between the supply rate and water used. Once the water is treated, four smaller reservoirs are used to store the water. Collectively, these four reservoirs hold 4 MG (CH2M Hill, Inc., 1988).

Table 1. Newport's Water Rights.

Water Resource	Priority Date	MGD
Big Creek	1926	6.45
Siletz River	1963	3.88
Jeffries Creek	1968	0.26
Nye Creek	1923	0.45
Blatner Creek	1909	0.35

Note: Data compiled from WRIS database.

Water Use

The economy of Newport is comprised of approximately 12% manufacturing, 22% retail, 21% service, and 21% government entities (CH2M Hill, Inc., 1990). Water consumption varies by industry. Industry, commercial business, government, and domestic users collectively use on average 2.20 MG of water per day. Records of water use in Newport are categorized by numerous industry and residential classifications, water meter size, and geographical location.

Table 2 compares water consumption and cost for several classifications in 1994 and 1997. In 1994, the largest water users were the "Fish Plants." The second-largest users were "Single Family Dwellings." In 1997, that was reversed as water consumption by single family dwellings increased by about 3% and consumption by the seafood processing plants decreased by

---

oxygen content in the water. This creates pockets of stale water and large amounts of decaying matter, which affects taste and odor. The plant has created the need for additional monitoring and testing (personal communication, John VanDyver).

approximately 7%. This is probably due to population growth and lower fish and shrimp landings. "Public-Institutional" and "Retail and Service" classifications have been the third-largest users, followed closely by "Apartments" and "Motels."

Community Objectives

A community's goals and objectives are often reflected in a city's water rates and rules governing water use among different groups during water shortages. According to the City of Newport Water System Master Plan,[11] the City's goal is to provide a water system that can satisfy the water needs of all users. However, during periods of drought when water conservation might be necessary, sanitation and public health are given highest priority. For situations when demand is high and supply is low, the seafood processing plants have been the first to encounter limitations on supply. Residential use is a priority during droughts (personal communication, Sam Sasaki).

The structure of the water rate pricing system also indicates the distributional priorities of a community. The water rate structure in Newport demonstrates that its seafood processing plants have lower water rates than its residential users. For example, Table 2 lists some general industry and residential classifications[12]. For each classification, total annual amounts billed in dollars and total annual water consumption in thousands of gallons are listed respectively in the first two columns labeled "Billed" and "Consumed." The next two columns list the amount a specified classification is charged by the city as a percentage of total revenue from water bills

[11]The Water System Master Plan contains information about current water system infrastructure and water supplies as well as recommendations for future water system needs. These include suggestions for attainment of additional water supplies, installation of new pump stations, piping, other infrastructure, and improvements on existing infrastructure. The Water System Master Plan typically outlines water needs over a five-year period. According to the Newport Water System Master Plan, an adequate and reliable water system is one that can satisfy all of the water demands of the various users under normal and predictable daily and seasonal patterns of use and, at the same time, has sufficient ability for firefighting and other emergency situations throughout the total service area (CH2M Hill, Inc., 1988).

[12]More rate sub-classification exist than are listed here. Those listed, except "Fish Plants," receive both water and sewer services. All listed classifications are located within city limits.

Table 2. Comparison Between 1994 and 1997 Amounts Billed and Consumed Water among Different Rate Classifications.

1994		Billed	Consumed (thousands of gallons)	% Billed	% Consumed
Fish Plants		$135,557.58	176,972	17.87%	27.11%
Single Family		$312,170.06	173,484	41.15%	26.57%
Public-Institutional		$55,657.25	62,490	7.34%	9.57%
Retail & Service		$73,373.96	60,166	9.67%	9.22%
Motels		$43,585.82	48,472	5.75%	7.42%
Apartments		$42,719.81	43,352	5.63%	6.64%
RV Parks		$23,839.75	27,630	3.14%	4.23%
Multiple Dwelling		$37,482.11	27,311	4.94%	4.18%
Restaurants		$25,393.85	26,453	3.35%	4.05%
Non-Water Process		$2,214.75	2,152	0.29%	0.33%
Residential		$3,520.84	1,625	0.46%	0.25%
Municipal		$0.00	1,252	0.00%	0.19%
Commercial		$2,391.14	1,033	0.32%	0.16%
Res-Comm		$744.13	432	0.10%	0.07%
Total		$758,651.05	652,824	100.00%	100.00%

1997		Billed	Consumed (thousands of gallons	%Billed	%Consumed
Single Family		$327,723.17	188,522	43.33%	29.63%
Fish Plants		$102,117.75	132,088	13.50%	20.76%
Retail & Service		$71,034.00	59,416	9.39%	9.34%
Apartments		$50,765.05	53,245	6.71%	8.37%
Public-Institutional		$48,939.43	52,974	6.47%	8.33%
Motels		$44,264.41	49,612	5.85%	7.80%
Restaurants		$25,851.60	27,108	3.42%	4.26%
Multiple Dwelling		$35,993.93	25,736	4.76%	4.05%
RV Parks		$21,071.92	23,912	2.79%	3.76%
Commercial		$13,016.59	10,761	1.72%	1.69%
Residential		$11,769.70	7,801	1.56%	1.23%
Non-Water Process		$3,136.43	3,270	0.41%	0.51%
Municipal		$0.00	1,368	0.00%	0.22%
Res-Comm		$730.00	422	0.10%	0.07%
Total		$756,414.66	636,235	100.00%	100.00%

Note: Data provided by the Newport City Hall Finance Department.

and the amount of water consumed by the specified classification as a percentage of total water consumption in Newport. These are listed respectively as "% Billed" and "% Consumed."

"Single Family Dwellings," "Residential," "Multiple Dwellings," and "Residential-Community" classifications all contributed a greater percentage to total revenue than they consumed. The greatest differences existed among "Fish Plants" and "Single Family Dwellings." While fish plants consumed between approximately 27% and 21% of the water in Newport for 1994 and 1997 respectively, they paid approximately 14% and 18% respectively for those years. While single family homes consumed approximately 27% and 30% of water in Newport respectively for 1994 and 1997, they paid for 41% and 43%. In general, residential water rates are higher than those for the fish plants on an average use basis. However, if a residential user consumed as much water as a seafood processing plant, then the per 1,000 gallons charge to the residential consumer would be less than the per 1,000 gallon charge to a seafood processing plant.

The use of reduced water rates for industry is not unusual in Oregon.[13] Of 27 utilities within the Portland metropolitan region, only four water providers used increasing block rates in 1998. One used a uniform rate. Of 11 utilities surveyed outside the Portland region, only Corvallis used an increasing block rate for their commercial and industrial customers. Hillsboro, Forest Grove, Eugene, and La Grande all have water rate structures that charge less per unit as more water is used (OEC, 1998).

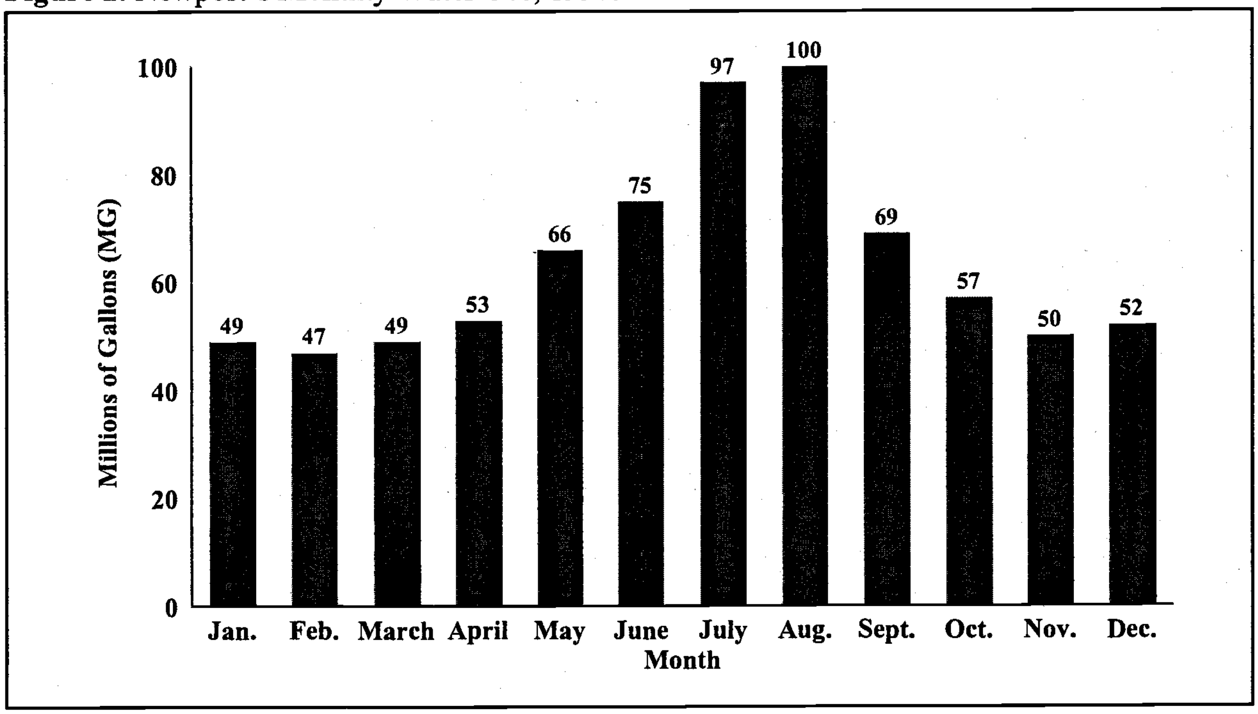
Charging residential customers more than industrial users is uncommon but does occur elsewhere in Oregon. In Forest Grove, the rate structures is designed such that commercial rates are less than residential rates and industrial rates are less than commercial rates (OEC, 1998). In Garibaldi, industry rates are higher than residential rates. According to at least one study, many utilities in Oregon charge the same rates to industrial customers as they do to residential customers (OEC, 1998).

---

[13]Decreasing water rates for industry are often implemented for the same reasons given for the existence of decreasing water rates for seafood processing firms. Reasons for this are discussed later in this section.

Newport's current rate schedule, shown in the next subsection, was developed at a time when fish plants were expanding and plentiful water supplies enabled the City to charge relatively low rates to fish plants. Fish plants provided steady employment for many Newport residents. The low cost of water was intended to enable the fish plants to remain competitive with other communities with fish processing plants. At that time, the fish plants were considered a major economic engine that provided jobs and local income. The rates were based on those outlined by the American Water Works Association[14] (personal communication, Don Davis).

Figure 2. Newport's Monthly Water Use, 1997.



Note: Data provided by the Newport Water Department.

[14]The American Water Works Association (AWWA) is an international nonprofit scientific and educational society dedicated to the improvement of drinking water quality and supply.

Seasonal Water Use

Newport's water use varies with the seasons. Figure 2 shows Newport's monthly water use in 1997.[15] During the months of December through April, Newport pumped, on average, 50 MG of water per month. By July and August, approximately 100 MG were used monthly. In September, water use had declined to almost 70 MG (see Figure 2). High summer use creates the potential for inadequate supplies of water during dry years.

Water Rates

Water use can be significantly influenced by water rates, depending on the rate structure. Water rates in Newport vary by classification. Table 3 provides information on water rates for three different classifications. The amount of water a business, home, or other entity uses is measured by a water meter. All water users in Newport are required to have water meters. All consumers with water meters are charged for water use except those classified as "Municipal" entities. Newport currently charges for water by means of a base rate and a volumetric rate.[16] Both rates are dependent upon one's classification. Newport's water rates are structured in decreasing blocks; that is, the marginal price of water decreases as water use increases.

The rate is multiplied by the amount of water used each month. This is measured by a water meter. Residential dwellings with a 3/4-inch meter, for example, are charged a base rate of $5.80 for the first 1,000 gallons of water used and a rate of $1.10 for every 1,000 gallons used up to 40,000 gallons. Approximately $0.85 per 1,000 gallons is charged for any amount over 40,000 gallons (see Table 3).

[15]1997 has been noted as a typical year for water use (personal communication, John VanDyver).

[16]In Newport, water rates do not cover the total cost of supplying water; property taxes are also used to cover costs.

Table 3. Newport Water Rates for Selected Classifications, August 2000.

	Base Amount		**2nd Block**		**3rd Block**	
Classification	*Range (gallons)*	*Rate (dollars)*	*Range (gallons)*	*Rate (dollars)*	*Range (gallons)*	*Rate (dollars)*
Single Family Dwellings	up to 1,000	$5.80	1,000 - 40,000	$1.10 per 1,000	40,000+	$0.85 per 1,000
Public-Institutional	up to 23,000	$30.05	23,000 - 41,000	$1.10 per 1,000	41,000+	$0.85 per 1,000
Fish Plants	up to 41,000	$49.90	41,000+	$0.85 per 1,000	na	na

Note: Information provided by the Newport City Hall Finance Department.

Over the past two years, water and sewer rates[17] in Newport have been raised by 10%. This involved a 5% increase in July 1998 and a 5% increase in August 1999 across all classifications for both base and volumetric rates. Another 5% increase will occur in the coming year (Lee Ritzman, personal communication). While increases in water rates were necessary to continue maintenance and upkeep, the sewer rates were raised to help pay for the "establishment, operation, and maintenance of a complete sewer system and disposal plant, both within and without the City of Newport" (Resolution establishing sewer service fees, 1998). Previous to the recent rate changes, Newport's last water rate increase occurred in September of 1989.[18]

---

[17]The increase in sewer rates is helping to pay for a new sewer system. A new sewer system is necessary and is required by the Oregon Department of Environmental Quality in accordance with a Mutual Agreement and Order (MAO). The MAO was developed for Newport in response to a water discharge permit violation. Newport discharges their waste water about 1800 feet out in the ocean. The discharged water had high Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) levels. Newport was given a Notice Permit Violation (NPV) and was required to respond to the NPV by decreasing the BOD and TSS levels. When this did not occur, the city was required to pay fines to the state and was issued an MAO and required to adhere to a compliance schedule. One of the requirements in the MAO is the construction of a sewer plant. The city was required to procure draft plans for this sewer system no later than January 1, 2000 (personal communication, Mark Hamlin). To pay for the plant, Newport residents voted on a bond to fund the project in November 1998.

[18]Many coastal municipalities have recently raised their water rates to comply with government regulations and to pay for system maintenance. Warrenton residents experienced a

Estimating Future Demand

Newport's future acquisition of new water rights and water system developments will be based on future expected water demand and whether current supplies are sufficient to meet those demands. Presently, Newport's water rights exceed its current water use. Newport's recent annual water use trends are depicted in Figure 2. It would appear that Newport's water rights on Big Creek, its primary water source, exceed its present water use and that no short term future planning for additional water supplies are necessary.

The information used to determine water right allocations however, is based on "rough" approximations. Furthermore, accurate predictions of future demand cannot be based simply on extrapolations of current trends. Future demand will also depend on expected population and industry growth as well as other factors. Therefore, information presently used to represent water supply (water rights) and water demand (current water use) is inadequate. Because water rights do not accurately represent water availability, and because future seafood production levels, population, and industry growth are difficult to forecast, prediction of future water needs are rough approximations at best.

Indicators of Water Availability

Water rights are often used as an indicator of water supply or water availability. However, in the past, Newport has withdrawn all of Big Creek's natural streamflow without exceeding its water rights on the creek. A "Water right" is not necessarily an accurate proxy for "water availability"; however, it is the best proxy available.

33% increase in their water rates in September 1999. The three seafood processing facilities in Warrenton have seen a 21% base rate increase over the past three years. Tier rate increases ranged from 68 to 141% depending on the tier. More rate increases are expected in the near future. The purpose of the water rate increase in Warrenton is to fund a water treatment plant that will bring the town into compliance with the Clean Water Act. Toledo is another coastal town experiencing increases in water rates. The town has raised its water rates by $0.10 annually for several years now. Toledo is conducting a study to evaluate further water rate increases to cover the cost of several projects, including construction of a new treated water storage reservoir.

Assessments of water availability are based on gauge readings on rivers that have monitored river levels. On streams without streamflow gauges, a statistical regression analysis is conducted. Regression analysis of this sort involves more than 20 variables including precipitation rates and variables describing the physical features of the stream. Without a water gauge on the stream, this statistical based prediction technique is determined to be the next best alternative by the OWRD. Big Creek is not monitored by a water gauge.

Water rights on Big Creek have been determined at a 50% exceedance level compared to an 80% exceedance level standard used currently. That is, the amount of a water right issued indicates that the amount is available approximately 50% of the time. This standard was adopted to account for variations in streamflow. Therefore, the amounts issued on Newport's water right for Big Creek (as shown in Table 1) do not indicate the amount of water consistently available for withdrawal, but rather the amount available 50% of the month. Thus, amounts of water awarded through water rights cannot be used with accuracy as indicators of water supply without knowledge of the exceedance level, particularly during summer low flows.

Another factor in estimating water availability is climate change. Some believe that increasing concentration of greenhouse gases are warming the earth's surface and changing its climate. One plausible climate scenario indicates warmer, wetter winters and warmer, drier summers for the Pacific Northwest. Precipitation would increase during the winter and decrease during the summer. Climate change also might result in an increase in the intensity of precipitation (Snover, 1997). Decreases in precipitation during the summer months could result in an increase in water supply shortages.

Factors Involved in Prediction of Water Demand

Determining future water demand in Water Systems Master Plans traditionally has been assessed by studying social and economic factors affecting water use. These factors could include population growth, land use, housing occupancy, property uses, changes in community and family character, resource conservation, economic conditions locally and nationally, and the water use habits of the community's residents. Water needs assessments are sometimes made primarily through calculating expected population growth. These expectations are based on past increases in a municipality's population, and sometimes the past growth of commercial and industrial entities.

Seafood processing is a large industry in Newport. When determining future water needs, a major problem is the uncertainty of future growth of the seafood industry. One particular problem is determining shrimp landings. Shrimp production involves high water use. Figure 3 shows the variability of shrimp landings in Oregon. Peak landings occurred in 1978, 1987, 1989, and 1992, indicating a relatively high water need during those years. Currently, shrimp landings are declining. However, if past trends continue, one can expect large variability in landings. If harvest levels continue to decline, the need to secure new water resources for the future will decline. But if harvest levels rebound, the City will need to supply more water than is currently provided to meet demand. This could involve securing new supplies of water from current supplemental sources or additional sources. Alternatively, based on availability, demand management could be used to meet consumer demand without additional water supplies.[19]

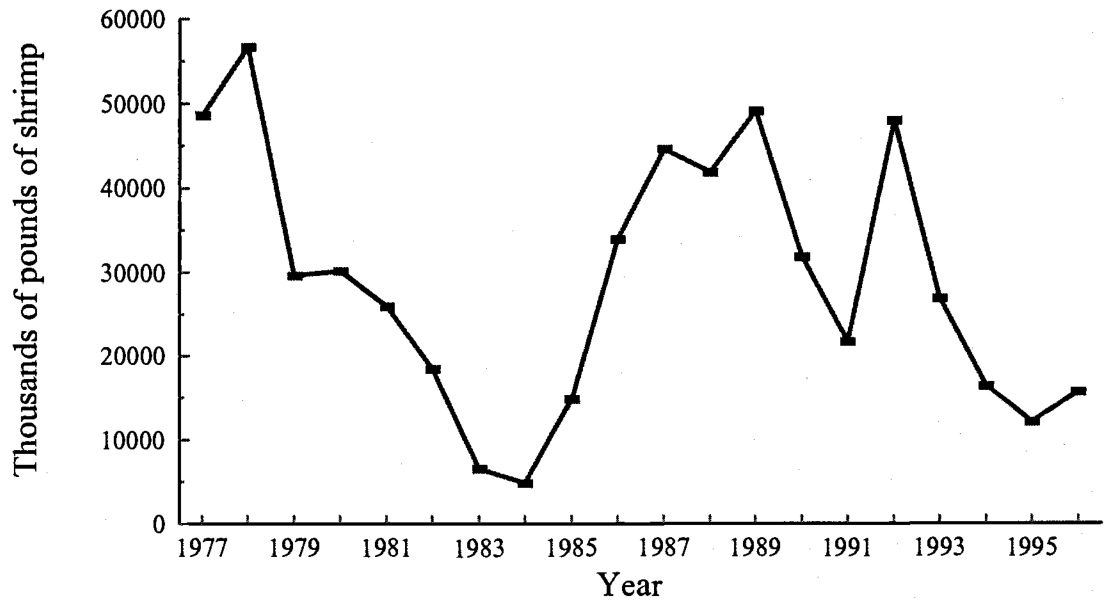
---

[19]In the past, Newport has experienced shortages in water supply from their primary water source. In 1992, before the addition of the Siletz River as a supplemental water source, Newport faced a drought year. Several measures were taken to decrease water use. One measure applied to the five seafood processing plants. The seafood processing plants were given a total consumptive water quota which they divided among themselves. At the time, they were collectively consuming approximately 2.8 to 3 million gallons per day, but were given a 2 million gallon quota during the shortage.

Residents were encouraged not to wash their cars or water their grass. Gray water use - or water re-use - was not unusual and people called the city with complaints about excessive use by their neighbors. In addition to encouraging conservation of water, the City received a grant through the Water Conservation Program and Bonneville Power Administration for purchase of flow regulators for use in showers and other home and hotel/motel water uses. The City distributed the devices free of charge and helped individuals to install them (personal communication, Sam Sasaki).

Since 1992, water has become less scarce in Newport as a result of two developments. First, the City developed two major projects to increase their raw water supply. A pump and piping was installed from the Siletz River and a silt-removal project was completed for Big Creek reservoir No. 1 (CH2M Hill, Inc., 1990). The silt removal project increased the amount of water the reservoir could hold and therefore increased the amount of time the City could go without resorting to supplemental water sources. Second, fish production off the Oregon coast has declined, causing seafood processors' water needs to decline. Some of the decrease can be observed in the change in Fish Plant consumption from 1994 to 1997 in Table 2 above.

Figure 3. Shrimp Landings in Oregon, 1977-1996.



Note: Data provided by the Oregon Department of Fish and Wildlife.

However, if the City secures a sufficient water supply and the fish processing plants substantially decrease production due to declining fish stocks, the City will have difficulty covering the fixed costs associated with the new water system improvements. This problem is a major concern now that overall fish stocks are declining (personal communication, Sam Sasaki).

Some advances in technology tailored to shrimp production can decrease current water use. A Waste Water Management System has been designed by the Latram Corporation. Two systems can be used in conjunction with shrimp peelers: one filters out waste from production; the other filters waste and then recirculates and reuses water. The system has water use savings of 70 to 80%, depending on the amount of fresh water added during recirculation (personal communication, Bill Caten). In addition, a low water use shrimp peeler is currently undergoing experimentation. These options, if used, could decrease water use in Newport during the summer months. However, incentives might be necessary to induce seafood processors to implement the devices.

Tourism, another large industry in Newport, continues to grow. The most widely accepted measure of growth in the tourism industry is derived from lodging tax receipts. Transient lodging taxes[20] are one of the most direct means for counties to collect revenues from visitors. Tax receipts are useful in measuring the sales to visitors across the state. Because room sales to residents are limited, most of these sales are made by visitors. Therefore, lodging can be considered a relatively "pure" travel commodity and transient lodging tax receipts provide a basis for analyzing the distribution of travel-related economic activity within the state (Dean Runyan Associates, 1997). From fiscal year 1994/95 to 1996/97, Lincoln County tax receipts increased 26% (from $3,483,376 to $4,378,275) and lodging tax receipts increased 49% (from $920,119 to $1,374,456) (Dean Runyan Associates, 1997).

While Newport's fish plants have decreased their recent water use, the city's tourism industry appears to have increased its water use slightly. Motels/hotels and other businesses that support the tourism industry (such as restaurants, RV parks, and retail and service businesses) have all increased their water use slightly since 1994 (Table 2).

The remainder of the "Estimating Future Demand" section estimates future water needs in a "best" and "worst" case scenario with simple calculations incorporating variations in population growth rates.[21] A "best" case scenario examines the effects on demand of a relatively smaller population growth rate than in a "worst" case scenario; that is, a "best" case scenario assumes relatively less change in water demand.

---

[20]"During fiscal year 1996/97, 80 cities and 14 counties in Oregon levied a locally administered transient lodging tax. This tax, ranging from 3% to approximately 10%, is collected on the "sale" (rental) of a room or campsite at a lodging establishment such as a hotel, motel, bed and breakfast, or campground. Transient lodging taxes also are collected in some jurisdictions on the rental of vacation homes" (Oregon Tourism Commission, 1997).

[21]Because future water use is influenced by several indeterminable factors, we do not profess that the estimates calculated here are accurate predictions of future water needs. The results simply provide approximations produced by one method of estimation. More sophisticated methods of estimation are likely to provide more accurate predictions because they incorporate more information into the forecast.

Many studies use an increasing per capita use of water[22] whereas the estimates made here use a constant per capita use of water. Average per capita water use in Newport is 220 gallons per day. However, average Oregon residential per capita water use is approximately 104 gallons per day (Bastasch, 1998). Much of the per capita use is due to high industry use. Increasing per capita water use assumes that water use will increase over time on a per capita basis. The increase could result from either domestic or industry use or both. Constant per capita use assumes that there is no change in per capita use. Therefore, if population increases, in order to keep per capita water use constant, growth must occur in total industry water use where "industry" refers to non-residential use. One also may assume that "the probable increased per capita use in rural area development will be offset by a corresponding conservation effort in high use areas, especially during the water short years, which are used to determine future needs" (Fuller and Morris, 1998).

Newport's Future Water Demand

As noted above, population growth is often the primary variable used to assess the future demand for water. Population growth is used in the following forecasts, which are approximations of future total water demand given constant per capita water use. The per capita water use estimate will be based on summer use to produce an estimated demand for maximum use. Therefore, total water use in June, July, and August is divided by 90 and then divided again by population. This yields a per capita water use of 302 gallons per day during summer months.

Newport's population has fluctuated between 8,800 and 10,000 people. Although population growth has been much greater in the past 40 years, an assessment in 1988 found that the city had grown only about 2.0% annually over the past 20 years (CH2M Hill, Inc, 1990). Portland State University estimated a lower growth rate of 1.3% for the period 1990 to 2010 (CH2M Hill, Inc., 1990). The 2.0% growth rate will be used to assess a "worst" case scenario. The 1.3% growth rate will be used to assess a "best" case scenario.

---

[22]Per capita use of water, unless otherwise stated, is total annual water use divided by population and then divided by 365. This is also called gallons per capita per day (gcd).

Table 4 shows the estimated expected future needs for Newport in 2000 to 2050 in 10-year increments in a "worst" case scenario. Table 5 shows estimated expected future needs in a "best" case scenario. Estimates were made by multiplying population by per capita water use.

According to the "worst" case scenario estimates, by the year 2020 summer needs will be 55% greater than summer use in 1998. By the year 2050, Newport will have almost exceeded its water rights on Big Creek and the Siletz River. Shortages will probably occur before that time due to low flows during the summer months. According to the "best" case scenario, Newport probably will have to rely substantially on the Siletz River for supplemental water. Without additional water supplies, in both scenarios summer shortages will be much more common by 2050 than they are now.

Table 4. Newport's "Worst" Case Scenario.*

Year	Population	Millions of Gallons per Day (MGD)	Water Rights**	Difference
2000	10,404	3.14	10.6	7.46
2010	12,682	3.83	10.6	6.77
2020	15,460	4.67	10.6	5.93
2030	18,845	5.69	10.6	4.91
2040	22,972	6.94	10.6	3.66
2050	28,003	8.46	10.6	2.14

*Estimates use a 2.0% growth rate and 302 gcd.
**Includes rights to Big Creek, Siletz River, and Jeffries Creek.

Future Plans

According to a study titled "Long-Range Water Supply - A Study of Newport's Water Supply and the Potential for Future Regionalization of Water Supplies" completed in 1997 by consultants Fuller & Morris for the City of Newport, projected growth estimates indicate the need for additional water storage by 2030. The reason for urgency in finding and developing a water storage site is attributed to the dwindling number of available site locations for this type of project (Fuller and Morris, 1998).

Table 5. Newport's "Best" Case Scenario.*

Year	Population	Millions of Gallons per Day (MGD)	Water Rights	Difference
2000	10,262	3.10	10.6	7.50
2010	11,677	3.53	10.6	7.07
2020	13,286	4.01	10.6	6.59
2030	15,118	4.57	10.6	6.03
2040	17,203	5.20	10.6	5.40
2050	19,575	5.91	10.6	4.69

*Estimates use a 1.3% growth rate and 302 gcd.

Rocky Creek as a Regional Water Supply

Rocky Creek, located north of Otter Crest, is among three sites that could potentially meet Newport's future water needs as assessed by Fuller and Morris. When Highway 101 was constructed in 1952, the creek was channeled into a culvert and directed under the road to a 30-foot drop to the ocean eliminating any possibility for fish passage.

Besides its potential as a water source, Rocky Creek also might provide potential salmon habitat. The Oregon Department of Fish & Wildlife (ODF&W) named Rocky Creek as a high priority for restoration by the Oregon Department of Transportation (ODOT). The cost involved in restoration has been estimated at over $1 million (Sue Chase, personal communication). ODOT's decision of whether or not to implement a restoration project for Rocky Creek has been postponed until the state decides whether the site is permissible as a water supply (Jim Fuller, personal communication).

In 1997 and 1998, Newport met with groups concerned about the use of Rocky Creek as a water source (personal communication, Greg Nelson). Since then, Lincoln City has entered into a partnership with Newport in planning the development of Rocky Creek as a potential regional water supply. All other water providers in Lincoln County have expressed interest in the project and passed resolutions in support of development of Rocky Creek (Jim Fuller, personal communication).

According to the study conducted by Fuller and Morris, Rocky Creek has potential as a water supply for the region extending from Lincoln City to Waldport. Several potential benefits exist for developing regional supplies. A new regional supply could reduce use of other sources of water. It is possible that participating towns could modify or give up some of their water rights. In addition, it is recognized that there are "fish" habitat needs and there are domestic needs for water. These two needs clash, and Rocky Creek could provide a means for mitigation. Potential for decreasing pressure on other streams is the "negotiating and mitigating factor that brings everybody to the table" (personal communication, Sam Sasaki).

Another potential significant benefit of the project is the distribution of fixed costs over a larger amount of people than would be possible were the project funded by Newport alone. The idea is consistent with state objectives. OWRD would like to find ways to encourage entities to consolidate water supplies. However, communities often want control over their own water supply and are unlikely to relinquish that control to another entity (personal communication, Greg Nelson).

The possibilities for development of a regional supply have been considered for a long time. The idea is popular among Newport leaders and the City Council. The City feels that the technology is there and that the plan could solve Newport's water supply issues well into the next century. However, completion of the project is decades away and many considerations and obstacles must be overcome. First, the possibility of building a dam must be assessed. According to state water law, all dams must have fish passage. However, providing for fish passage means decreased potential storage capacity because the water level must be kept high.

Second, the water right permit, although applied for, needs to be obtained. Third, an Environmental Impact Statement must be completed. Fourth, transport must be planned. For example, Cape Foulweather lies between Newport and the proposed reservoir. Transportation of the water from the reservoir will have to go through, over, or around the hill to either arrive at Newport or connect to the Siletz. Fifth, an entity that will control and manage the reservoir must be selected. Sixth, it is unknown whether the project would require a regional water treatment facility. For example, the water could be treated either near the raw water source or at each individual destination (personal communication, Mike Schoberg).

The cost of the project is approximated at $40 million (personal communication, Sam Sasaki). Funding sources for the project could include municipal bonds, higher water rates, federal or state grants, and/or loans. Federal or state assistance might be possible since construction of the reservoir could decrease water withdrawals from rivers with anadromous fish.

Conservation is currently not a priority for the city. Since 1992, conservation of water has become standard practice with the continued use of flow restrictors by Newport residents and the tourist sector (e.g. motels/hotels). How much water has been conserved is unknown since some individuals probably stopped using the flow restrictors after the drought. However, emergency restrictions implemented in 1992 increased citizen awareness of water as a limited resource (personal communication, Sam Sasaki). In addition, certain practices implemented to conserve water in 1992, such as pressure controls on hoses in Newport fish plants, also have become common practice according to one processor.[23] The City began pressuring fish plants to implement more significant water conservation in 1992, but most conservation methods were not implemented due to the increase in water availability and declining supplies of fish and shrimp processed by the plants (personal communication, Sam Sasaki).

Conservation[24]

If Newport is awarded a water right for Rocky Creek, the city will be required to submit a *Management and Conservation Plan* with a conservation element. Conservation probably would

---

[23]Other seafood processors located along the Oregon coast have taken similar steps. A processing plant in Warrenton has reduced water flows in some of its operations, such as a filleting line, by 70%. They also have placed disconnectors on water nozzles, collected solids before spraying during cleanup, and used de-icing tanks instead of water spray. Although this has helped defray some costs, most of the costs are unavoidable because the equipment and processes required to produce surimi and process shrimp are water intensive. Another facility in the Warrenton area has taken similar action and is considering implementing a water-reclamation system for use in some of its operations. For both facilities, the increase in the cost of water is considered a major problem.

[24]Use of the term "conservation" in this paper refers to "practices, techniques, and technologies that improve the efficiency of water use" (AWWA, 1999). This includes, but is not limited to, increasing and seasonal water rate pricing structures, metering, auditing of water use, reduction of transmission and distribution leaks, education, toilet retrofits, and faucet and showerhead replacement by low flow devices.

be insufficient to meet Newport's long term water needs, because those needs might be greater than conservation methods would supply. However, in many cities, conservation has been used successfully to reduce peak demand and as an interim water supply during periods of transition when municipal population is growing but before access to a new water supply is available. (Examples of successful endeavors of this kind are summarized in Section V under the subheading "Successful Conservation Programs.") In most cases, conservation is only part of a larger management plan that often includes efficiency improvements, among other supply management techniques. Depending on municipal characteristics, supply side management can be more cost-effective than demand management techniques such as conservation. Conservation also might have disincentives associated with it that prevent municipalities from considering this management option.

If the city implemented additional water conservation measures and techniques (or steps taken to increase efficiency), water use would decline given no other changes in the system such as population growth or water system expansion. A decrease in water use would generate less revenue for the City due to decreasing water bills. Consequently, the City would have relatively less money to cover fixed and variable costs. The City has fixed costs in the form of bond payments, infrastructure maintenance, and "lumpy" variable costs. Variable costs would include expenses on new projects and non-essential labor costs. Rates would have to be increased to cover the lost revenue. Increases would compel consumers to use less water and further decrease revenues. Like many municipalities state and nationwide, the City is in a difficult situation: although in the long run conservation is the "correct" thing to do, in the short run, it sometimes is "politically" difficult, expensive to implement, and can increase instability in revenue (personal communication, Sam Sasaki). This cycle of events is called the "Conservation Paradox".[25] The subject is explored further in Section V.

[25]The authors use the term "Conservation Paradox" to describe the problem stated above. The problem is common and is encountered by all municipalities that consider either changing to a conservation rate structure or implementing conservation measures. The ubiquitous nature of the problem has created a substantial amount of literature to help municipalities overcome the difficulties described. Section V refers to some of these sources.

Fish processing plants also have little incentive to implement water saving devices and techniques, but for different reasons. Similar to the situation with the water supplier, implementation of some water conservation devices and techniques requires substantial fixed costs. These can be recovered through reduced water bills. However, this will decrease the processors' historical use of water. Future City plans for the water system will determine needs according to current and future expected water use levels. Future expected water use levels could underestimate seafood processors' water needs if they do not account for the uncertainty associated with shrimp and other harvestable species' production cycles. These are difficult to predict year to year. Therefore, if future water needs projections fail to account for the water needs of processors during years when production is high, fish processors could find themselves with too little water. As a result, seafood processors have less incentive to conserve water during periods of relatively low harvests.

A city's primary concerns are providing all users with a reliable supply of water and collecting enough revenue to cover loans on bonds and operation costs. By definition, conservation, reduces water use. Without rate increases, revenues decrease. Therefore, cities will not conserve unless these problems are resolved. Similarly, seafood processing plants - and perhaps other large water users with variable water use - also resist conservation without appropriate incentives. This hindrance to conservation is explored in Section V.[26]

Port Orford

Water Rights

Port Orford has three water rights. These include a water right on Port Orford's primary water source of the north fork of Hubbard Creek (0.81 MGD), Garrison Lake (1.65 MGD),[27] and Gold Run River (0.75 MGD) (WRIS database). In addition, there is a raw water reservoir of unknown

---

[26]Similar to the disincentive associated with conservation, little incentive also might exist to implement supply side management options such as increasing water efficiency through leak repair, since these measures do not increase city revenue. This is a chronic problem associated with many government-run entities.

[27]Garrison Lake has been unusable as a water source since 1999 when winter storms brought large amounts of salt water into the lake.

capacity located on Hubbard Creek (personal communication, Jerry McNurlin). There are two treated water concrete reservoirs with the capacity of 1.0 and 0.2 MGD (HGE Inc. Engineers and Planners, 1995).

Community Objectives

Port Orford's primary objective with respect to water is to implement a protection plan for the Hubbard Creek watershed by: 1) restoring eroded riverbanks in conjunction with the South Coast Watershed Council; 2) making land purchases; and 3) securing land easements. Port Orford is interested in working with landowners within the Hubbard Creek watershed to protect the watershed from possible effects of new upstream development. Those living on the newly developed land will draw water from wells and use septic tanks which could threaten the quantity and quality of water available for withdrawal from the Hubbard Creek reservoir.

A secondary objective is finding new raw water sources (Martha Weaver and Johnny Alexander, personal communication). Finding new raw water sources is important because of concern about the reliability of the current primary water sources and the inability to use Garrison Lake, the former supplemental water source.

Primary water problems in Port Orford include: 1) concerns about the future water quality from Hubbard Creek; 2) lack of a supplemental water source; and 3) inadequate storage capacity. It has been 10 years since the creek reservoir was dredged. Increasing silt buildup from road construction has reduced pond storage capacity. At the end of the summer, the reservoir or pond on Hubbard Creek usually is drawn down to unacceptably low levels (HGE Inc. Engineers and Planners, 1995). When this occurred in the past, Port Orford relied on Garrison Lake for water. Besides a taste, odor, and turbidity problem resulting from algae blooms in the lake during the summer and fall months, some Garrison Lake residents had septic tanks - a potential danger to lake water quality. The lake was also used by motor boats and other water vehicles, which polluted the water with motor oil. Efforts to limit motor boat use had faced stiff opposition due to the high property values associated with lakefront water use.

Garrison Lake is located between the ocean and Highway 101. Several years ago, a drain field was placed in the sand dunes between the lake and the ocean. Three years ago, El Nino was blamed for erosion that washed away the drain field and brought logs, sand, and salt into the north end of Garrison Lake. Presently, Port Orford is allowed to pump treated effluent into the ocean under a DEQ permit. There is not enough land to rebuild the drain field and there is strong citizen opposition to this proposal. In addition to damage from winter storms, there were fears that an earthquake could cause the lake to drain or become contaminated from highway runoff near a corner of the lake. In one location, the lake and the ocean were separated by only 25 feet of land. Because the lake is only 11 feet above sea level, it was in danger of draining into the ocean. Recent saltwater intrusion into the lake due to storms has caused Port Orford to stop pumping from it (personal communication, Jerry McNurlin).

Besides finding a new water source, other recent objectives have been: 1) making water more affordable for consumers; 2) increasing water use; and 3) restructuring the billing cycle. Water and sewer billing every two months causes hardship for some residents of Port Orford with lower incomes. The possibility of subsidizing water rates for low income residents has being explored in the past. However, the costs associated with a subsidy program would include personnel to evaluate, monitor, and re-evaluate individual needs (personal communication, Jim Polen).

Another objective has been to encourage water use in the city. Many individuals do not water their lawns during the summer due to high water rates. Consequently, the city has a "brown" appearance. Encouraging residents to water their lawns and making it affordable for them to do so would improve the physical appearance of the city and make the city more appealing to tourists (personal communication, Jim Polen).

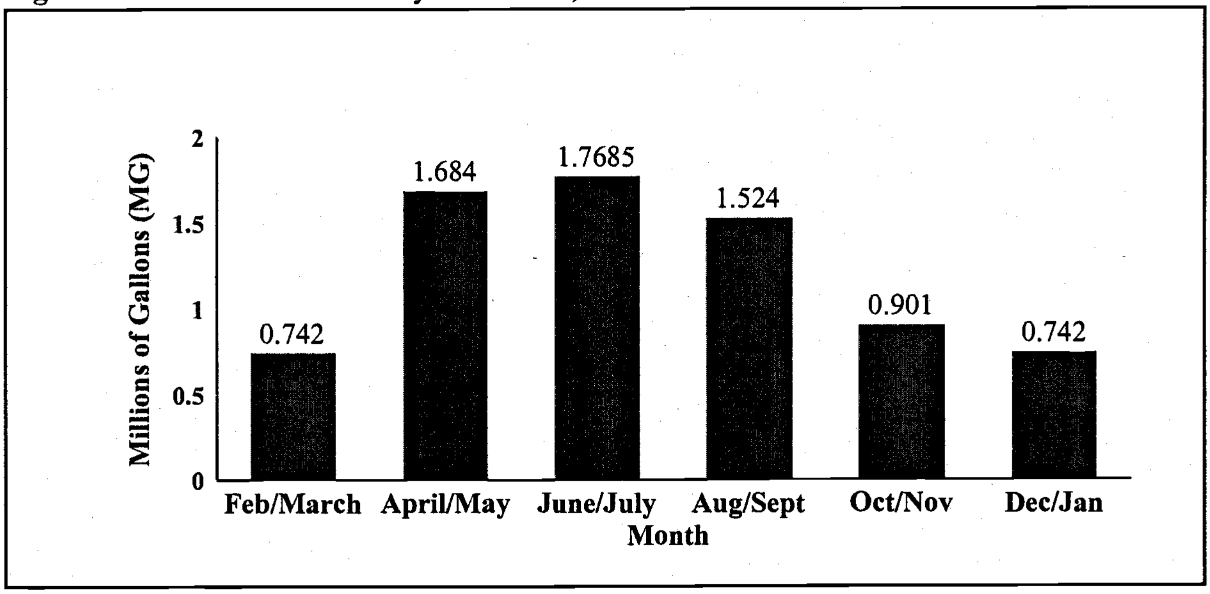
The third recent objective has been to make the billing cycle monthly instead of bimonthly. This objective, which is contingent on the capabilities of the City's existing computer system, would result in three benefits. First, it would increase the efficiency of water use, because leaks are discovered primarily through examination of water bills. Second, it is easier for people to pay their water/sewer bills on a monthly basis. Third, past due bills can be dealt with in a more timely manner (personal communication, Jim Polen).

Water Use

Port Orford's economy includes fishery-related businesses, several motels, and small businesses such as restaurants and gift shops that rely on the tourism and recreation industries as well as retirement needs. There are no exceptionally large water users in Port Orford. The Port of Port Orford is currently the largest user. There is also one seafood processing plant in Port Orford called Premium Pacific Seafoods. A significant portion of Port Orford's population is retired. About 66% of the total metered water connections are residential.

In 1997, Port Orford used 7.36 MG of water. Figure 4 shows bimonthly water use for 1997. In June and July of 1997 combined, the city used 1.77 MG of water. In August and September, water use was 1.52 MG. By October/November, water use had dropped to 0.90 MG.

Figure 4. Port Orford Bimonthly Water Use, 1997.



Note: Data provided by Port Orford City Hall.

Seasonal Water Use

During the summer months, the water withdrawn from Garrison Lake had taste and odor problems. In the past, this has caused problems for Premium Pacific Seafoods. Premium Pacific Seafoods has relatively high water demand during the summer season and it became necessary for the fish plant to install a water filtration system to avoid tainting processed seafood with the taste and odor of the water.

Water Rates

All water use in Port Orford except well water use is measured by water meters. Port Orford has a uniform rate structure. Domestic and commercial users are billed the same rate. The rate is a combination of water and sewer charges with a base rate of $49.50 plus $4.77 per 1,000 gallons of water and sewer used ($1.67 per 1,000 gallons of water plus $3.10 per 1,000 gallons of sewer). This relatively high price acts as an incentive for residents to avoid unnecessary water use (personal communication, Jim Polen). This is evident in Port Orford's estimated annual and summer water use of 18 gallons per capita per day (gcd) and 27 gcd respectively; however, one reason for these extremely low estimates is that many residential users supplement their water use with private wells (Port Orford City Hall, 1998).

Estimating Future Demand

Port Orford's Future Water Demand

Estimates of Port Orford's future water demand were derived using the same technique applied to Newport's demand. Port Orford's current population is approximately 1,100. Port Orford's average annual growth rate has been estimated at 2.0% (HGE Inc. Engineers and Planners, 1995). No other estimates of population growth were found. Therefore, a 1.0% growth rate was chosen for use in estimating forecasts under a "best" case scenario, while 2.0% was used as a "worst" case scenario.

Water use not based on population growth estimates is expected to decline, because the tourism and fishing industries in Port Orford have declined in recent years[28]. With regard to tourism, Port Orford is located in Curry County, where transient lodging tax receipts have decreased slightly from $389,421 during the 1994/95 fiscal year to $387,895 in 1996/97. Port Orford's lodging tax receipts increased only slightly from $24,325 to $25,498 over the same period of time (Dean Runyan Associates, 1997). The seafood plant in Port Orford recently has downsized its operations and has changed production from sea urchins to live fish.

[28]However, since the completion of a new dock in Port Orford, the Port district is looking to develop the area. This would create an increase in demand for water and sewage services.

Estimated future water demands, assuming constant per capita water use, are presented as "worst" and "best" case scenarios in Tables 6 and 7, respectively. Based on summer per capita water use estimates, the results indicate a large increase in water demand. Under the "worst" case scenario, water demand almost triples. Under a "best" case scenario, water demand nearly doubles.

Table 6. Port Orford's "Worst" Case Scenario.*

Year	Population	Millions of Gallons per Day (MGD)	Water Rights**	Difference
2000	1144	0.027	0.81	0.783
2010	1395	0.033	0.81	0.777
2020	1701	0.041	0.81	0.769
2030	2073	0.050	0.81	0.760
2040	2527	0.060	0.81	0.750
2050	3080	0.074	0.81	0.736

*Estimates use a 2.0% growth rate and 24 gcd.
**Includes Hubbard Creek only, since Garrison Lake is currently unusable.

Table 7. Port Orford's "Best" Case Scenario.*

Year	Population	Millions of Gallons per Day (MGD)	Water Rights**	Difference
2000	1122	0.027	0.81	0.783
2010	1240	0.030	0.81	0.780
2020	1369	0.033	0.81	0.777
2030	1512	0.036	0.81	0.774
2040	1671	0.040	0.81	0.77
2050	1846	0.044	0.81	0.766

*Estimates use a 1.0% growth rate and 24 gcd.
**Includes Hubbard Creek only.

Future Plans

The Water Improvement Project was developed to solve some of the water supply problems in Port Orford. There are six construction schedules in the Project: 1) water treatment plant improvements; 2) Hubbard Creek reservoir dredging; 3) Coast Guard Hill Pump Station improvements; 4) reservoir improvements; 5) distribution pipeline improvements; and 6) a new Hubbard Creek raw water line and new Garrison Lake intake (HGE Inc. Engineers and Planners, 1998). The new intake planned for Garrison Lake was deeper than the old intake currently located in a marshy area. Engineers hoped for improved water quality in deeper areas of the lake and that the City would be able to withdraw for longer periods of time. This would have increased water supplies for the City as will plans to dredge the Hubbard Creek reservoir. The improvements to the 21 year old water plant will enable improved treatment of turbidity but will not increase capacity. Construction on the Project began in September 1998 and most portions are nearing completion (personal communication, Jerry McNurlin).

The cost of implementing the Water Improvement Project was $1.05 million. Port Orford received a $1 million grant from the Oregon Economic Development Department (OEDD) and other government agencies; the remaining $50,000 will be paid by Port Orford through higher water rates. A survey by Portland State University found that 66% of Port Orford residents were low and moderate income persons. This qualified Port Orford for a Community Development Block Grant administered by OEDD. Financing was also provided through the Rural Economic and Community Development program and the Water and Wastewater Financing Program, also administered by the OEDD.

Other potential water supplies have been evaluated besides those available through the Water Improvement Project. The possibility of a water supply from wells is being evaluated. One test well did not produce enough water to help the City. Another site, at a higher elevation, also failed to produce enough water. A third possibility is to search outside City boundaries. This, however, is not desirable because it would entail purchasing property and result in higher transportation and piping costs (personal communication, Jerry McNurlin).

Garibaldi

Water Rights

Garibaldi has two water rights to a groundwater source supplied by the Miami River. The City has water rights to 0.84 MGD from two wells. Well No. 2 provides 0.58 MGD and is the primary source, while Well No. 1 provides 0.26 MGD and serves as an emergency backup. Two surface water sources, Lagler Creek and Struby Creek, are available for emergency use.

The City has two reservoirs that collectively hold 399,000 gallons of water. In addition, the City has three storage containers. These include two above ground containers and a third buried container. Together they store 429,000 gallons of water (Handforth Larson and Barrett, Inc., 1993).

Community Objectives

Currently, Garibaldi's first priority is to find additional raw water supplies. In years that experience a dry summer and autumn, the water table is approximately 10 feet below the ground surface at the well heads (Handforth Larson and Barrett, Inc., 1993). At times, Garibaldi has had to exceed its water rights. The City exceeded its rights on Well No. 1 from April of 1991 to August of 1991 and on Well No. 2 in January and July of that year. In addition to finding more supplies, Garibaldi would like to develop a water supply that requires no filtration. The current groundwater source requires no filtration and the town has no water filtration plant (Handforth Larson and Barrett, Inc., 1993).

Equality in the water rate billing structure was a high priority during the last administrative changes which took place in 1994. The authors of the 1993 Master Water Plan remarked that while residents used approximately 25% of the water, they contributed about 45% of the monthly revenue. They stated that "In effect, the residents of Garibaldi are subsidizing the water of large consumers. While the success of the large industries is important to the economic well-being of the City, it should not come at the expense of the residents" (Handforth Larson and Barrett, Inc., 1993). The authors' proposed solution was a change in the water rates for large consumers. This change was adopted by the City Council.

Water Use

Industries based on forestry, fisheries, and tourism have supported Garibaldi's economy. Historically, the largest water users have been the fish processing plants, RV parks, marinas, and lumber industry. Approximate annual use for 1996 and 1997 was 107 MG (personal communication, Dennis Sheldon). Average monthly use is shown in Figure 5.

Seasonal Water Use

Monthly water use fluctuates with the needs of the seafood processing plant. During the summer months, the plant produces shrimp. Other products, are processed following the shrimp season. This accounts for the high water use in October and November shown in Figure 5. Starting in December, the plant processes crab (Dennis Sheldon, personal communication).

During the summer months, water availability is lowest. Garibaldi has been forced to exceed its water rights and at times has pumped during periods below "minimum stream flow." Annual average water use in Garibaldi is 307 gallons per capita per day (gcd[29]). During the summer months, it increases to 331 gcd. High gcd estimates in Garibaldi might be a product of several large water users and a small population. The data to calculate individual residential water use was unavailable for Garibaldi and Port Orford.

Water Rates

Until last year, Garibaldi residents paid for water through a flat rate. In July of 1998, water meters were installed to increase revenue and conservation. Residents were charged a base rate of $20.00 for 3,000 gallons of water. Water rates were raised due to increasing revenue needs.[30] The

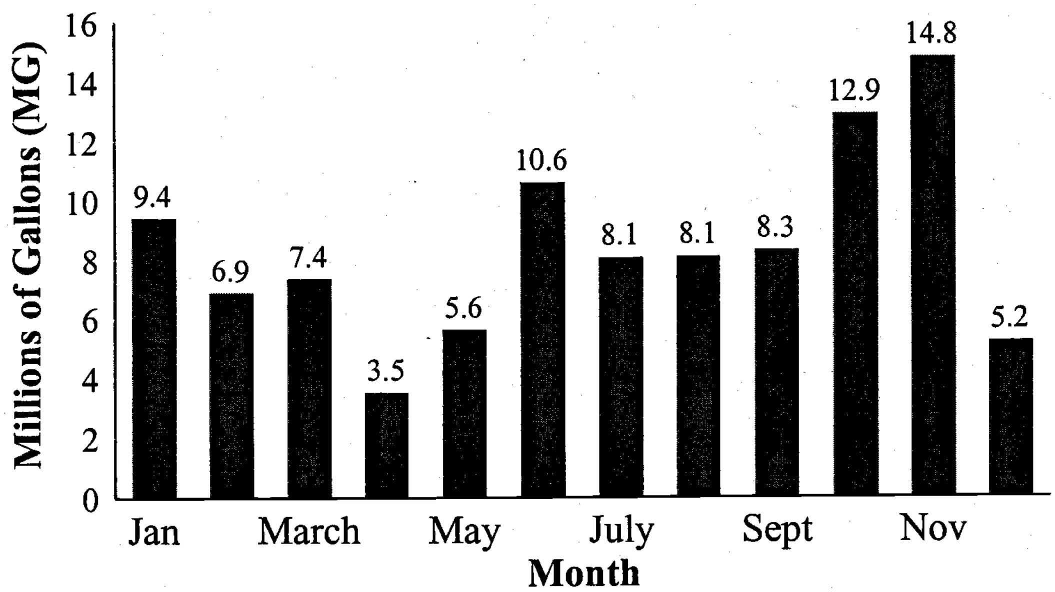
---

[29]The gcd (gallons per capita per day) statistic is the result of dividing total water use by population and then dividing again by the number of days within the observed time period.

[30]At one time, the City was home to several fish processing facilities including three shrimp processing plants. With declining yields, many went bankrupt or were bought out by larger processors. In 1991, Hoy Bros. Fish and Crab Co. and Smith's Pacific Shrimp were the only two processors left in Garibaldi; now, only Smith's remains. Hoy Bros. was bought out in 1994 and serves mainly as a buying location. In 1991, Smith's Pacific Shrimp used 13.8 MG. (Hoy Bros. had used 49.8 MG).

public objected, and in September a base of 6,000 gallons and $1.65 for each additional 1,000 gallons per month was allowed. Large industry water rates are $324.50 for the first 96,000 gallons and $1.65 per 1,000 gallons thereafter (data provided by Garibaldi City Hall).

Figure 5. Garibaldi Average Monthly Water Use, 1996/97.



Note: Data provided by Garibaldi City Hall.

Estimating Future Demand

Garibaldi's Future Water Demand

Garibaldi's water demand is calculated in the same manner as Port Orford's and Newport's. From 1980 to 1990, Garibaldi's permanent population decreased from 999 to 900, or -1.05% per year (Handforth Larson and Barrett, Inc., 1993). A "best" case scenario assumes that water use will decline. This assumes that the fishing and lumber industries will continue on a downward trend. This is represented by forecasts with a -1.05% growth rate. A "worst" case scenario assumes increases in tourism and a rebound in the fishing industry represented by a 2.0% growth rate. The tourism industry in Garibaldi and in Tillamook County has been growing. County transient tax receipts increased from $399,766 to $490,187 from fiscal year 1994/95 to 1996/97. Garibaldi's lodging tax receipts increased from $20,403 to $24,000 over the same time period (Dean Runyan Associates, 1997).

A constant per capita water use is assumed. Summer water use of 331 gcd is used in the forecast. Tables 8 and 9 provide estimates of "worst" and "best" case scenarios for Garibaldi's

Table 8. Garibaldi's "Worst" Case Scenario.*

Year	Population	Millions of Gallons per Day (MGD)	Water Rights	Difference
2000	936	0.31	0.84	0.53
2010	1141	0.38	0.84	0.46
2020	1391	0.46	0.84	0.38
2030	1696	0.56	0.84	0.28
2040	2068	0.68	0.84	0.16
2050	2520	0.83	0.84	0.01

*Estimates use a 2.0% growth rate and 331 gcd.

Table 9. Garibaldi's "Best" Case Scenario.*

Year	Population	Millions of Gallons per Day (MGD)	Water Rights	Difference
2000	881	0.29	0.84	0.55
2010	793	0.26	0.84	0.58
2020	714	0.24	0.84	0.60
2030	642	0.21	0.84	0.63
2040	578	0.19	0.84	0.65
2050	520	0.17	0.84	0.67

*Estimates use a -1.05% growth rate and 331 gcd.

future water demand. Under a "worst" case scenario in year 2020, summer water use will have increased by 55% above current use. Under a "best" case scenario in the year 2020, summer water use will have decreased by 17% of current use.

Future Plans

For many years, the town has tried to discover another viable water source. Due to limited funds and high demand for water, sources have been difficult to find. According to the 1993 Water System Master Plan, water supplies needed to be increased. One proposal was to obtain an additional 0.84 MGD of water rights on Well No. 2, which would double the amount of water the City now takes through both wells. The City applied for a permit but withdrew the application after three years, following the discovery of new information about the source of Garibaldi's groundwater and its withdrawal effects on reducing flows of the Miami River. Further groundwater withdrawals would cause the Miami River streamflow to decrease below minimum levels. A permit for additional water withdrawal from Well No. 2 would limit additional water withdrawals to less than 12 months a year. Upon withdrawal of the permit, other options are being considered (personal communication, Dennis Sheldon).

Section V: Commonalities and Alternative Options

Commonalities

The communities of Newport, Port Orford, and Garibaldi, although different in many respects, have encountered similar issues with respect to municipal water management. The following problems exist for at least two of the municipalities:

- Decreasing options for additional water supplies
- Peak demand during summer months
- Difficulty in covering operational costs
- Increasing importance of domestic consumers in designing new rate structures
- Tendency to avoid implementing conservation strategies until absolutely necessary
- Management "conundrums" resulting from the "Conservation Paradox"

Decreasing Options for Additional Raw Water Sources

One of the widely recognized problems by city managers, planners, and municipal water managers is decreasing options for additional raw water supplies. This is partially due to geographical limitations for reliable raw water sources. Reliable sources include rivers and groundwater sources that supply adequate water quantity and quality to meet a substantial portion of municipal demand through most of the year. Another reason for decreasing options is the increasing importance of water for recovering and sustaining salmon populations. Some city decision makers and utility managers feel that salmon needs have been given a higher priority than municipal needs. They believe that allocation of water in the form of instream water rights will decrease their chances to obtain additional water rights.

Peak Demand During Summer Months

A common reason for obtaining additional water rights is to satisfy demand during the summer months when stream levels are relatively low. Due to 1) low rates of precipitation from June through September, 2) increasing growth in tourism, and 3) seafood processing plant needs during the summer months, all three municipalities have been forced at times to rely on supplemental water sources. There are at least three reasons why these municipalities have named the Siletz River, Garrison Lake (although no longer used), and Garibaldi's Well No. 1 as supplemental sources. Either:

1) The source is less reliable;
2) The source is of lower water quality and therefore more expensive to treat; or
3) The source is located where water is relatively expensive to transport.

Figure 1 in Section II illustrated Newport's peak demand in 1997. Newport's water use is 100% greater in summer than in winter while Port Orford's summer use is 138% greater. Summer is the season when flows are at their lowest level. Sometimes streamflows decline to such low levels that the three cities are forced to pump from supplemental sources or streams that are below minimum flow. Table 10 compares the maximum number of months each town has withdrawn from the supplemental source and the average number of months each municipality experienced shortages in their primary water source each year from 1987 to 1997. Table 10 also provides information on primary water supply rights, supplemental water supply rights, total supplies from all rights, and raw water storage capacity.

Switching from a primary to a supplemental source is not optimal, because the source is either less reliable, poorer quality, or more expensive to transport. However, it is not an unusual occurrence and it does not necessarily indicate a shortage of water availability. But it does indicate how often stream levels decrease to unacceptable levels, or water quality degrades below a preferred standard; that is, it indicates the reliability of the primary water source for each municipality. In Newport, supplemental water sources are usually used only during a drought. In Garibaldi, the switch to supplemental sources is a more common occurrence. Before 1999, Port Orford changed water sources every year. The fact that Garibaldi often switches water sources is representative of the lack of year long, reliable water sources in some coastal areas.

Table 10. Water Source Supply and Shortages.

	Months Primary Supply Inadequate (1987-97)*		Primary Water Rights (mgd)[31]	Supplemental Water Rights (mgd)[32]	Other Rights (mgd)	Storage (MG)[33]
	Max**	Avg.***				
Newport	4	0.4	6.45 (645)****	3.88 (388)	1.4	381
Garibaldi	5	4	0.58 (644)	0.26 (288)	-	0.399
Port Orford	6	5	0.81 (736)	none	0.75	? [34]

Data gathered from various sources, including personal communication with John Van Dyver, Jerry McNurlin, and Dennis Sheldon.

* The amount of time in months the city used supplemental water sources over the period 1987-97.
** The maximum number of consecutive months during any one year that the city used supplemental water sources over the period 1987-97.
*** The average number of months per year that the city withdrew water from supplemental water sources over the period 1987-97.
**** Figures in parentheses are the gallons per capita per day water supply.

Table 11 provides information about summer and annual water use and estimated water needs for the next 10, 20, and 50 years. The estimates are based on the forecasts completed in section three for "worst" case scenarios. Comparison of summer per capita per day water use shows Garibaldi with the highest estimate and Port Orford with the lowest. Garibaldi's high per capita use of 331 gcd results from the town's small population and large industrial water use. Port Orford's much smaller 24 gcd estimate results from 1) conservation due to high water rates, 2) lack of large water users, and 3) higher use of individually owned well water. Newport's large

[31]Millions of gallons of water per day (mgd) a city can legally withdraw from its primary water source. A primary water source is that source which provides the community with the majority of its water.

[32]Millions of gallons of water per day a city can legally withdraw from its supplemental water source. A supplemental water source is that source which provides the next best alternative source of water after the primary source.

[33]MG = Millions of gallons

[34]Port Orford's reservoir holds an uncalculated amount of water.

gpd estimate of 302, like Garibaldi, is a result of large water users incorporated into the per capita estimate.[35]

Table 11. Water Use and Future Expected Water Need.

Expected Future Needs (mgd)*					
	Average Water Use 1997 (mgd)	**2000**	**2020**	**2050**	**Per Capita Per Day Water Use (gcd)**
Newport	3.02	3.14	4.67	8.46	302
Garibaldi	0.30	0.31	0.46	0.83	331
Port Orford	0.026	0.027	0.041	0.074	24

* Estimated with a 2.0% growth rate and constant per capita per day water use.

Table 12 shows a comparison between annual water use, incorporating all water users and gallons of water per capita per day, with domestic use only.[36] Information for Garibaldi and Port Orford was not available. A more accurate forecast of expected demand could be generated by using estimates of per capita water use and growth rates for specific industries.

Difficulty in Covering Operational Costs

When a municipality borrows money by issuing bonds and designs a rate structure that will cover the bond payments, it is structured based on assumptions about water use. Water use will determine the amount of revenue the city must pay for the bond and operation and maintenance

[35]These estimates do not in any way indicate that residential or any other classification of users in one city necessarily uses more water than users in another city. Sufficient data does not exist to make these determinations.

[36]For the purpose of comparison, the United Nations determined that 23 gallons of water per capita per day is the minimum quantity necessary to maintain a healthy person (Nieswiadony, 1998).

of the water system. If a large water user goes out of business or uses substantially less water than when the rate structure was designed, the city loses revenue. As a result, the city will experience difficulty covering its costs of operation. These are fixed costs that cannot be altered in the short term.

Table 12. Per Capita Per Day Water Use, 1997.

	All users	Large Industry	Domestic Users
Oregon	212	NA	104
Newport	174	90,471	82
Garibaldi	307	NA	NA
Port Orford	18	NA	NA

This situation occurred recently in Garibaldi when the town lost a large water user and consequently a large amount of revenue. The City is now having difficulty covering its costs of operation. The public also has opposed efforts to raise water rates. Other coastal towns are likely experiencing this same problem due to declining fish yields and declining water use by seafood processing plants.

Port Orford also has experienced difficulty in covering costs. The City of Port Orford has not been able to pay for needed water system improvements using locally generated funds. However, they have been successful in securing government funds to implement the Water Improvement Project.

Increasing Importance of the Domestic Consumer in Designing New Rate Structures

Table 13 shows a comparison of water rates between the three towns. Newport and Garibaldi both have declining rate structures; that is, the price of one more unit of water declines as water use increases. This is sometimes called a declining block structure. Port Orford has a uniform rate structure and the price of water is constant as use increases.[37]

[37]Toledo, Oregon is another coastal town with a uniform rate structure. Warrenton, also

In 1996, Water Stats[38] conducted a survey of 1,000 utilities that gathered information about water rate structures for residential consumers across the U.S. and Canada. The results are shown in Table 13. As water conservation has become more important, water utilities have reduced their use of decreasing block rate structures. According to one study, fewer than 10% of water utilities in the western U.S. continue to use decreasing block rates (Ernst & Young, 1992). Figures 6 and 7 show Newport's and Garibaldi's rate structures for residents and large industry consumers.

Table 13. Water Rate Structures, 1996.

Type of Rate Structures	West	Midwest	South	Northeast	Canada
Uniform Rate	46%	34%	31%	46%	48%
Declining Block	3%	58%	40%	32%	10%
Increasing Block	36%	4%	27%	19%	10%
Other	15%	4%	2%	3%	32%

Source: Water Stats, The Water Utility Database, 1998.

Table 14 shows the charge to residents for using 3,000 gallons of water and 10,000 gallons of water in each town, and the charge to large industry for using 100,000 gallons of water and 500,000 gallons in each case study. Table 14 also shows the marginal cost of the last 1,000 gallons purchased in each category. In 1998, the average price of 1,000 gallons in the U.S. was $2.00, or only $0.002/gallon (Nieswiadomy, 1998). The reader should note that Newport also uses property taxes to cover the cost of maintaining and operating its water system, and that the base rate for Port Orford includes both water and sewer charges.

---

on the Oregon coast, has a uniform rate structure for residents and a declining rate structure for seafood processing facilities.

[38]Water Stats is a cooperative project of the American Water Works Association and the AWWA Research Foundation.

Figure 6. Newport's Residential and Large Industry Water Rate Structures, 2000.

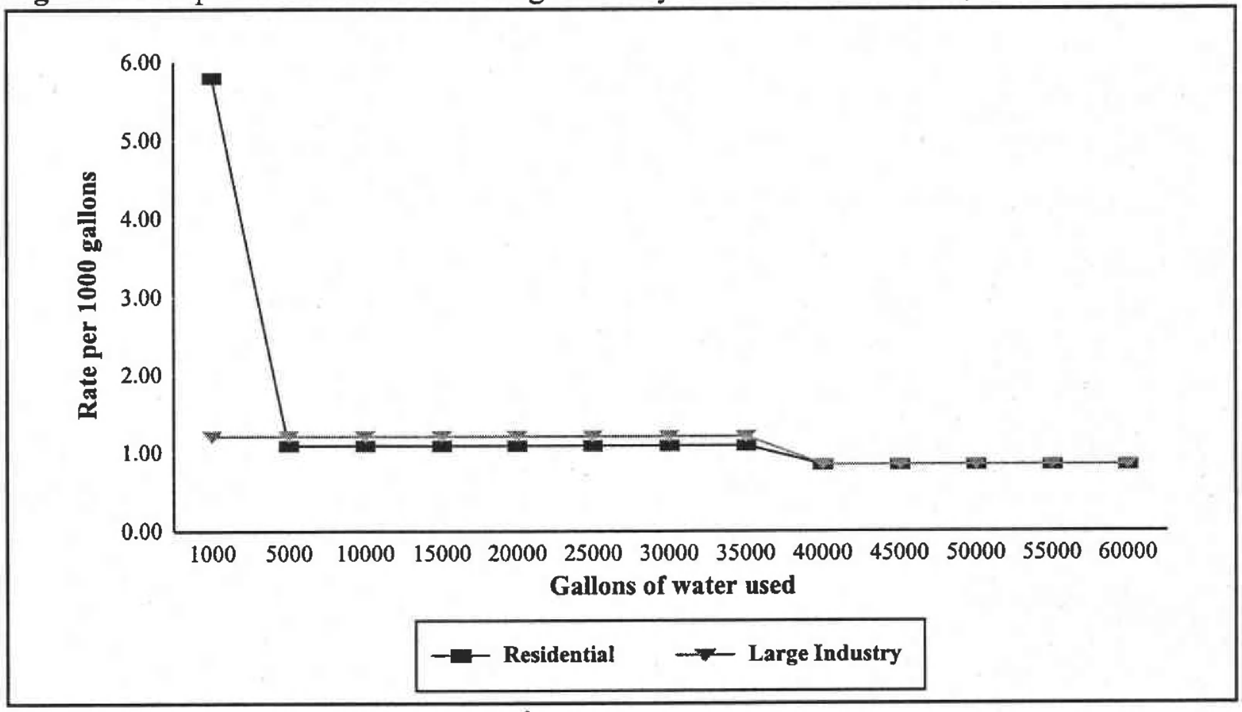
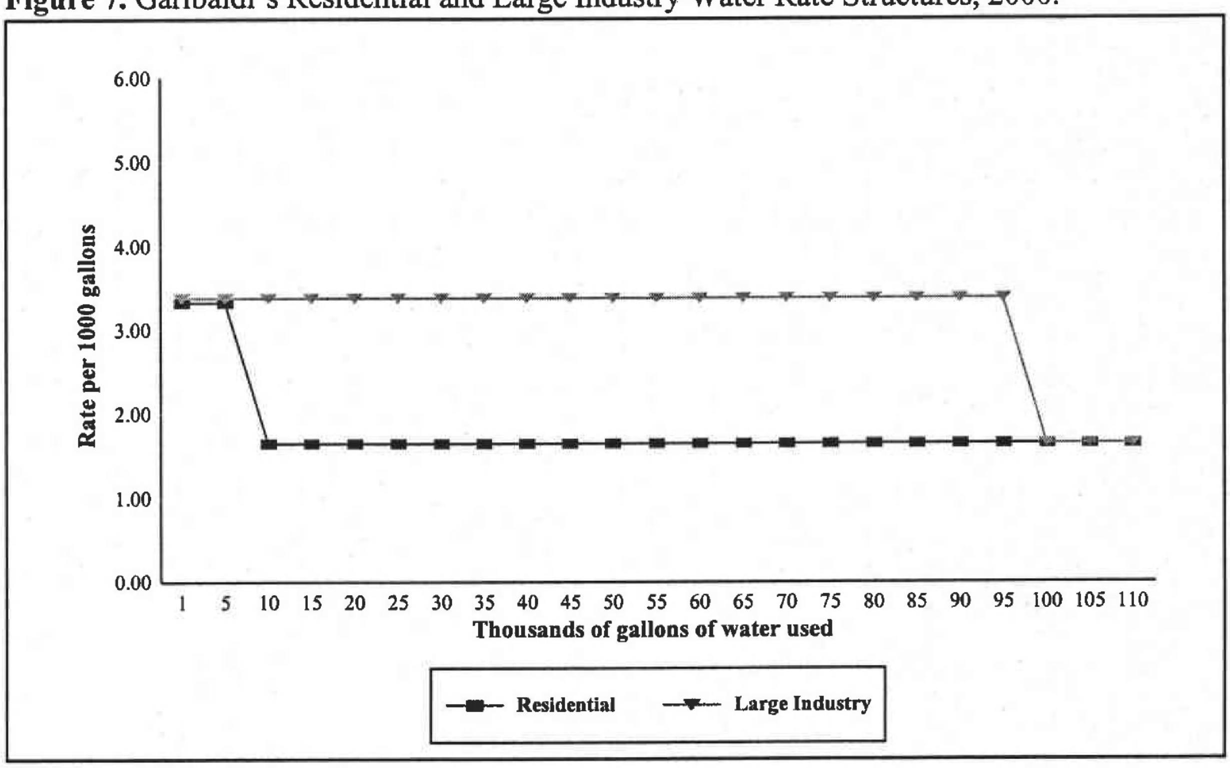


Figure 7. Garibaldi's Residential and Large Industry Water Rate Structures, 2000.



Two recent changes in Garibaldi's water rates favored residential consumers. A new rate structure was designed with the intention of making industrial water rate charges consistent with the costs incurred by industrial users. Prior to the change, consumers were perceived as subsidizing industry. The city allowed the base amount of water for residential consumers to increase by 100% with no change in the base rate. The importance of the domestic consumer is also evident in Port Orford's objective to make water more affordable for residential consumers.

Tendency to Avoid Implementing Conservation Strategies until Absolutely Necessary

None of the three towns plans to implement additional water conservation measures in the future. There are no plans because either there is no perceived shortage of water, or conservation would create the need for rate increases to cover operating expenses. Although there are no plans to implement additional conservation measures, the cities are using relatively less water than before 1992 when a drought occurred. All three towns use water meters for all consumers, and all three conduct leak detection and leak repair to some extent. Since 1992, voluntary conservation is believed to have increased due to the use of low flow devices on faucets and showerheads. Furthermore, mandatory building requirements has created water conservation.

Management "Conundrums" Resulting from the "Conservation Paradox"

"Conservation Paradox" refers to the financial disincentives (from the perspective of the municipality) associated with conservation. As mentioned in the Newport section, successful implementation of conservation will decrease water use and, many believe, consequently decrease the amount of revenues the city receives through service charges. If revenues are too low, the city will be required to raise water rates. An increase in water rates is believed by some city decision makers to cause further decline in water use and revenues. The extent to which this occurs is discussed in conjunction with water rates.

The second half of this section discusses conservation methods. The water conservation literature acknowledges that conservation has a cost and that decreases in revenues can occur. There might be ways however, to avoid this series of events. These are discussed in the following pages.

Table 14. Comparison of Water Rates, August 2000.

	Rate Structure	Total and Marginal[39] Residential Costs		Total and Marginal Large Industry*** Costs	
		3,000 g.	10,000 g.	40,000 g.	500,000 g.
Newport[40]	declining*	$8.00 (1.10)****	$15.70 (1.10)	$49.90 (1.25)	$440.90 (0.85)
Garibaldi[41]	declining	$20.00 (3.33)	$26.60 (1.65)	$324.50 (3.38)	$991.10 (1.65)
Port Orford[42]	uniform**	$54.51 (18.17)	$66.20 (1.67)	$116.30 (2.91)	$884.50 (1.67)
OWRD sample	increasing*****	$17.95 ($4.80)	$21.10 (0.35)	na	na

Data gathered from various sources, including Newport Billing Office, Garibaldi City Hall, and Port Orford City Hall.

* Type of rate structure where rate decline as water consumption increases.
** Type of rate structure where rates remain constant as water use increases.
*** Rates refer to those for seafood processing plants and other large industry.
**** Figures in parentheses are (marginal) rates per 1,000 gallons in that tier.
***** Type of rate structure where rates increase as water consumption increases.

---

[39]Marginal costs refers to the cost of the last 1,000 gallons. This varies depending on the block level.

[40]***Residential rates:*** $5.80 for the first 1,000 gallons, $1.10 per 1,000 gallons for up to 40,000 gallons, $0.85 per 1000 gallons thereafter (3/4-inch meter).
Industry rates: $49.90 for the first 41,000 gallons, $0.85 for each 1,000 gallons thereafter (4-inch meter)

[41]***Residential rates:*** $20.00 for the first 6,000 gallons, $1.65 for each 1,000 gallons thereafter (3/4-inch meter).
Industry rates: $324.50 for the first 96,000 gallons, $1.65 for each 1,000 gallons thereafter (4-inch meter).

[42]***Residential rates:*** $49.50 base rate for water and sewer combined, $1.67 per 1,000 gallons.
Industry rates: $49.50 base rate for water and sewer combined, $1.67 per 1,000 gallons.

Conservation as a Possible Option for Additional Water Supply

The American Water Works Association defines water conservation as "practices, techniques, and technologies that improve the efficiency of water use" (AWWA homepage, 1998). Efficiency is defined in many ways. In general, improving efficiency involves decreasing waste. In other words, improving efficiency entails using less water while providing service to the same number of people. Several utilities have found efficiency improvements through conservation to be an economical and environmentally responsible way to satisfy new water demands. Rather than concentrating on supply management, many water providers throughout the U.S. have chosen to focus on demand management of water resources. This is spurred by several factors: increasing competition for limited supplies, regulatory difficulties in developing new supplies, increasing costs of developing new supplies, maximum use of current facilities, delay of capacity expansion, and increasing support by the public for conservation of natural resources (AWWA homepage, 1998).

This section describes and discusses possible benefits from conservation, the cost of conservation, and several possible methods of conservation for use in coastal communities. These methods include conservation-based water rates, residential conservation, commercial and industrial conservation, and conservation education. The application of these approaches to each community can vary and will depend on myriad social, political, economic, geographical, and geophysical issues.

This section does not, however, include all possible conservation options.[43] Instead, it discusses some of the most widely used and successful conservation measures and techniques in the U.S. Discussion is directed at conservation methods already in use in the Northwest, given regional and climatic similarities.

As coastal salmon habitat becomes more environmentally valuable and coastal human populations grow, potential future water supplies are decreasing. Conservation is one method that allows water providers to distribute water for more uses using the same quantity of water. In some cases, conservation can be an alternative to developing new raw water supplies.

---

[43]Conservation methods such as aquifer recovery and gray water use are not discussed in any detail, even though they can be part of a successful conservation program.

Conservation also can serve other purposes. For example, as discussed above, many Oregon coastal communities are anticipating the development of regional water supplies to help satisfy peak demand during the summer months. However, project completion - and therefore new water availability - is 10-30 years in the future. Conservation can be a viable means of satisfying demand from growth until other supplies are available. In addition, conservation can help water providers contend with common coastal water management problems including: increasing peak demand, exceeding water rights or pumping below minimum flows, and resorting to increasing use of expensive supplemental water sources.

Successful Conservation Programs

Conservation provides an alternative source of water by reducing per capita use and freeing up water for other uses. Several cities have noted substantial savings in water use due to implementation of conservation programs. The Northwest cities of Portland and Seattle use, or have plans to use, conservation as a means of stalling the need for new raw water sources until they are made available or existing infrastructure can be expanded.

Seattle's conservation program has allowed Seattle Public Utilities to expand its service by 5% to new customers while holding constant water demand (Paschke, Philip E. et al., 1998). The decision to invest in conservation as a reliable resource was made as the Cedar and Tolt rivers, Seattle's source of water, were approaching their capacity to serve the region's growth. Conservation actions have been used to stretch existing sources until and beyond the time when water supply is increased, through increased capacity of a water filtration plant on the Tolt River and a new supply source from an intertie with Tacoma's water system.

All Seattle conservation programs meet a test of cost effectiveness. That is, "the program cost will be no greater than the cost avoided by elimination or postponement of the need for new, conventional water supply"[44] (Seattle Public Utilities, 1993). Besides cost effectiveness, other principles applied in Seattle's Long Term Conservation Plan included: "meeting the summer

---

[44]Discussion of the calculation of the cost of new water supply includes the following note: "for purposes of the cost effectiveness plan, ten percent is added to the cost of conventional supply to account for unmitigated environmental impacts associated with such projects" (Seattle Public Utilities, 1993).

supply challenge by focusing on programs that reduce demand during the summer; ensuring equity among ratepayers by offering programs for residential and nonresidential customers and promoting customer cost sharing; ensuring program success by monitoring and evaluating program savings and costs and testing programs design with pilot efforts prior to full-scale program implementation" (Seattle Public Utilities, 1993). The Water Conservation Potential Assessment completed by Seattle Public Utilities found that a decrease of up to 31 MGD, or 16% of Seattle's peak season water use, could be attained over the next 20 years (Seattle Public Utilities, 1998).

In the Portland Metropolitan region, 17 water providers are members of the Columbia-Willamette Water Conservation Coalition. Together, the group developed a Regional Water Supply Plan that estimated an 19% reduction in peak demand from new conservation programs by 2050. Members pay dues totaling $180,000 to the Coalition to achieve this goal. They are currently involved in evaluating the best methods to measure conservation efforts and success before implementing their conservation plan. Many cities have conservation budgets that exceed the dues to the Coalition. They range from zero in six communities to $800,000 in Portland to more than $195,000 in Gresham, $31,000 in Hilsboro, $27,000 by Clackamas River Water, and less than $10,000 by most of the other jurisdictions (OEC, 1998).

Portland participates in a community-based conservation program called EcoTeams.[45] The program's goal is to start neighborhood teams that help each other incorporate more resource efficient practices into their lifestyles. Through the program, there has been a 20% reduction in water use (OEC, 1998). Of 11 utilities surveyed outside the Portland region by the OEC, three communities had no budget for conservation. Eugene had the largest budget for conservation at $198,000; Corvallis allocated $120,000; Ashland $94,000; Salem $58,000; and Medford $40-45,000. These programs have emphasized public education, low flow showerhead use, and decreasing water use in outdoor irrigation (OEC, 1998).

Corvallis is noted as a leader in effective water conservation. The city has an increasing block rate structure, distributes information to consumers about water conservation, and participates in

[45]EcoTeams was developed by the Global Action Plan group that contracts with local governments to work in communities on issues involving resource conservation (OEC, 1998).

water conservation programs. Corvallis participates in the Wash Wise Program sponsored by the Northwest Energy Efficiency Alliance. The program awards in-store discounts and state tax credits to consumers when they purchase water and energy saving appliances. Corvallis also participates in the Water Alliances for Voluntary Efficiency (WAVE) Program offered through the EPA. The program helps encourage water conservation in businesses and industries (OEC, 1998).

The EPA reports that more than 40 states have some kind of water conservation program. They also report that more than 80% of water utility customers are willing to use some form of water conservation (EPA homepage, 1998). Other areas of the U.S. are finding beneficial uses of conservation as well. In Florida, Tampa's water efficiency program resulted in a 15 to 18% reduction in demand during the dry months of March through June. The annual average decrease was 7% (EPA(1), 1998). In Los Angeles, mandatory installation of low-flow showerheads and toilet tank displacement devices reduced water use by 4% between 1987 and 1990. The City hopes its redesigned rate structure will limit annual growth in sewage flows to 7 MGD and decrease water use by 15% by the year 2000 (EPA(1), 1998). The implementation of a water conservation program in Phoenix, Arizona has resulted in a decrease in water consumption from 267 gallons per capita per day (gcd) in 1980 to 234 gcd in 1990. Gallup, New Mexico's water conservation program has resulted in an estimated decrease of per capita use from 160 to 150 gcd (EPA(2),1998). In California and Arizona, the cities of San Jose, Lompoc, and Tucson also have been successful with their water conservation programs. New York City and Washington D.C. also have developed extensive water conservation programs (EPA(1), 1998).

In some of these cases, conservation was used to postpone development of new raw water supplies, postpone the need to expand existing water treatment and wastewater facilities, improve habitat for fish and other aquatic wildlife, accommodate population growth needs, and decrease peak demand. In some situations, no alternative water supplies existed; in other cases, conservation programs were less expensive on a marginal cost basis than developing new raw water supplies.

In the short term, conservation often requires up front costs and political courage. In the long term, conservation can decrease current water system costs by providing for a larger population.

The result is a larger customer base over which to spread costs. This can result in lower average water rates.

The Cost of Conservation

The disincentives for water utilities to invest in demand-side methods of water management result from three interrelated issues: 1) traditional rate structures are incompatible with demand management; 2) demand management options can reduce municipal revenues; and 3) demand management options can increase utility risks and compromise profitability (Beecher et al., 1994).

Conservation programs often involve up-front costs and short-term revenue losses. Some municipalities are hesitant to implement water conservation due to its tendency to decrease municipal revenues and create a need for increasing water rates. This creates difficult choices for the water provider. In general, conservation does not allow water utilities to substantially downsize their *existing* operations. Rather, primary savings result from avoiding capital and operational expenses for new water source development and treatment (Beecher et al., 1994).

Conservation programs develop gradually due to a time lag that can be attributed to installation of water saving devices, landscape modification, and consumer adjustment (Nieswiadomy, 1996). Usually, the public is opposed to rate increases, but perception can be changed over time as the public is educated about the need for and benefits of conservation. This can be accomplished through conservation education programs.

Methods of Conservation

Several approaches exist for conserving water. Conservation can result from behavioral and technological change. Behavioral change can occur through changes in water rate structure and consumer education. Technological changes are often implemented in association with new incentives. This section discusses 1) alternative water rate structures designed to encourage conservation, 2) potential savings from residential conservation, 3) potential savings from industrial and commercial conservation, and 4) conservation through consumer education.

Water Rate Structures

Conventional water rate structures often fail to generate necessary revenues, send inaccurate signals as to the worth and scarcity of water resources, and are increasingly difficult to defend politically (Chesnutt and Beecher, 1998). The primary goal in designing a rate structure is to generate revenues to maintain water operations. The secondary goal of any rate structure is fairness in allocating water system costs. The American Water Works Association (AWWA) believes that, in general, both these goals can be satisfied in a rate structure that encourages conservation or penalizes the excessive use of water. They state that conservation-oriented rate structures will be most effective when combined with a customer education program (AWWA homepage, 1998).

Increasing Block Rates: One of the most common types of conservation rates is an increasing block structure: the block rate is structured with increasing tiered rates at specified use levels. If the first block allows some estimated average water use for consumers, then those who exceed this level will pay the higher tiered rate. This provides an incentive for consumers to use less water. However, they will have no incentive to use less water if their typical use is below the maximum allowed under the first block rate. Therefore, increasing block rates will encourage conservation only up to a specified level.

The use of increasing block rates is a popular conservation pricing method. Analysis of more than 100 demand studies demonstrate that increasing block rates is a "powerful conservation tool" (Gerston, 1997). Conservation rates, or rates structured to encourage the conservation of water, are successful to the extent that water demand is elastic with respect to prices. Water demand price elasticity is a measure of the percentage change in water use resulting from a 1% increase in the price of water; the greater the change in water use resulting from a rate change, the greater the elasticity of demand for water. The greater the elasticity of demand, the greater the potential conservation effect resulting from a rate increase.

Estimates of the elasticity of residential water demand vary. One study of 24 academic journal articles between 1967 and 1993 report an average of -0.51 elasticity for residential water demand (Espey, M., J. Espey, and W.D. Shaw, 1997). That is, a 1% increase in the price of water results in a 0.51% decrease in water usage. Most studies indicate an elasticity of water demand between

-0.2 and -0.5 (Nieswiadomy, 1998). Based on these studies, water demand appears to be slightly inelastic (i.e. less than 1%). It is inelastic for at least three reasons: 1) it is difficult for households to substitute away from water, and a high cost is associated with monitoring water consumption; 2) the consumption of water precedes payment for the water, creating a disconnection between the two events for the consumer; and 3) consumers are not willing to pay the up front costs necessary to decrease water use when the price of water is so low relative to other goods (Nieswiadomy, 1998).

Short term water consumption has been shown to be more price inelastic than in the long run. This could be due to the time lag associated with installation of water saving devices, landscape modification, and other consumer adjustments (Nieswiadomy, 1996).

These studies indicate that rate changes can be an effective means to conserve water. The studies reported here, however, focus on residential water demand elasticities. Commercial, industrial, and institutional water demand elasticity estimates will differ from residential elasticity estimates. Elasticities also will vary due to ambient air temperature (range from 0.35 to 0.55), precipitation (range from -0.1 to -0.2) (Weber, 1989), and income (0.31) (Billings and Day, 1989), as well as other consumer and geographical characteristics.

The Oregon Water Resources Department provides an example of an increasing rate structure in their 1997 Sample Water Management Plan. It is specified as follows:

First 5 HCF*:	Base rate of $17.95
Additional HCF to 35 HCF:	$0.35 for each 100 cubic feet
Additional HCF to 65 HCF:	$0.55 for each 100 cubic feet Base rate changes to $28.45
Additional HCF over 65 HCF:	$0.75 for each 100 cubic feet Base rate changes to $44.95

* A hundred cubic feet (HCF) is equal to 748 gallons. Therefore, 5 HCF is equal to 3,740 gallons, or about 125 gallons per capita per day.

** Changes in the base rate when water use reaches 36+ HCF replace the original base rate of $17.95. Changing the base rate is one method of charging higher prices to larger water users for increasing maintenance costs.

Most researchers have found increasing block rates and seasonal rates successful in encouraging conservation (Nieswiadomy, 1998). Increasing block rates, however, can hurt low income consumers by forcing them to consume less water for the same dollar expenditure. However, increasing block rates also can be structured to benefit lower income consumers. For example, Oregon City charges lower monthly charges and rates for seniors and people with disabilities (Oregon Environmental Council, 1998).

The use of increasing block rates has increased substantially over the past decade. According to a survey conducted by the AWWA, comparison of rate structures in 1986 and 1996 showed that community use of increasing block rates has grown from 8% to 22%. The use of decreasing block rates decreased from 60% to 48% (American Water Works Association, 1996). The same trend occurred in Oregon. In 1994 and 1998, the Oregon Environmental Council (OEC) conducted a survey of 27 utilities in the greater Portland metropolitan region and 11 utilities outside the Portland region. Within the Portland region, the use of increasing block and seasonal rates increased from 21% to 30%. In 1994, 7% of Portland area municipalities used decreasing block rates; in 1998, no Portland area municipalities used decreasing block rates. All other utilities charged a uniform rate (OEC, 1998).

Among utilities outside the Portland region, the use of increasing block and seasonal rates increased from 18% in 1994 to 45% in 1998. The percentage of utilities using decreasing block rates decreased from 27% to 18% (OEC, 1998).

Increasing block rates are ineffective unless consumers "receive" appropriate price signals. In 1996, almost three-quarters of Portland's residential customers remained within the first tier of their increasing block rate structure. Therefore, only about one-quarter of residential customers received prices signaling that increasing water use will result in increasing rates. To correct this problem, Portland raised the rates at each tiered level and lowered the levels of the blocks by two-thirds. More consumers now receive price signals, and the price signals they receive better represent the opportunity costs associated with water use (OEC, 1998).

Seasonal Water Rates: Seasonal rate structures can be useful in regions with peak demand. Some structures employ different summer and winter use rates. Seattle's peak season rate over the four summer months is 1.5 to 2.6 times more costly than rates during the remainder of the year (depending on consumer classification) (Dietemann, 1998). El Paso Water Utilities in Texas has seasonal rates where block 2 and 3 rates are 85% and 131% higher than block 1 rates during the summer months (Gerston, 1997). Other utilities use average winter use as a baseline and create a surcharge for consumers who exceed the baseline during the summer months. Seasonal rate structures like these require citizens to readjust their needs each summer.

Feebates: Many municipalities have ruled out increasing block rates as an option, due to fears they will decrease water revenue or their impacts cannot be easily predicted (OEC, 1998). Approaches to address this concern include "feebate" pricing systems and marginal cost pricing. A "feebate" system (suggested by Robert Collinge at the University of Texas at San Antonio) requires determining conservation baselines[46] for each customer and assessing a fee for users who exceed the baseline amount. These fees would fund rebates, called "feebates," for customers who use less water than the baseline. In this way, the plan is revenue-neutral. Feebates could change monthly to achieve the seasonal target water use objective. While this rate structure might involve higher administration costs, it also has the potential to decrease water use more than by an increasing block structure by issuing increasingly larger rebates as water use decreases (Collinge, 1993). This program was adopted in Santa Fe, New Mexico (OEC, 1998).

Rate Structures Based on Marginal Cost Pricing: Marginal cost pricing is one of the most efficient forms of water pricing. Marginal cost pricing sets the price of water equal to the cost of supplying one additional unit of water. Using this approach, consumers pay the "true" value of obtaining one more unit of water at the margin by incorporating capital costs, operating costs, and the "scarcity" opportunity cost of water. However, this approach depends on determining capacity and actual total and marginal operating costs, which can be difficult to estimate. As a result, municipalities often use average cost pricing as a proxy, even though it does not compel users to consider appropriate price-induced conservation incentives. In addition, water providers also avoid marginal cost pricing due to its perceived conflict with goals of equity and revenue

---

[46]The baseline would be determined by the available water supply. The sum of customer baseline amounts would equal the target water supply (Collinge, 1993).

neutrality (Collinge, 1992). Marginal cost pricing rate structures, however, have been one of the best techniques for reducing peak demand in Seattle (Dietemann, 1998).

Robert Collinge has proposed an approach for generating revenue neutral water conservation through marginal cost pricing with discount coupons (Collinge, 1992). The discount coupon system, or DCS, is "a technique to price water efficiently at the margin for each consumer while at the same time meeting revenue goals (such as zero revenues in excess of costs)" (Collinge, 1992). Under this system, the management agency requires no information about consumer demand; only information about existing supplies.[47]

---

[47] DCS works in the following way as specified by Collinge:

Step 1. Water discount coupons are printed. Each coupon allows a prespecified discount off the base price of consuming a unit of water in a specified month. Each coupon could be equal to 1,000 gallons.

Step 2. The base price is set equal to the long-run marginal cost of water from supplemental water sources. The discounted price would equal the average variable cost of water from current sources. Therefore, the coupons would offer discounts of the base price less the discounted price. A lump sum monthly meter charge would cover fixed costs.

Step 3. The total amount of coupons issued over a year would be equal to the expected annual sustainable yield of the currently existing water. Coupon amounts could be adjusted to account for deviations from normal flow. For example, during a drought, the total coupon amount would be decreased.

Step 4. Customers receive a predetermined number of water coupons with their bill. The coupons would specify an expiration date. For each unit of water billed, a coupon attached to the bill would permit the customer to subtract the coupon amount. Coupons could be traded through convenience stores if transactions costs between consumers were high.

Step 5. Because coupons would not be accepted that exceeded the amount billed, the coupons could be traded. The value of one coupon would be equal to the marginal value and marginal cost of the last unit of water. Collinge suggests that an alternative to trading coupons would be to paste coupons in excess of water usage on the bill for a to-be-determined credit to the account or rebate. Those using water in excess of their coupons would be subject to a credit between the undiscounted price and the price of a coupon. The sum of the discounts to consumers using water over and under the coupon amount would aggregate to the sum of the amounts on the coupons (Collinge, 1992).

DCS has another advantage over increasing block rates. Increasing block rates do not achieve efficiency, because the last unit of water used by low volume users has a lower marginal value than the last unit of water used by a high volume user (Collinge, 1992). In contrast, DCS operates by issuing coupons to water consumers that represent the marginal cost of purchasing one more unit of water to the consumer.

If discount coupons were then transferable, the market price of coupons would indicate when tapping a supplementary water source is cost-effective (Collinge, 1994). If issuing coupons were cumbersome, a utility could deposit coupons as credits to customers' water accounts (Collinge, 1992 and Collinge, 1994). This is termed a "water entitlement transfer system," or WETS. Under WETS, the utility would have to estimate the market clearing price of a coupon to enable them to credit an individual's account with unused coupons or water use in excess of the coupons. This variation requires information about the elasticity of water demand.

In this way, consumers automatically purchase coupons if they exceed water usage. The benefits of this type of program are: 1) each consumer buys and sells coupons only if it in his or her best interest; 2) all customers have the same incentive to conserve; and 3) customers don't need to understand the program procedure, they only need to notice that their bill rises sharply with increased usage and falls sharply with conservation (Collinge, 1994).

Several other conservation-oriented rate structures can be designed, depending on community objectives. Other pricing systems also exist, including excess-use rates, indoor/outdoor rates, sliding-scale rates, scarcity pricing, spatial pricing, and penalties (Beecher et al., 1994).

Residential Water Use

Table 15 shows water use and water savings from various types of residential fixtures and appliances. The Energy Policy Act of 1992 established water efficiency standards for manufacturers producing faucets, showerheads, water closets, and urinals after January 1, 1994.[48]

[48]Specific types and maximum flow rates can be found in the USEPA Water Conservation Plan Guidelines posted on the EPA homepage at www.epa.gov.

Table 15. Water Use and Savings for Residential Appliances and Fixtures.

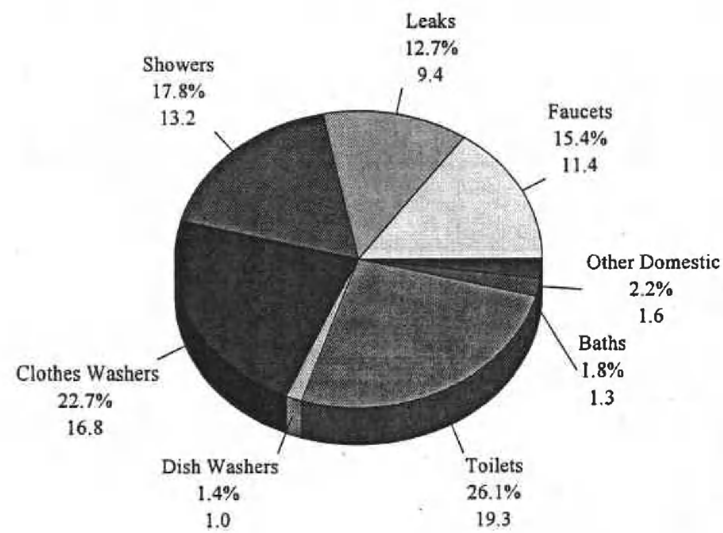
Fixture [a]	Fixture capacity [b]	Water Use (gpd)		Water Savings (gpd)	
		Per capita	2.7-person household	Per capita	2.7-person household
Toilets [c]					
Efficient	1.5 gallons/flush	6.0	16.2	na	na
Low-flow	3.5 gallons/flush	14.0	37.8	8.0	21.6
Conventional	5.5 gallons/flush	22.0	59.4	16.0	43.2
Conventional	7.0 gallons/flush	28.0	75.6	22.0	59.4
Showerheads [d]					
Efficient	2.5 [1.7] gal/min	8.2	22.1	na	na
Low-flow	3.0 to 5.0 [2.6] gal/min	12.5	33.8	4.3	11.7
Conventional	5.0 to 8.0 [3.4] gal/min	16.3	44.0	8.1	22.0
Faucets [e]					
Efficient	2.5 [1.7] gal/min	6.8	18.4	na	na
Low-flow	3.0 [2.0] gal/min	8.0	21.6	1.2	3.2
Conventional	3.0 to 7.0 [3.3] gal/min	13.2	36.6	6.4	17.2
Toilets, Showerheads, and Faucets Combined					
Efficient	na	21.0	56.7	na	na
Low-flow	na	34.5	93.2	13.4	36.4
Conventional	na	54.5	147.2	33.5	90.4

Source: Amy Vickers "Water Use Efficiency Standards for Plumbing Fixtures: Benefits of National Legislation ," *American Water Works Association Journal.* Vol. 82 (May 1990): 53.

na = not applicable
[a] Efficient = post-1994
Low-flow = post-1980
Conventional = pre-1980
[b] For showerheads and faucets: maximum rated fixture capacity (measured fixture capacity). Measured fixture capacity equals about two-thirds the maximum.
[c] Assumes four flushes per person per day; does not include losses through leakage.
[d] Assumes 4.8 shower-use-minutes per person per day.
[e] Assumes 4.0 faucet-use-minutes per person per day.

WaterWiser[49] provides information about domestic indoor water use with and without conservation. Figure 8 shows water use allocations for a typical, single family home. The numbers are based on the average inside uses measured in 1,188 homes in 12 cities in North America. The numbers calculated for Figure 8 include an additional 6% that accounts for existing conservation measures, appliances, and fixtures already in place. Water use amounts are shown in gallons per capita per day (gcd). Water use depicted in Figure 8 totals 74.0 gcd for indoor water consumption.

Figure 8. Typical Single Family Home Water Use Without Conservation.



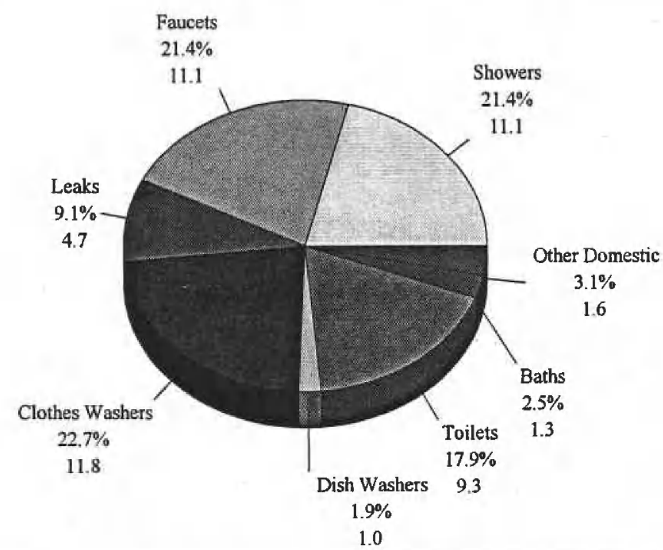
Source: American Water Works Association, 1998.

However, with conservation, the average home can decrease its water consumption by approximately 30% by installing water efficient appliances and minimizing leaks. This reduces the gallons per capita per day to 51.9 gcd from 74.0 gcd.

---

[49]WaterWiser is a cooperative project of the American Water Works Association, the U.S. Environmental Protection Agency, and the U.S. Bureau of Reclamation. Their mission is to be the pre-eminent resource for water efficiency and water conservation information.

Figure 9. Typical Single Family Home Water Use With Conservation.



Source: American Water Works Association, 1998.

Typical, single family home water use with conservation measures and fixtures is shown in Figure 9. Water use depicted in Figure 9 totals 51.9 gcd. Water fixtures and measures that produced Figure 9 include:

- Ultra-low flush toilets (1.6 gallons)[50]

---

[50]A toilet of this size satisfies the standard set forth in the Energy Policy and Conservation Act of 1992. The Act established national water conservation standards for showerheads (2.5 gallons per minute), toilets (1.6 gallons per flush), faucets (2.5 gallons per minute), and urinals (1.0 gallons per flush). These standards eased the problems associated with satisfying differing state and locality stipulations. However, there is controversy over the effectiveness of many of the early water efficient models. On the other hand, recent surveys in Santa Rosa, California and Denver, Colorado report a 95% and 87% consumer satisfaction rate respectively (Waterwiser, 1999). Proposed legislation (H.R. 859) introduced by Congressman Joe Knollenberg (R-Michigan) called for a repeal of the federal mandate on toilets of 1.6 gallons per flush capacity. The American National Standards Institute (ANSI), the Plumbing Manufacturers Institute, the National Association of Plumbing-Heating-Cooling Contractors, and the American Society of American Engineers (ASME) opposed the bill.

- Showerheads that use no more than 2.5 gallons per minute when wide open
- Faucets with a 2.2 gallon per minute maximum
- A high efficiency clothes washer that use 30% less water and 40 to 50% less energy
- Conduct routine leak detection and control

Eliminating leaks resulted in savings of 50%. Installation of fixtures and appliances resulted in savings of 52%, 30%, 16%, and 2% for toilets, clothes washers, showers, and faucets respectively (AWWA, 1998).

Figures 8 and 9 illustrate potential savings for residential use. Installation of new appliances and fixtures, however, is expensive and unnecessary for significant water conservation. For example, if a one-quart bottle (filled with sand or dirt to provide stabilization) were placed in a traditional toilet tank that uses five to seven gallons per flush, the bottle would save more than five gallons per day for a family of four. This simple conservation technique has approximately the same effect as placing a brick in a toilet tank. However, bricks are not recommended because they can break and cause problems (SFWMD, 1998). Repairing a dripping faucet can result in significant savings as well. If a faucet drips at a rate of one drop per second, 2,700 gallons per year will be lost (SFWMD, 1998).

By 2005, Seattle will improve indoor water efficiency by 19% over 1990 levels. This efficiency is being achieved through increasing water rates pricing structure, customer incentives, and plumbing code changes. Water savings are a result primarily from installation of high efficiency plumbing appliances (e.g. toilets, showerheads, dishwashers, washing machines, and faucet aerators) (Seattle Public Utilities, 1993).

During periods of peak demand, outdoor water use can account for a large percentage of total water use. According to information collected from 90 single family homes over a two week period during the summer in Seattle, 58% of end use occurred in irrigation or landscape water use. Attempts to reduce landscape water use included demo gardens, informative mailings and bill inserts, consumption histories on water bills, zoning and landscape codes, and summer campaign media coverage. The summer campaign and bill inserts are noted as one of four techniques that have worked best for Seattle in reducing peak demand (Dietemann, 1998). Other methods used in other regions of the U.S. have been: daytime irrigation bans, rain switch ordinances, landscape water management programs, production and distribution of lawn-watering guides, and drought tolerant planting methods (EPA (1), 1998).

Incentives: Several conservation measures are used successfully without consumer incentives, including education programs, dissemination of information concerning leak detection, mandatory regulations, and city ordinances. However, for additional conservation, or to encourage adjustment over a shorter period of time such as during peak demand,[51] incentives are often used. Incentives might require higher "up front" costs, but this could be less expensive than the alternative of developing new raw water sources.

Several municipal water providers have used incentives to encourage water conservation in the home. In 1993, Seattle Water implemented the Home Water Saver Apartment/Condominium Program. The program installed low flow showerhead and faucet aerators in one-third of the multi-family dwellings in Seattle. Savings amounted to 14 to 16 gallons per day (gpd) per dwelling. The new showerheads produced savings of 4.5 gpd, faucets saved 9.8 gpd, and toilets saved 0.8 gpd. (Other measures, reductions, and life span of the products are shown in Table 16). These are usually part of a broader conservation program that involves commercial and industrial entities. Some incentives include appliance rebates and retrofits.

Incentive Based Programs for Residential, Industrial, and Commercial Conservation

Seattle uses two incentive programs to encourage commercial conservation: a commercial toilet program and a commercial incentive program. The commercial toilet program provided a

---

[51]Seattle has been successful in reducing its peak demand by almost one-third while increasing its service population by approximately 20%. Direct benefits have resulted from postponement of some distribution and supply facility expansions, which have saved millions of dollars in debt service and helped to decrease short term rate increases. Indirect benefits include added operational flexibility in routing of flows in the distribution system, reduced energy pumping costs, and reductions in labor/overtime (Dietemann, 1998).

rebate of $100 to $160 for each qualified fixture. An average of 85 gpd was saved per fixture (Paschke et. al, 1998).

Tampa, Florida implemented a toilet-replacement incentive projects including rebate and retrofit programs. The Los Angeles residential program includes an ultra low-flush toilet rebate program. San Jose's retrofit program reduced flows by more than 25,000 gpd in 1991. Lompoc,

Table 16. Benchmarks for Savings from Selected Conservation Measures.

Category	**Measure**	**Reduction in end use**	**Life span (years)**
Universal Metering	Connection metering	20%	8-20
	Submetering	20-40%	8-20
Water accounting and loss control	System audits and leak detection	Based on system	na
Cost and pricing	10% increase in residential prices	2-4%	na
	10% increase in nonresidential prices	5-8%	na
	Increasing-block rate	5%	na
Information and education	Public education and behavior changes	2-5%	na
End-use audits	General industrial water conservation	10-20%	na
	Outdoor residential use	5-10%	na
	Large landscape water audits	10-20%	na
Retrofits	Toilet tank displacement devices (for toilets using >3.5 gallons/flush	2-3 gpcd	1.5
	Toilet retrofit	8-14 gpcd	1.5
	Showerhead retrofit (aerator)	4 gpcd	1-3
	Faucet retrofit (aerator)	5 gpcd	1-3
	Fixture leak repair	0.5 gpcd	1
	Governmental buildings (indoors)	5%	na
Pressure management	Pressure reduction, system	3-6% of total production	na
	Pressure-reducing valves, residential	5-30%	na

Category	Measure	Reduction in end use	Life span (years)
Outdoor water-use efficiency	Low water-use plants	7.5%	10
	Lawn watering guides	15-20%	na
	Large landscape management	10-25%	na
	Irrigation timer	10 gpcd	4
Replacements and promotions	Toilet replacement, residential	16-20 gpcd	15-25
	Toilet replacement, commercial	16-20 gpcd	10-20
	Showerhead replacement	8.1 gpcd	2-10
Replacements and promotions	Faucet replacement	6.4 gpcd	10-20
	Clothes washers, residential	4-12 gpcd	12
	Dishwashers, residential	1 gpcd	12
	Hot water demand units	10 gpcd	na
Reuse and recycling	Cooling tower program	Up to 90%	na
Water-use regulation	Landscape requirements for new developments	10-20% in sector	na
	Graywater reuse, residential	20-30 gpcd	na
Integrated resource management	Planning and management	Energy, chemical, and wastewater treatment costs	na

Source: Water Conservation Plan Guidelines, U.S. Environmental Protection Agency (EPA-832-D-98-001), 1998.

California developed a retrofit condition for new developments in the city. This ordinance required a developer to either carry out a retrofit program of existing housing or pay a fee to the city that would be directed into the city's retrofit rebate program for showerheads, kitchen and bathroom sinks, and toilets. New York City's Toilet Rebate Program began in 1994 for residents who have had a new water conserving toilet installed by a New York City licensed plumbing company (EPA homepage, 1999).

Seattle's commercial incentive program, offered up to a 50% rebate on technologies that qualified for incentives and involved 26 projects in its first year. In total, the 26 projects saved

560,000 gpd. It was estimated that the incentive programs reduced sector use by 20%. However, the program experienced participation barriers including identification of suitable projects, lack of available funding for feasibility research, up front costs, difficulties in coverage, skepticism, and credit/cash flow problems for small, struggling businesses (Dietemann and Paschke, 1998).

Seattle Public Utilities published the results of their commercial incentive program in "Program Evaluation of Commercial Conservation Financial Incentive Programs" (Dietemann and Paschke). Projects undertaken included a water recycling and treatment system for aquaculture at a research facility, an air washer for a soft drink bottling company, water fountain recycling at a park, and a cooling tower to replace single pass refrigeration at a fish market (Seattle Public Utilities, 1998).

Consumer Education

In a Sample Water Management and Conservation Plan for Athena, Oregon, the OWRD states that "public education is the foundation of every water conservation measure and is an essential component if a measure is to succeed" (OWRD, 1997). Distribution of water saving kits and other methods of education are popular means of increasing knowledge about conservation.

Water Saving Kits

Several cities have distributed water saving kits or fixtures as part of their water conservation programs. In Florida, Tampa's water efficiency program included the distribution of water-saving kits to 10,000 Tampa homes. The kits included two toilet tank dams, two low-flow showerheads, two lavatory faucets aerators, some Teflon tape, a pamphlet with instructions on detecting and fixing leaks, and leak detection dye tablets. A reported 94% of homeowners that received the kits installed the devices. An estimated 7 to 10 gcd were saved (EPA homepage, 1998). Lompoc, California also provided water conservation kits. The State of Connecticut requires water providers to provide "free" water-efficiency kits, payed for by users through their water rates (EPA homepage, 1998). In Oregon, the cities of Beaverton, Wilsonville, Bend, and Klamath Falls all distribute water saving kits. Oak Lodge administers a toilet bag program that saves one gallon per flush.

Other Methods Used in Oregon

Other methods of consumer education are being used by Oregon water utilities. For example, the Clackamas Water District conducts demonstrations at the county fair on water wise gardening and general conservation. Rockwood, Eugene, Medford, Gresham, and Salem all participate in a home and garden show and/or water wise landscaping and gardening. Fairview, Gladstone, Milwaukee, Corvallis, and Medford distribute newsletters. Distribution of water saving tips, leak detection pointers, and other bill stuffers is common. Youth education is conducted in Klamath Falls, Rockwood, Tualatin, Tualatin Valley Water District, Gresham, and Forest Grove (OEC, 1998).

The Sample Water Management Plan mentioned above suggests other possibilities. One suggestion is promoting "champions," or community and civic leaders who have developed and administered successful conservation programs. Other suggestions are water use comparisons in bills to draw consumer attention to water consumption changes, materials for in-school use that could be incorporated into the core curriculum, poster contests, and home interior and exterior water use surveys for school age children with prizes for completion such as low-flow fixtures. High school student programs could involve partnerships between city hall and high schools to manage a fixture retrofit program, with rebates provided to the school for each fixture replaced. Funds could be obtained through donations or a state grant (OWRD, 1997).

While education programs alone might not decrease water use by more than a few percentage points, education programs create the foundation for success of all future programs that involve citizen participation or public support.

Resolving the Conservation Paradox

Conservation rate structures, such as increasing block rates, or marginal cost pricing can dramatically change the revenues paid by each sector of the municipality. It also can increase revenue variability for the municipality. Table 17 outlines the basic steps and considerations in designing a rate structure and evaluating revenue effects.

Revenue instability increases costs in the form of increased borrowing, more complex planning, and increased political anxiety (Chestnutt et al., 1996). However, revenue uncertainty

Table 17. Steps in Designing a Rate Structure and Evaluating Revenue Effects.

Basic Steps	Basic Considerations
Express a percentage demand reduction goal for the water system	$\frac{\text{Water demand goal}}{\text{Current water demand}}$
Estimate the expected reduction in demand based on the price elasticity of demand for the service territory, by customer class if appropriate	Factors to consider and their relationship to elasticity: prices (+), consumer income (-), persons per household (-), rainfall (-), temperate climates (-)
Determine the percentage change in price needed to achieve demand reduction goals, by customer class if appropriate	$\frac{\text{Percentage reduction goal}}{\text{Estimated demand elasticity}}$
Calculate the revised price level	$\frac{\text{(\% Change in price) * (Existing price)}}{\text{Existing price}}$
Calculate the revised demand level	(% Change in price) * (Elasticity value)
Estimate revised revenues under the revised prices based on expected demand reductions	(Revised demand) * (Revised price)
Calculate revenue requirements based on reductions in variable costs resulting from reductions in demand	(Fixed costs) + (Variable costs at revised demand level)
Compare revised revenues with original revenues	(Revised revenues) - (Original demand * original price)
Select a rate structure that achieves the demand reduction goal while recovering allowable water system costs	In allocating costs, the impact of the rate structure on user demand and revenues for specific customer classes must be considered
Evaluate the need for special ratemaking provisions (such as cost-recovery or lost-revenue mechanisms)	Potential revenue instability can be addressed with additional rate structure modifications (e.g., revenue adjustments mechanisms)

Source: Adapted in part by Beecher et al., 1994 from the American Water Works Association, *Before the Well Runs Dry: Volume 1--A Handbook for Designing and Local Water Conservation Plan* (Denver, CO: American Water Works Association, 1984).

can be quantified. Chestnutt, McSpadden, and Christianson illustrate two types of high resolution micromodels of water demand (1996). Empirical measures of uncertainty can be used to create probability statements about surpluses and shortfalls in revenue. Once quantified, coping mechanisms can be used to hedge against the risks associated with revenue surplus and shortfall, including:

- Contingency funds;
- Incorporation of a margin of risk in revenue requirement determination;

- Automatic or more frequent adjustments to rates; and
- Cost reductions or deferrals (Beecher et al., 1994).

A contingency fund is also known as an annual carryover, a reserve fund, or a rate stabilization account (Chestnutt, et al., 1996). It can be argued that the risk of resource scarcity should be shared by consumers through higher rates (Jones, 1974). Alternatively, a regulating agency could provide revenue relief to help counter the negative, short-run effects of conservation.

The revenue neutral pricing mechanisms do not cause revenue instability, as long as the conservation baseline (under the feebate system) and the monthly water target (under DCS or WETS) are determined correctly. Because the revenue neutral systems might require readjustments, the system could benefit from one or more of the coping mechanisms listed above for conservation rate structures, including increasing block pricing. Marginal cost pricing requires price changes when cost changes occur: it assumes that costs will always exactly equal revenues if the marginal cost is determined after monthly consumption has been calculated.

Incorporating other conservation measures and methods will require re-examination of expected elasticities and estimates of risk and uncertainty to ensure revenue stability. For example, residential elasticity of demand for water will vary depending on knowledge about the importance of water conservation resulting from a city-wide education program.

Future Research Needs

Additional research is necessary to make conservation a possible option for Oregon coastal communities. To implement a water conservation programs, perhaps the most necessary element is accurate information. Municipalities must be aware of how much water is used and by whom. This information is necessary to assess and monitor water use. *Water Management and Conservation Plans* require these types of analysis. Often, this information is inaccessible and only approximate amounts of use are known. However, this information is necessary to calculate revenues and avoid shortfalls or instability when conservation based pricing structures or other conservation methods are implemented.

Research is needed about variability in seafood production and water demand variability. This information could be used to determine and predict approximately when and how often shortages might occur. Cities could then begin to develop plans that incorporate this knowledge and avoid emergency conservation planning that results in limitations and rules with high adjustment costs, limits on seafood processing production, and long implementation terms relative to plans established prior to a water shortage. The design of such a plan could also result in conservation planning by seafood processing plants and other large water users.

Because the concept is new to Oregon, coastal communities might need additional assistance in developing appropriate conservation plans and demand side management methods. Because costs of system operations are increasing, management of water will increasingly incorporate demand side and cost effective management. Because successful demand side management involves citizen cooperation, city councils and the public must be involved in water system and conservation planning. Environmental groups such as Waterwatch have provided Oregon communities with assistance in making improvements in their water use efficiency. Resource specialists within the Water Resources Department also provide water management assistance. However, they might be unable to assist all communities that need help. Available personnel are necessary to maintain the policies and principles stated in Oregon law and summarized in Section II of this report.

Conclusions

The State of Oregon advocates efficient water use and conservation according to each municipality's perceived needs and determination of options that are best for their individual situation. Conservation planning is required for those water utilities acquiring new raw water rights, but are not required for entities expanding use of currently held rights or for entities whose water resources are reaching unsustainable levels of withdrawal.

In addition to increasing peak demand and decreasing raw water supplies, the case studies indicate increasing costs of operation due partially to the need for new water system infrastructure and decreasing demand from the seafood processing industry. The increasing importance of the residential consumer has prevented rate increases and limited project options in some instances.

Expectations of water demand relative to water supply in coastal communities are increasing due to decreasing raw water supply options, increasing existence value of anadromous fish, and a growing tourism industry. By evaluating demand side forces and adopting efficient (or cost-effective) conservation strategies, municipalities might be able to "create" additional water supplies as they approach their service capacity.

Presently, conservation is not viewed as a desirable option due to its perceived revenue decreasing effects, i.e., the "Conservation Paradox." However, conservation measures exist that do not destabilize revenue. A revenue neutral "feebate" system developed by Robert Collinge could induce conservation while satisfying revenue needs. Water rates that use marginal cost pricing set costs equal to revenues thus avoiding revenue shortfalls while inducing conservation. In addition, estimation of revenue uncertainty is possible. Once revenue uncertainty is quantified, coping strategies can be used to avoid revenue shortfalls or exceedance of revenue needs.

Opportunities exist for the State to play a role in motivating municipalities to implement conservation programs. Due to revenue variability concerns resulting from conservation, the State could provide funding to ease the municipality's transition to a more efficient water system. Currently, the State offers workshops to assist municipalities in writing *Water Management and Conservation Plans*. Developing and implementing *Water Management and Conservation Plans* results in planning and organization of conservation programs. Additional municipal water conservation might assist in attaining the goals set toward salmon restoration through increased instream flows and decreased stress on undeveloped water sources. Identifying and eliminating the disincentives associated with the somewhat unutilized tool, conservation, will create an increased number of management options for use by coastal municipalities.

The recent listing of an additional nine salmon stocks in Oregon as threatened or endangered will place increasing pressure on all Oregon municipalities to conserve water and protect salmon habitat. Municipalities will need to identify conservation strategies that: 1) meet municipal objectives, including efficiency and equity; 2) are consistent with state and federal regulations; and 3) address the "Conservation Paradox." We believe the issues and options discussed in this report can help coastal Oregon communities develop conservation strategies to successfully meet these objectives.

REFERENCES

Alexander, Johnny. Personal communication.
City Manager
Port Orford City Hall
Port Orford, OR 97465
541-332-3681

Bastasch, Rick. 1998. *Waters of Oregon*. Corvallis: Oregon State University Press.

Beecher, Janice A., Patrick C. Mann, Youssef Hegazy, and John D. Standford. 1994. Revenue Effects of Water Conservation and Conservation Pricing: Issues and Practices. The National Regulatory Research Institute.

Billings, R. Bruce, and W. Mark Day. "Demand Management Factors in Residential Water Use: The Southern Arizona Experience," *Journal of the American Water Works Association,* vol. 81, issue 3, pp. 58-64.

Brinckman, Jonathan. "Species Act now covers NW salmon, steelhead." *The Oregonian*. March 17, 1999.

CH2M Hill, Inc. 1988. City of Newport Water System Master Plan.

Caten, Bill. Personal communication.
Latram Corporation
1-800-533-8253

Chase, Sue. Personal communication.
ODOT Fish Program
503-986-3008

Chestnutt, Thomas W., and Janice A. Beecher. 1998. "Conservation Rates in the Real World." *Journal of the American Water Works Association,* vol. 90, issue 2, pp. 60-70.

Collinge, Robert. 1993. "Optimal Conservation by Municipal Water Customers: A Revenue Neutral Feebate System." *Proceedings of Conserv 93: The New Water Agenda,* pp.707-717, American Water Works Association.

Collinge, R.A. 1992. "Revenue Neutral Water Conservation: Marginal Cost Pricing with Discount Coupons." *Water Resources Research*, pp. 617-622.

Collinge, Robert A. 1994. "Transferable Rate Entitlements: The Overlooked Opportunity in Municipal Water Pricing." *Public Finance Quarterly*, pp. 46-64.

Davis, Don. Personal communication.
Former Mayor of Newport
541-265-2465

Dean Runyan Associates. 1997. Oregon Travel Impacts and Visitor Volume, 1991-1997. Prepared for the Oregon Tourism Commission.

Dietemann, Allan. February 1998. "A Peek at the Peak - Case Study: Reducing Seattle's Peak Water Demand." Seattle Public Utilities.

Dietemann, Allen and Philip Paschke. 1998. "Program Evaluation of Commercial Conservation Financial Incentive Programs." Seattle Public Utilities.

Ernst &Young. 1992. Ernst & Young's 1992 National Water and Waste Water Rate Survey.

Espey, M., J. Espey, and W.D. Shaw. 1997. "Price elasticity of residential demand for water: A meta analysis." *Water Resources Research*, vol. 33, no. 6, pp. 1369-1374.

Fuller & Morris Engineering, Inc. 1997. Long-Range Water Supply. Project No. 9701.

Fuller, Jim. Personal Communication.
Consultant
Newport City Hall
810 SW Alder
Newport, OR 97365
541-265-5331

Gerston, Janice. 1997. "Conservation rates affect demand management." *Texas Water Savers*, vol. 3, no. 4.

Goldhor, Susan H., and Johan D. Koppernaes. A Seafood Processor's Guide to Water Management. Written for the New England Fisheries Development Association, Inc.

HGE Inc. Engineers & Planners. 1998. Water System Improvements.

HGE Inc. Engineers & Planners. 1995. City of Port Orford Water System Master Plan. Portland, OR.

Hamlin, Mark. Personal communication.

Handforth Larson and Barrett, Inc. 1993. City of Garibaldi Master Water Plan.

Lund, Jay R., and Robert U. Reed. 1995. "Drought Water Rationing and Transferable Rations." *Journal of Water Resources Planning and Management,* Nov./Dec. 1995, pp. 429-437.

McNurlin, Jerry. Personal communication.
Water Systems Manager
Port Orford City Hall
Port Orford, OR
541-332-3681

Nelson, Greg. Personal communication.
Planner
Water Resources Department
Resource Management Division
158 12th St. NE
Salem, OR 97310-0210
1-800-624-3199

Newport City Council. 1998. Resolution Establishing Sewer Service Fees.

Nieswiadomy, Michael. 1998. "Water Demand Management: The Effectiveness of Price as a Conservation Tool." In *Advances in Business and Management Forecasting,* vol. 2, pp. 113-129.

OWRD, WRIS database.

Oregon Administrative Rules, 690-086-0010.

Oregon Administrative Rules, 690-410-060.

Oregon Environmental Council. 1998. "Water Conservation: Is the Price Right?"

Oregon Water Resources Department. 1997. Water Rights in Oregon.

Paschke, Philip E., Suzan Hill, Shelley Lawson, and Matt Chadsey. 1998. "At the Vanguard of Commercial Water Conservation." Seattle Public Utilities.

Polen, Jim. Personal communication.
Former City Manager
Port Orford City Hall
541-332-3681

Lee Ritzman. Personal communication.
Public Works
Newport City Hall
810 SW Alder
Newport, OR 97365
541-265-5331

Sasaki, Sam. Personal communication.
City Manager
Newport City Hall
810 SW Alder
Newport, OR 97365
541-265-5331

Sample Water Management and Conservation Plan. 1997. Water Resources Department. Salem.

Schoberg, Mike. Personal communication.
City Planner
Newport City Hall
810 SW Alder
Newport, OR 97365
541-265-5331

Seattle Public Utilities. 1998. "Water Conservation Potential Assessment: Executive Summary."

Seattle Public Utilities. 1993. Long Term Water Conservation Plan.

Seattle Public Utilities. 1998. "Program Evaluation of Commercial Conservation Financial Incentive Programs."

Sheldon, Dennis. Personal communication.
Public Works Superintendent
City Hall
P.O. Box 708
Garibaldi, OR 97118
503-322-3327

Snover, Amy. 1997. "Impacts of Global Climate Change on the Pacific Northwest." Workshop Preparatory White Paper.

Southwest Florida Water Management District. 1998. "50 Ways to Do Your Part."

Tarno, Veral. Personal communication.
Oregon State Senator.
503-986-1724

Weber, Jack A. "Forecasting Demand and Measuring Price Elasticity." *Journal of the American Water Works Association,* vol. 81, issue 5, pp. 57-65.

(1)U.S. Environmental Protection Agency. 1998. "Regional Approaches to Efficient Water Uses: Tales from the Trenches." In Cleaner Water Through Conservation - Chapter 4. Washington, DC.

(2)U.S. Environmental Protection Agency. 1998. "Public Education." Washington, DC.

(3)U.S. Environmental Protection Agency. 1998. Water Conservation Plan Guidelines. Washington, DC.

Van Dyver, John. Personal communication.
Newport Water Plant Manager
Newport City Hall
810 SW Alder
Newport, OR 97365
541-265-7421

Martha Weaver. Personal communication.
City Administrator
Port Orford City Hall
Port Orford, OR 97465
541-332-3681

Additional Resources

Organizations

Oregon Environmental Council
520 SW 6th Avenue, Suite 940
Portland, OR 97204
503-222-1963
oec@orcouncil.org

Waterwatch of Oregon - Facilitates professional involvement from all natural resource fields. Provides information for sound decision-making in natural resources management.
921 SW Morrison, Suite 438
Portland, OR 97205
Phone: 503-295-4039
Fax: 503-295-2791
watrwtch@teleport.org

WaterWiser
Water Efficiency Clearinghouse
6666 W. Quincy Ave.
Denver, CO 80235
Phone: 800-559-9855
Fax: 303-795-1440
bewiser@waterwiser.org
http://www.waterwiser.org

Water Alliances for Voluntary Efficiency (WAVE) Program
Environmental Protection Agency
401 "M" St., SW
Mail Stop 4204
Washington, DC 20460
Phone: 202-260-7288
Fax: 202-260-1827
wave@epamail.epa.gov
http://es.inel.gov/partners/wave/wave.html

EcoTeam Program
Global Action Plan
David Gershon
P.O. Box 428
Woodstock, NY 12498
914-679-4830

American Water Works Association
http://www.awwa.org

Association of California Water Agencies
http://www.acwanet.com

NRCS's Water, Science and Tech. Services
http://www.wcc.nrcs.usda.gov/water/quality/wst.html

Seattle Public Utilities
http://www.ci.seattle.wa.us/util

Oregon Climate Service
http://ocs.orst.edu

Water for the 21st Century
http://www.csu.org/community/wtr21st/WPlan1.html

U.S. Water News
http://www.uswaternews.com/homepage.html

National Drought Mitigation
http://enso.unl.edu/ndmc/

Grants and Loans

Appendix E of Water Conservation Plan Guidelines
http://www.epa.gov:80/owmitnet/overview.pdf

EPA
http://www.epa.gov/ogd/grants.htm

Oregon Economic Development Department
http://www.econ.state.or.us/javahome.htm

WRD- Water Development Loan Fund
http://www.wrd.state.or.us/Index.html

Publications

"50 Ways to Do Your Part"
Southwest Florida Water management District
http://www.dep.state.fl.us/swfwmd/pamphlet/swf50way.htm

Water Conservation: Is the Price Right? - Includes survey results of 38 Oregon utilities' water rates and conservation programs (including activities, budgets, staff appointments, and dues)
Oregon Environmental Council
503-222-1963

USEPA Water Conservation Plan Guidelines - Step by step methods and conservation measures that water system planners can use to develop and implement plans for water conservation. The Guidelines include federal funding sources for water conservation.
http://www.epa.gov:80/owmitnet/overview.pdf

Directory of Water-Related Resources in Oregon. Oregon Water Resources Research Institute. February 1997.

Water Rights in Oregon - An Introduction to Oregon's Water Law and Water Rights System Water Resources Department. October 1997.

Revenue Effects of Water Conservation and Conservation Pricing: Issues and Practices by Janice A. Beecher Ph.D.; Patrick C. Mann Ph.D.; Youssef Hegazy Ph.D.; John D. Stanford, J.D. The National Regulatory Research Institute, Ohio State University. September 1994.

Managing the Revenue and Cash Flow Effects of Conservation
American Water Works Association Foundation

Alternative Rates
American Water Works Association