

# Table of Contents

<u>Section</u>	<u>Page</u>
<b><u>Executive Summary</u></b>	<b><u>ES-1</u></b>
Scope of Work	ES-2
Population Forecast	ES-2
Water Demand Projections	ES-5
Planning Criteria	ES-7
Description of Existing System	ES-10
Evaluation of Existing System	ES-11
Recommendations	ES-12
<b><u>Section 1 – Introduction</u></b>	<b><u>1-1</u></b>
Scope of Work	1-2
Authorization	1-3
<b><u>Section 2 – Population Forecast</u></b>	<b><u>2-1</u></b>
Estimated Recent and Current Population	2-
1	
Previous Population Forecasts	2-3
Future Population Forecasts	2-3
Metro 2015 Allocation	2-3
Maximum Build-out Projection	2-5
Rate of Growth Projection	2-6
Open-Lot Projection	2-6
Recommended Population Forecast	2-7
Maximum Build-out Projection	2-7
2015 Population Forecast	2-8
Urban Reserve Area	2-10
<b><u>Section 3 – Water Demand Projection</u></b>	<b><u>3-1</u></b>
Historical Water Demands	3-1
Water Demand Forecasts	3-3
Per Capita Consumption	3-3
Recommended Per Capita Consumption	3-4
Projected Demand	3-6

Urban Reserve Area	3-6
--------------------	-----

## **Section 4 – Planning Criteria** **4-1**

---

Planning Period	4-1
Planning Area	4-1
Design Criteria	4-2
Service Pressure	4-2
Source	4-2
Transmission Pipelines	4-2
Distribution Pipelines	4-2
Pressure Reducing Stations	4-3
Pump Stations	4-3
Storage	4-3

## **Section 5 – Existing System Description** **5-1**

---

General Description	5-1
Supply System	5-1
History of the SFWB	5-1
Clackamas River Basin Characteristics	5-2
Raw Water Quality	5-3
Watershed Management	5-6
Water Rights	5-6
Existing SFWB Facilities	5-6
Transmission to the City of West Linn	5-7
Emergency Intertie	5-8
Distribution System	5-8
Distribution System Water Quality	5-8
Pipelines	5-10
Reservoirs and Tanks	5-10
Pump Stations	5-12
Other Facilities	5-14
Instrumentation and Controls	5-14
Meters	5-14
Organization and Management	5-14
Staffing	5-14
Standards, Codes and Plans	5-15
Budget	5-15
Rates	5-15
Fiscal Policies	5-18

<b>Section 6 – Evaluation of the Existing System</b>	<b>6-1</b>
Field Observation of Key Facilities	6-1
Transmission Main	6-2
Reservoirs	6-2
Pump Stations	6-4
Pressure Reducing Valves	6-5
Recommended Improvements	6-6
Comparison of Source to Planning Criteria	6-8
Comparison of Reservoirs to Planning Criteria	6-8
Alternative Planning Criteria	6-8
Storage Calculations	6-8
Comparison to Other Communities	6-11
Emergency Vulnerability Assessment	6-11
Factors Influencing Storage	6-19
Comparison of Pump Stations to Planning Criteria	6-20
Comparison of Pipelines to Planning Criteria	6-21
Hydraulic Model Evaluation	6-22
Model Development	6-22
Demand Allocation	6-23
System Deficiencies Analysis	6-24
Capital Improvement Development	6-25
Identified System Deficiencies	6-26
Unaccounted-for Water and Pilot Leak Detection Survey	6-28
Water Supply	6-28
Measured Metered Water Use	6-29
Authorized Unmetered Water Uses	6-31
Water Losses	6-32
Summary of Unaccounted-for Water Survey	6-33
Recommendations	6-34
Review of Other Information and Issues	6-35
Emergency Supply/Source Reliability	6-35
Service Replacement	6-37
Water Quality	6-37
Operator Certification	6-38
Rate Structure	6-38
Conservation Programs	6-38
Staffing Level	6-39
Urban Reserve Area	6-39

<b><u>Section 7 – Basis of Cost Estimates</u></b>	<b><u>7-1</u></b>
-	
Pipelines	7-2
Storage Tanks and Reservoirs	7-3
Pump Stations	7-5
Maintenance Projects	7-5
<b><u>Section 8 – Summary of Public Involvement</u></b>	<b><u>8-1</u></b>
<b><u>Section 9 – Summary of Capital Improvement and Capital Maintenance Programs</u></b>	<b><u>9-1</u></b>
Capital Improvement Program (CIP)	9-1
Pipelines	9-1
Reservoirs	9-2
Pump Stations	9-6
Cost Allocations	9-7
Capital Maintenance Program	9-9
<b><u>Section 10 – Conclusions and Recommendations</u></b>	<b><u>10-1</u></b>
Conclusions	10-1
Recommendations	10-1
<b>References</b>	
<b><u>Appendix A Capital Improvement Program – Project Summaries</u></b>	
<b><u>Appendix B Capital Maintenance Program – Project Summaries</u></b>	
<b><u>Appendix C Facilities Field Inspection Worksheets</u></b>	
<b><u>Appendix D Results of Stakeholder Survey</u></b>	
<b><u>Appendix E Summary of Comments at Public Meetings</u></b>	

# Introduction

The City of West Linn currently receives its water as a wholesale customer of the South Fork Water Board (SFWB). SFWB is an ORS 190 (Intergovernmental Agreement) agency jointly owned by the cities of West Linn and Oregon City. The source water is the Clackamas River. The SFWB operates a conventional water treatment plant. This plant is located on the south side of the Clackamas River near its confluence with the Willamette River. The SFWB system includes an intake, the water treatment plant, and a transmission pipeline to a pump station located on Division St. in Oregon City. The City of West Linn's water system includes:

- a master meter from the SFWB system,
- a single 24" transmission line from the Division St. Pump Station which crosses the Willamette River on the I-205 bridge,
- approximately 100 miles of distribution and transmission pipelines,
- six reservoirs, three pump stations, 17 pressure reducing valves, and other facilities.

The City also maintains an emergency intertie with the City of Lake Oswego from its water treatment plant which is located in West Linn.

The last time that the City of West Linn undertook a comprehensive analysis of its water system was in the 1982 Comprehensive Water System Plan (Murray, Smith and Associates, 1982). A brief update to that plan was prepared in 1987 (Murray, Smith and Associates, 1987). The 1982 plan projected growth in water demand to 7.85 million gallons a day (mgd) by the year 2000 and identified over \$6,000,000 in projects which needed to be built to meet those demands. While some of those projects have been built and are in operation, others from the 1982 plan remain to be constructed. In June of 1996, the West Linn Water Rate Review Task Force (WLWRTF) recommended, as one of twelve recommendations, "that a new water master plan should be developed and followed...". This Master Plan fulfills that recommendation. This Master Plan is also required to partially fulfill the requirements of Goal 11, Public Facilities and Services, of the State of Oregon land use program. This Goal requires the City "to plan and develop a timely, orderly and efficient arrangement of public facilities and services to serve as a framework for urban and rural development".

This Master Plan is intended to be a recommended plan and long-term guide for the development of the City's water system. It is not intended to be a specific list of required projects. While projects are listed in this Master Plan as being scheduled for construction in a given year, this is intended only to provide a general guideline of priorities, relationships between projects, ties to levels of growth, and understanding of maintenance priorities. Each year the City should review the Master Plan and adopt a specific Capital Improvement and Capital Maintenance Program which incorporates the general guidelines of the Master Plan into the specific activities for that year. The Master Plan should also be reviewed and updated every five years to account for changing circumstances and new information.

The Draft of this Master Plan was reviewed by the Oregon Health Division (OHD), the State regulatory agency for drinking water systems. In a letter dated June 1, 1998, OHD found that "...this Master Plan meets the criteria of OAR 333-61-060 (5), and is approved" (Curry, 1998).

## **SCOPE OF WORK**

The general scope of work for this project was to update the Water Master Plan. The scope included tasks to:

- Review and develop new forecasts of population and water demands,
- Develop planning criteria to be used in evaluating the existing system and future system expansions,
- Evaluate the existing system for deficiencies compared to the planning criteria,
- Identify the system improvements needed to support anticipated growth and development and provide means to anticipate system improvements before growth is constrained,
- Prepare a Capital Improvement Program and a Capital Maintenance Program based on the evaluation of existing and future facilities,
- Prepare a study of unaccounted-for water and make recommendations to reduce the level of unaccounted-for water,
- Conduct a public involvement program associated with the development of the Master Plan.

Determining water system rates or financing mechanisms were not a part of the Scope of Work for this Master Plan.

The South Fork Water Board, which supplies water to the City of West Linn, recently completed a Water Master Plan for its system (Montgomery Watson, 1997). The SFWB Master Plan covers the supply system for the City of West Linn and should be read in conjunction with the City's Water Master Plan to obtain a complete picture of the City's water system. Improvements and other recommendations from the SFWB Master Plan are not repeated in this document.

#### **AUTHORIZATION**

Montgomery Watson was selected to prepare this Master Plan by the City in response to a Request for Proposals from the City of West Linn dated October 10, 1996. A contract authorizing the work was signed and dated January 27, 1997.

# **City of West Linn**

# Water System Master Plan

## Executive Summary

The City of West Linn currently receives its water as a wholesale customer of the South Fork Water Board (SFWB). SFWB is an ORS 190 (Intergovernmental Agreement) agency jointly owned by the cities of West Linn and Oregon City. The source water is the Clackamas River. The SFWB operates a conventional water treatment plant. This plant is located on the south side of the Clackamas River near its confluence with the Willamette River. The SFWB system includes an intake, the water treatment plant, and a transmission pipeline to a pump station located on Division St. in Oregon City. The City of West Linn's water system includes:

- a master meter from the SFWB system,
- a single 24" transmission line from the Division St. Pump Station which crosses the Willamette River on the I-205 bridge,
- approximately 100 miles of distribution and transmission pipelines,
- six reservoirs, three pump stations, 17 pressure reducing valves, and other facilities.

The City also maintains an emergency intertie with the City of Lake Oswego from its water treatment plant which is located in West Linn.

The last time that the City of West Linn undertook a comprehensive analysis of its water system was in the 1982 Comprehensive Water System Plan (Murray, Smith and Associates, 1982). A brief update to that plan was prepared in 1987 (Murray, Smith and Associates, 1987). The 1982 plan projected growth in water demand to 7.85 million gallons a day (mgd) by the year 2000 and identified over \$6,000,000 in projects which needed to be built to meet those demands. While some of those projects have been built and are in operation, others from the 1982 plan remain to be constructed. In June of 1996, the West Linn Water Rate Review Task Force (WLWRTF) recommended, as one of twelve recommendations, "that a new water master plan should be developed and followed...". This Master Plan fulfills that recommendation. This Master Plan is also required to partially fulfill the requirements of Goal 11, Public Facilities and Services, of the State of Oregon land use program.

This Master Plan is intended to be a recommended plan and long-term guide for the development of the City's water system. It is not intended to be a specific list of required projects. While projects are listed in this Master Plan as being scheduled for construction in a given year, this is intended only to provide a general guideline of priorities, relationships between projects, ties to levels of growth, and understanding of maintenance priorities. Each year the City should review the Master Plan and adopt a specific Capital Improvement and Capital Maintenance Program which incorporates the general guidelines of the Master Plan into the specific activities for that year. The

Master Plan should also be reviewed and updated every five years to account for changing circumstances and new information.

## **SCOPE OF WORK**

The general scope of work for this project was to update the Water Master Plan. The scope included tasks to:

- Review and develop new forecasts of population and water demands,
- Develop planning criteria to be used in evaluating the existing system and future system expansions,
- Evaluate the existing system for deficiencies compared to the planning criteria,
- Identify the system improvements needed to support anticipated growth and development and provide means to anticipate system improvements before growth is constrained,
- Prepare a Capital Improvement Program and a Capital Maintenance Program based on the evaluation of existing and future facilities,
- Prepare a study of unaccounted-for water and make recommendations to reduce the level of unaccounted-for water,
- Conduct a public involvement program associated with the development of the Master Plan.

Determining water system rates or financing mechanisms were not a part of the Scope of Work for this Master Plan.

The South Fork Water Board, which supplies water to the City of West Linn, completed a Water Master Plan for its system in September 1997. The SFWB Master Plan covers the supply system for the City of West Linn and should be read in conjunction with the City's Water Master Plan to obtain a complete picture of the City's water system. Improvements and other recommendations from the SFWB Master Plan are not repeated in this document.

The Draft of this Master Plan was reviewed by the Oregon Health Division (OHD), the State regulatory agency for drinking water systems. In a letter dated June 1, 1998, OHD found that "...this Master Plan meets the criteria of OAR 333-61-060 (5), and is approved" (Curry, 1998).

## **POPULATION FORECAST**

Recent historical population estimates for the City of West Linn are available from data provided by the Center for Population Research and Census, Portland State University (PSU). The PSU data represents estimates of population on July 1st of each year within the West Linn City limits. Their estimates are based on census counts published by the U.S. Census Bureau every ten years. Annual estimates between census counts are derived by analyzing supplemental data, including economic changes, building permits,



vehicle registrations, annexations, and other data. The PSU population estimates for the City from 1991 through 1998 are shown in Table ES-1. In addition to the City population, an estimated population of 560 outside the City limits (in the Tanner Basin) was served by the West Linn water system, for a July 1, 1998 total population of 21,965.

There have been several previous forecasts of population for the City of West Linn. The 1982 Water Master Plan forecast an ultimate build-out population of 58,000 persons based on the City's Comprehensive Plan at that time. The 1989 Sewerage Facility and Financial Master Plan Technical Report forecast a year 2010 population of 21,100 and an ultimate build-out population of 38,200 based on the zoning and growth rate observed at that time. In 1996, the City updated its System Development Charges (SDCs). That report utilized the 38,200 build-out population from the 1989 Sewer Master Plan and assumed that 85% of that population would be achieved by the year 2015, resulting in a year 2015 forecast population of 32,470.

**Table ES-1  
West Linn City Limits  
Recent Historical Population Estimate  
PSU Data Base**

YEAR	POPULATION	% ANNUAL GROWTH
1991	17,160	-
1992	17,645	2.83
1993	18,185	2.95
1994	18,860	3.83
1995	19,370	2.70
1996	19,960	3.05
1997	20,415	2.28
1998	21,405	4.85

Several methodologies and data sources are available and were used to forecast future population for the City. Metro has prepared a region-wide forecast of population to the year 2015, and then has allocated this regional forecast to specific communities. This forecast was obtained for the City of West Linn. A projection of maximum build-out population for the City was developed using the City's zoning at the time of the estimate and assuming that all existing land will redevelop to that zoning density, even if a lower density use is already present on the site. Another approach based on land use that was used, the Open-Lot Forecast, was to assume that the only lots which will develop are those that are currently undeveloped. Another method of population forecasting that was used was to assume that future growth rates will be similar to past growth. Both the high growth rates of the period of 1991 through 1996 and the lower growth rates of the longer period of 1980 through 1994 were projected forward. The results of all the various population forecasts are summarized in Table ES-2.

Of the build-out forecasts, the 1982 Water Master Plan forecast is out-of-date and should be discounted. The 1989 Sewer Master Plan gave a population projection of approximately 38,000. The current build-out forecast based on existing zoning yields a forecast between 30,600 and 43,800. A build-out assumption of 38,000 as used in the Sewer Master Plan and the SDC study would assure consistency in water and sewer planning. Thus, **it is recommended that a population of 38,000 be considered the build-out projection** for the purposes of this Water System Master Plan.

**Table ES-2  
City Of West Linn  
Summary Of Population Forecasts**

<b>SOURCE</b>	<b>2015</b>	<b>BUILD-OUT</b>
<b>1982 Water Master Plan</b>	na	58,000
<b>1989 Sewer Master Plan &amp; 1996 SDC Study</b>	32,470	38,000
<b>Metro 2015 Allocation</b>	25,731	na
<b>Historic Rate of Growth</b>	28,000 - 32,000	na
<b>Build-out Forecast</b>	na	30,600 - 43,800
<b>Open-Lot Build-out Forecast</b>	26,700 - 32,000	na

While there is uncertainty in the build-out projection, there is even more uncertainty in the rate at which or the pattern in which this build-out will be attained. Of all the forecasts for the year 2015, the Metro 2015 allocation provides the lowest estimate, at less than 26,000 persons. The historic rate of growth in the City (using the periods of 1980 through 1994 and 1991 through 1996) provides an estimate of between 28,000 and 32,000 persons by 2015. The analysis of potential for development of open lots within the City provides an estimate of between approximately 27,000 and 32,000 people by 2015. While the Open-Lot forecast does not predict when the lots will develop, it indicates that the City has readily available land that is appropriately zoned and which can be developed to continue the City's historic rate of growth.

There are a couple of factors that may make it reasonable to view the lower end of this range as the appropriate population forecast for 2015. First, the longer term historic rate of growth projects to the lower end of the range. While recent years have seen extraordinary growth in the City, it is unlikely that this rate of growth will continue unabated for the next twenty years. Second, Metro's allocation of 2015 population for the City and the policy the City adopted in 1997 to only require development at 70% of zoning density is less than the projected range, and thus there may be opportunities for

rezoning to reduced densities. Given these reasons, it is recommended that the lower end of the historic rate of growth projection be used. **The recommended 2015 population projection then becomes 28,000.** However, in reviewing the water system facilities for the year 2015, it is also recommended that the impact of a 32,000 population on the sizing of facilities be reviewed. This will assure that if the population increases at the higher end of the projection, a plan for increased facilities, if needed, will be available.

It must be recognized that these estimates are predictions based on the best information available at this time, and should be subject to continuous updating and adjustment based on the actual population growth that the City experiences over time.

## **WATER DEMAND PROJECTIONS**

The level of effort and sophistication which goes into estimating water demands can vary substantially. The demand projection in this Section relies upon historical information from the City and engineering judgment. In making a projection, it is important to understand the use of that projection. For this Water System Master Plan, the demand projections must be large enough so that the facilities that are planned will be adequate to cover future water needs in the community. At the same time, the demand forecast must not be too large, as then the planned facilities will also be too large, and unnecessarily expensive. The balance between these two concerns must be found. It is also important to understand that these projections are for planning purposes only. The final sizing and capacity of the recommended facilities should be evaluated against growth trigger points and reviewed during individual project predesign to determine their appropriate sizing and other design criteria.

Table ES-3 provides the historical water demands which the City of West Linn has experienced over the last several years. These demands are based on the water that is supplied to the City from the South Fork Water Board and the population data from PSU. The maximum day per capita demand ranged from a low of 249 gallons per capita per day (gpcd) to a high of 335 gpcd.

Predicting future water use has several inherent uncertainties. Per capita consumption in a community is influenced by many factors and can vary widely even between adjacent neighborhoods. Among the factors that cause this variability are the relative mix between residential, commercial and industrial users; the amount and type of landscaping; the area of lots which is irrigated; the use of automatic irrigation systems; the kind of irrigation systems that are used; the age of plumbing facilities in homes; the size of families in the neighborhood; and the amount of multifamily housing compared to single family housing. In addition, the peak demand in any given year is greatly influenced by the weather. The amount and frequency of summer rains and the temperature and duration of summer hot spells will vary substantially from year to year. Possible future changes in per capita consumption can occur due to conservation programs, the reduction (or increase) in unaccounted-for water, and changes in the mix of residential, industrial, and commercial water use. This latter change can occur if a

large manufacturing facility were to locate in or leave the City. The water demand characteristics of future residential growth also may not replicate the water demand characteristics of historical residential use, due to differences in lot sizes, landscaping, and the number and nature of water using fixtures. Denser development tends to have lower per capita consumption than more spread out development. New neighborhoods tend to have higher per capita consumption than more established neighborhoods due to the construction activity, new lawns, and a greater prevalence of automatic sprinkling systems.

**Table ES - 3  
West Linn Historical Water Demand Summary**

Year	Population Served	Annual Average of Daily Demand (mgd)	Maximum Daily Demand (mgd)	Per Capita Demand, gpcd	
				Average Annual	Maximum Daily
1991	17,160	2.51	5.33	146	<b>311</b>
1992	17,645	2.62	5.59	148	<b>317</b>
1993	18,165	2.47	4.52	136	<b>249</b>
1994	18,860	2.85	6.31	151	<b>335</b>
1995	19,930	2.72	5.72	136	<b>287</b>
1996	20,520	2.84	6.50	138	<b>317</b>
1997	20,975	2.79	6.00	133	<b>286</b>
1998	21,965	2.91	6.54	132	<b>298</b>

While the peak day per capita consumption can vary significantly from year to year due to the weather, there tends to be an upper limit in a community to the per capita consumption. Based on the distribution of the citywide values, it would not be unreasonable to expect peak day per capita consumption values up to approximately 5% higher than shown in this Table ES -3 under extreme weather conditions. Thus, the City-wide peak day per capita consumption could be as high as around 350 gpcd in a particularly hot year, even though the historical high over the last several years has been 335 gpcd.

For the purposes of this plan, it is recommended that for the peak day, the 350 gpcd figure be used for the year 2015 demand projection. This figure allows for relatively high consumption due to new construction and development in the City over this period. It also assures that even if the actual population growth is greater than the projected population growth, there is unlikely to be an extreme shortage of water supply and the need for curtailment. However, it is also anticipated that as denser development continues in the City and the effects of regional conservation measures take place, this level of per capita use should likely decrease. Thus, for the ultimate build-out population projection for the City, the lower peak day per capita consumption figure of 335 gpcd is recommended.

For the purposes of this plan, it is also recommended that the future average daily per capita demand be assumed to be 143 gpcd. This is approximately the arithmetic average of the average daily per capita demand over the six year period of 1991 through 1996.

It must be recognized that these estimates are predictions based on the best information available at this time, and should be subject to continuous updating and adjustment based on the actual water demand that the City experiences over time.

The future water demand forecast is obtained by multiplying the recommended per capita usage rate discussed above times the recommended population forecast. The results of this calculation are shown in Table ES - 4.

**Table ES - 4  
City Of West Linn  
Summary Of Projected Water Demands**

<b>YEAR</b>	<b>2015</b>	<b>BUILD-OUT</b>
<b>Population</b>	<b>28,000</b>	<b>38,000</b>
<b>Peak Day Per Capita Consumption (GPCD)</b>	<b>350</b>	<b>335</b>
<b>Average Day Per Capita Consumption (GPCD)</b>	<b>143</b>	<b>143</b>
<b>Average Daily Demand (MGD)</b>	<b>4.00</b>	<b>5.43</b>
<b>Peak Day Demand (MGD)</b>	<b>9.80</b>	<b>12.73</b>

**PLANNING CRITERIA**

Development of recommendations in this Water System Master Plan depend upon establishment of planning and analysis criteria which are used to evaluate the existing facilities and plan for new facilities. The criteria that have been used in this Master Plan include:

**Planning Period.** Three planning horizons are considered. Deficiencies of the existing system are identified. A detailed evaluation is conducted to the year 2015. Finally, the ultimate build-out population and development are analyzed.

**Planning Area.** The planning area for the Master Plan is the limit of the current City of West Linn water system. This includes all areas within the City limits and areas outside the City limits but within the Metro Urban Growth Boundary. The Master Plan examines the impacts on the current water system of service to land in the Metro Urban Reserve Area that is adjacent to the City of West Linn. The details of water system development in the URA are not evaluated.

**Service Pressure.** The minimum pressure that must be maintained in the system per State of Oregon Health Division standards is 20 pounds per square inch (psi). This pressure must be maintained even during a fire flow event on a peak demand day. The typical operating pressures that are currently obtained from the existing tanks and reservoirs of between 45 psi and 170 psi should be maintained.

**Source.** The main source of supply should be capable of providing the projected peak day demand. It should meet this demand with firm capacity - that is, with the largest pump, filter or other component of the system out of service. The City should also have an emergency source of supply that is capable of providing the average day demand for the length of time that the primary source of supply is out of service, such period lasting up to a week. This emergency source could be provided through an intertie, storage, a secondary source, or other methods.

**Transmission Pipelines.** Transmission pipelines are considered as those greater than or equal to 10-inches in diameter. Pipeline flow velocities in transmission pipelines should be less than 5 feet per second. All water transmission pipelines greater than or equal to 24-inches in diameter should be capable of providing peak day demands. All other transmission pipelines should be capable of supplying peak hour demands.

**Distribution Pipelines.** Distribution pipelines should be sized to serve peak hour demands and fire flow requirements. Flow velocities for a distribution system pipeline should be below 10 fps and headloss in the pipeline should be below 10 ft per 1000 ft of pipeline. Minimum pipeline diameter for new distribution pipes will be 6-inches in diameter. Any pipeline below 6-inches should be upgraded before being equipped with a fire hydrant. A 6-inch line with a fire hydrant should be part of a looped system or be no more than 500 feet in length.

**Pump Stations.** Pump stations should be sized for a firm capacity equal to the peak day demand. For reliability, power supplies to pump stations should have either two

sources of primary power feed, or one main source and standby or emergency power. The secondary power supply should be sized so that available pumping capacity is equal to average day demand, or fire flow, whichever is greater.

**Storage.** Storage facilities in water systems are generally provided for four purposes - equalization storage, operational storage, fire storage, and emergency storage. The total storage required in any tank or reservoir is the sum of these four components plus the dead storage (the volume of the tank that is unavailable to use due to physical constraints).

Equalization storage is needed in a water system to meet water system demands in excess of the transmission/pumping delivery capacity from the supply source to the reservoir. A value of 25 percent of peak day demand is recommended for equalization storage. Operational storage may be needed if the supply source does not continuously deliver supply. However, the South Fork Water Board maintains storage for this purpose and the City of West Linn does not operate its distribution system in a manner that requires additional operational storage beyond equalization storage.

Fire storage is provided to meet the single most severe fire flow demand within the system or pressure zone served by the storage facility. The fire storage volume required is determined by multiplying the fire flow rate by the duration of that flow.

Residential fire flows are 1000 gpm for 2 hours and can be applied at any fire hydrant in the pressure zone. Commercial, industrial, and multi-family fire flows can be applied at any fire hydrant within areas that have appropriate land use zoning and may be specific to the zoning and actual facilities in place. The City has established a 3,000 gallons per minute (gpm), three-hour duration, fire flow throughout the City for commercial, industrial, and multi-family areas. The current fire flow requirements are the result of recent building and fire code changes and efforts to retrofit West Linn schools with sprinklers.

Emergency storage is provided to supply water from storage during emergencies such as power outages, equipment failures, pipelines failures or natural disasters. The amount of emergency storage provided can be highly variable and is dependent upon an assessment of risk and the desired degree of system reliability. An emergency supply equal to one day of average demand within a pressure zone is considered typical for most distribution systems and is appropriate for the City of West Linn's system.

It is also desirable, although not required, that storage be provided from at least two separate storage reservoirs or is available through pumping or gravity from a secondary reservoir at a different elevation. This provides for continuous operations during maintenance, repairs or reconstruction or modifications to any single reservoir.

Based on the above criteria, the total recommended required storage in each pressure zone will consist of 25% of projected peak day demand for equalization plus the largest

fire flow demand plus one average day demand for emergencies. The proposed new criteria are typical of urban water systems. This compares with the storage criteria under the existing 1982 Water Master Plan of fire flow plus 20% of peak day demand. The existing 1982 Water Master Plan storage criteria would be considered the minimum level that would be acceptable in a water system. Although no longer required by regulation, for many years the Oregon Health Division's (OHD) drinking water standards required three average days of storage in water systems. Meeting the three days average demand criteria would generally result in even greater storage volumes being required than the criteria recommended in this Master Plan. All of these options for fire flow and storage criteria have been evaluated in this Master Plan.

## **DESCRIPTION OF EXISTING SYSTEM**

The City of West Linn currently receives its water as a wholesale customer of the South Fork Water Board (SFWB). The City then maintains and operates the transmission and distribution system to its water customers. The City of West Linn's connection to the SFWB system occurs on the discharge side of the Division Street Pump Station, through a master meter currently owned by the City and a 24-inch diameter transmission main. The 24-inch diameter transmission main proceeds across the Interstate 205 bridge from the Division Street Pump Station and connects to the City of West Linn's distribution system at the west end of the bridge. The transmission system was designed to have a capacity of approximately 13 million gallons per day.

The Cities of West Linn and Lake Oswego and the SFWB have an intergovernmental agreement to operate and maintain an 18-inch diameter intertie between the Lake Oswego water supply system and the 24-inch diameter transmission line in West Linn from the SFWB system. This intertie is designed to provide up to 3,750 gallons per minute, or 5.4 mgd, to West Linn from Lake Oswego.

The distribution system network is comprised of over 104 miles of pipes in sizes up to 24-inches in diameter. The pipe types include asbestos cement, cast iron, ductile iron, copper, steel, polyvinyl chloride, and galvanized iron. The oldest pipes in the system probably date back to 1915 when the SFWB was first developed.

The system has a total storage capacity of 6 million gallons spread across six storage reservoirs and tanks. The largest, the Bolton Reservoir, was built in 1913, and the smallest, the Rosemont Tower, was built in 1991. The water system includes three pump stations, the Willamette, Bolton, and Horton Pump Stations. The system also includes 17 pressure reducing stations, creating 13 subzones. A System Control and Data Acquisition (SCADA) system is used to control and monitor pumps, tanks, and other components. There are approximately 7,000 water meters throughout the water system. Over 96% of these meters are residential, 5/8 X 3/4-inch meters. Most of the remaining meters are 1-inch, 1 1/2 -inch, and 2-inch meters which serve multifamily, apartments, commercial, and public facilities.

The West Linn system is operated by a Water Crew Chief, a water quality control person, and four water distribution system operating personnel. The Water Crew Chief



reports to an Operations Manager, who has responsibility for sanitary sewers, storm water, solid waste and recycling, transportation, and vehicle maintenance in addition to water operations. Engineering support is provided by the Engineering Division of Public Works, which also supports the other operating functions of the City. Overall system management responsibility extends from the Public Works Director to the City Manager and the City Council.

The total yearly operating and maintenance budget for the water system is approximately \$2,000,000. For the 1997 - 98 fiscal year, over 40% of that budget is for payments to the South Fork Water Board for purchase of the water supply. The remainder of the budget goes to personnel costs for the water system employees and required ongoing training and certification (21%); utility bills to run the pump stations and other facilities (4%); materials for meter installation, main repair, facility repair and vehicle upkeep (6%); accounting and billing (4%); engineering and administrative support (11%); outside professional services (4%); and various miscellaneous administrative and other costs (10%). In addition to the operating and maintenance budget, a budget is maintained for Capital Maintenance Projects such as main replacement and reservoir painting.

The City currently bills its customers every other month. The units of measure which is used is a hundred cubic feet, or "ccf" (1ccf = 100 cubic feet = 748 gallons). A typical residential user is charged approximately \$19.70 bimonthly and receives the 14 ccf (10,472 gallons) of water use for that charge. For each additional ccf of water use, a commodity charge of \$1.14 is incurred.

## **EVALUATION OF THE EXISTING SYSTEM**

The City of West Linn's water system was evaluated in several ways in this Water System Master Plan. These methodologies included field inspection of key facilities; a comparison of key facilities to the planning criteria; an hydraulic model of the system; an unaccounted for water survey and leak detection pilot test; and a review of data, records and other information. Based on these evaluations, the following broad conclusions were drawn.

- The City of West Linn has a reliable long-term source of water. The South Fork Water Board will have adequate water to serve the needs of the City to its buildout population, from its current Clackamas River source. As long as the existing intertie with the City of Lake Oswego remains able to supply the 3,750 gpm design capacity, and Lake Oswego is willing to provide the water, the City of West Linn can be considered to have an adequate emergency backup source.
- The water quality of the both the Clackamas River supply and the West Linn distribution system is excellent. The system meets all existing regulations and is anticipated to continue to do so into the future as long as it accomplishes the required Capital Maintenance and Capital Improvement projects as needed.

- Significant investments in distribution system improvements are needed. These improvements are needed to correct existing deficiencies, to meet the needs of population growth, to provide more reliable service, and to meet proposed criteria for water system development.

## RECOMMENDATIONS

To meet the objectives stated above, a Capital Improvement Program that is shown in Table ES-5 should be funded. The cost of the recommended Capital Improvement program to the year 2015 is estimated to be about \$13.2 million. Another \$11.1 million would be spent after the year 2015 to meet the City's needs to buildout. Of the total capital needs of over \$24.3 million represented by the projects in the Master Plan, 67.5%, or \$16.4 million are allocated to future system, or growth. The remaining 32.5%, or \$7.9 million, is allocated to the existing system. Of the \$13.2 million in capital projects that are recommended prior to the year 2015, about 47%, or \$6.1 million, is allocated to existing customers and 53%, or \$7.1 million is allocated to future growth. Assuming approximately 7,000 services in the City currently, this represents a total of about \$872 per household, or \$54.50 a year averaged over the 16 year period assumed available to the year 2015.

Among the improvements attained through these projects are:

- Existing flow and pressure deficiencies at peak hour in the Bolton, Rosemont, Bland, Robinwood and Willamette Zones will be corrected.
- Existing pressure deficiencies during fire flows events in the Robinwood Zone will be corrected.
- The system improvements to accommodate the projected growth in water demand to the year 2015 will be provided.
- An emergency generator for the Willamette Pump Station would be provided.
- The Bland Circle No. 2 Reservoir, the Horton No. 2 Reservoir, and the Horton No. 2 Pump Station would be constructed to serve the Willamette, Bland, Horton and Rosemont zones.

As part of this Capital Improvement Programs the City should:

- Affirm a fire flow requirement throughout the City of 3,000 gpm for 3 hours.

- Adopt new storage criteria of fire flow plus 25% of maximum day demand for equalization plus one average day demand for emergency storage as a long-term goal.
- Bring sites that are available within the City of West Linn and that could serve the needs of both the SFWB and the City to the attention of the SFWB, and seek to build a joint-use reservoir with the SFWB.
- Replace the View Drive Reservoir at a higher elevation. This may be the same location/reservoir as the joint SFWB reservoir.

**In addition to the Capital Improvement Program, over the next five years approximately \$4.75 million is recommended for a Capital Maintenance Program. This recommended program is shown in Table ES - 6. This amount would be funded by existing customers. Assuming approximately 7,000 services in the City currently, this represents a total of about \$678 per household, or \$136 a year (\$11 a month) averaged over the 5 year period.**

This Capital Maintenance Program should:

- Stabilize the landslide at the Bolton Pump Station and stabilize potential areas for landslide along the 24-inch diameter supply line from the SFWB.
- Provide for the replacement of small, undersized water mains throughout the City.
- Make seismic, coatings, and cathodic protection repairs and improvements at the existing reservoirs.
- Solve flooding problems at existing PRV vaults.
- Provide for ongoing replacement of existing water meters on a 15 - 20 year cycle (between 430 and 325 meters a year) and services on a 75 year cycle.
- Make maintenance improvements to the I-205 Transmission Main to assure its continued operation.
- Make other minor repairs to assure the longevity of existing facilities.

**Table ES - 6  
Recommended Capital Maintenance Program**

<b>PROJECT</b>	<b>COST (\$)</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
Horton Reservoir Repair	\$50,000	\$50,000				
Bolton Slide Stabilization	\$200,000	\$200,000				
Reservoir Coatings	\$630,000	\$30,000	\$200,000	\$200,000	\$100,000	\$100,000
Reservoir Seismic Repair	\$180,000	\$40,000	\$50,000	\$30,000	\$30,000	\$30,000
PRV Vault Repair	\$80,000	\$16,000	\$16,000	\$16,000	\$16,000	\$16,000
Reservoir Cathodic Protect.	\$55,000	\$15,000	\$10,000	\$10,000	\$10,000	\$10,000
Service Replacement	\$190,000	\$38,000	\$38,000	\$38,000	\$38,000	\$38,000
Meter Replacement	\$130,000	\$26,000	\$26,000	\$26,000	\$26,000	\$26,000
Bolton Res Improvements	\$20,000	\$20,000				
Horton PS Improvements	\$40,000			\$40,000		
Lk. Oswego Intertie Upgrade	\$75,000		\$75,000			
Main Replacements	\$2,700,000	\$540,000	\$540,000	\$540,000	\$540,000	\$540,000
I-205 Main Catwalk&Fall Pro	\$400,000		\$400,000			
<b>TOTAL</b>	<b>\$4,750,000</b>	<b>\$975,000</b>	<b>\$1,355,000</b>	<b>\$900,000</b>	<b>\$760,000</b>	<b>\$760,000</b>

Note: Costs based on Seattle area ENR of 7124

**To develop better information over time on unaccounted-for water, and to reduce the amount of such losses, the following recommendations are made:**

- A routine leak detection program should be implemented. The complete system should be surveyed once every five years at minimum. Because the City already owns the sonic detection equipment necessary to conduct the survey, the City can conduct the survey with its own personnel, or it may contract with a leak detection survey firm.
- A leak repair log should be maintained. The estimated quantity of water that is being lost by each leak which is found and repaired, whether from the routine leak detection program or as a part of other activities, should be recorded.
- Unmetered water use reports should be maintained as part of the monthly operating logs. Water uses such as pump lubrication, main flushing, fire hydrant inspections, tank cleaning and draining, etc. should be recorded so as to maintain accurate unmetered water use statistics.
- Records on the amount of water used for fire fighting, hydrant flushing, and fire training should be maintained to record unmetered water use.
- All large meters (3-inch or greater) that are presently not outfitted with test ports, should be so fitted, and then tested on an annual basis.
- A pilot test program of small meters should be conducted. Fifty to 100 small meters representing the various models and ages (with an emphasis on older meters) in the system should be removed and tested to determine what the typical average rate of

underregistering is in the system and at what point it will become economical to replace them. Many systems have found that a schedule of replace of between 15 and 20 years, regardless of their condition, is economical.

- A program of metering construction water use, either through an honors system permit or through issuance of hydrant meters and construction water permits, should be considered. This would provide more detailed information on this unmetered water use and may add revenue from more accurate accounting of water use.

**When the City modifies its water rates, the City should:**

- Consider a cost-of-service rate structure which charges a commodity charge for all water used.
- Consider an inclining block rate structure for summer water use to the commodity component of its rate structure to encourage conservation.

**Other recommendations include:**

- The City should review its contractual agreement with the City of Lake Oswego with a view to strengthening that agreement to assure that the emergency intertie between the two systems will be available and operable whenever it is needed.
- The City, in conjunction with the SFWB, should obtain water quality data on Haloacetic Acid (HAA) levels in its system, to confirm that it has low levels of this compound that will soon be regulated.
- The City should prepare for other upcoming new federal drinking water regulations, including the Consumer Confidence Report which will be required starting in 1999.
- The City should participate in the regional Conservation Coalition effort that is identifying appropriate and achievable levels of conservation within the area. When the information from the Coalition work is available, the City should use it to expand its own conservation programs. In the interim, the City should provide public information about wise water use and begin to prepare for adoption of potential conservation program elements, such as landscape ordinances and industrial, commercial and residential water audits, in addition to the leak detection and rate structure evaluations discussed elsewhere in this section.
- The City must plan for and develop operators with the Level 3 certification.
- The City should expand the steady-state hydraulic model that has been developed in this Master Plan to a dynamic model, called an "extended period simulation" model, which will allow it to optimize the operation of the water system.

- The City should review its staffing levels and increase staffing as needed in order to implement the recommendations of this Master Plan. It appears that the staff have very little time to conduct efforts which go beyond the routine maintenance and operation to more long-term goals of improving the system. Recommendations such as increased leak detection work, conservation program development, better record keeping of unmetered water uses, and evaluation of the impacts of upcoming water regulations, which are contained in this Master Plan, are unlikely to be able to be implemented with the current staffing levels.
- The City should review its Design Code and determine whether changes are appropriate to it once this Water System Master Plan has been adopted.
- The City should update its System Development Charges once this Master Plan has been adopted.
- Each year, the City should adopt a Capital Improvement Program and a Capital Maintenance Program that incorporates the general guidance of the Master Plan into specific activities.
- This Master Plan should be reviewed and revised at least every five years in order to account for continually changing circumstances and conditions.

# Section 2

## Population Forecast

Water demand forecasts generally rely on estimating two key parameters - the population that is to be served and the amount of water each member of that population is likely to consume. The level of effort and sophistication that goes into estimating those two parameters can vary substantially. At one end of the spectrum are detailed econometric models that relate specific consumption patterns to individual types of water users and uses and forecasts future populations based on many trends. At the other end of the spectrum are simple calculations using broad regional averages of consumption and population growth. While the level of data and other information that is required across this spectrum of approaches varies, the need to estimate the two fundamental components of the forecast remains constant in all approaches. This Section provides the estimate for population that will be used in the West Linn Water Master Plan.

### ESTIMATED RECENT AND CURRENT POPULATION

The last time the City of West Linn conducted a comprehensive Water Master Plan was in 1982 (Murray, Smith & Associates, 1982). At that time, the 1980 census population for the City was 12,956 with an estimated additional 300 persons served by the water system but outside the City limits, for a total of 13,256 persons served by the water system.

In the Portland metropolitan region, Metro has the responsibility for managing regional growth. In carrying out this responsibility, Metro has developed the most extensive and accurate base of information in the region on population, households, and employment. They have developed this information in a computer based Geographic Information System (GIS). This system provides detailed data in 50 ft by 50 ft Transportation Analysis Zone "pixels" throughout the region. This data base was used to develop an estimate of current population in this Master Plan.

The City of West Linn provided Metro with a digital map of its water system showing the boundaries of the each pressure zone, including subzones. Metro then overlaid this map on its pixel data base of population and households for the area. Using this overlay, Metro then provided the total population and number of households within each subzone. The most recent date for which historical information was available at the time the forecast was prepared was January 1, 1994. The average number of persons per household was then calculated from these data. Table 2 - 1 shows the historical results. The figures in Table 2 - 1 include persons served by the West Linn water system, but who are outside the current City limits.

TABLE 2 - 1

## CITY OF WEST LINN

### JANUARY 1, 1994 BASELINE POPULATION METRO DATA BASE

Zone	Number of Households	Population	Calculated Average
------	----------------------	------------	--------------------

ES - 19

			Population per Household*
<b>Horton</b>	1336	<b>3876</b>	2.9
<b>Rosemont</b>	1405	<b>4268</b>	3.04
<b>Willamette</b>	1400	<b>4040</b>	2.89
<b>Bolton</b>	1581	<b>4565</b>	2.89
<b>Robinwood</b>	647	<b>1741</b>	2.69
<b>Bland</b>	266	<b>797</b>	3.0
<b>TOTAL</b>	<b>6635</b>	<b>19,287</b>	<b>2.91</b>

\*NOTE: Calculation may not appear accurate due to rounding of household and population data in tables.

Recent historical population estimates for the City of West Linn are also available from data provided by the Center for Population Research and Census, Portland State University (PSU). The PSU data represents estimates of population on July 1st of each year within the West Linn City limits. Their estimates are based on census counts published by the U.S. Census Bureau every ten years. Annual estimates between census counts are derived by analyzing supplemental data, including economic changes, building permits, vehicle registrations, annexations, and other data. The PSU population estimates for the City from 1991 through 1996 are shown in Table 2-2. In addition to the City population, an estimated population of 560 outside the City limits (in the Tanner Basin) was served by the West Linn water system, for a July 1, 1998 total population of 21,965.

**TABLE 2 - 2  
West Linn City Limits  
Recent Historical Population Estimate  
PSU Data Base**

YEAR	POPULATION	% ANNUAL GROWTH
1991	17,160	-
1992	17,645	2.83
1993	18,185	2.95
1994	18,860	3.83
1995	19,370	2.70
1996	19,960	3.05
1997	20,415	2.28
1998	21,405	4.85

### PREVIOUS POPULATION FORECASTS

There have been several previous forecasts of population for the City of West Linn. The 1982 Water Master Plan (MSA, 1982) forecast a year 2000 population of 23,100 based on the West Linn's Comprehensive Plan in effect at that time and the rate of growth in the late 1970's and early 1980's. It also forecast an ultimate build-out population of 58,000 persons, again based on the City's Comprehensive Plan at that time.



A new population forecast was prepared in the 1989 Sewerage Facility and Financial Master Plan Technical Report (MSA, 1989). That Master Plan forecast a year 2000 population of 17,300, a year 2005 population of 19,100 and a year 2010 population of 21,100. This estimate was based on the City's Comprehensive Plan at that time and the lower growth rates which were observed in the early 1980's. It forecast an ultimate build-out population of 38,200 based on the zoning at that time.

In 1996, the City updated its System Development Charges (SDCs). That report (Financial Consulting Solutions Group, 1996) utilized the 38,200 build-out population from the 1989 Sewer Master Plan and assumed that 85% of that population would be achieved by the year 2015. That resulted in a year 2015 forecast population of 32,470.

## **FUTURE POPULATION FORECASTS**

### **Metro 2015 Allocation**

In addition to maintaining a detailed data base of the population, households and employment in 1994, Metro also prepared a Portland metropolitan region forecast of population for the year 2015. This forecast was prepared based on a detailed evaluation including employment, demographic, and growth data. This forecast was prepared on a region-wide basis. Once this forecast was completed, Metro went through a process of allocating the growth predicted by that forecast, to specific communities within the region. This allocation does not represent a direct forecast of the growth in the community. Instead, it is a reasonable proportionate share of the forecast regional growth.

The City of West Linn provided Metro with a digital map of the water system showing the boundaries of the each pressure zone, including subzones. Metro overlaid this water system map on its pixel data base of population and household allocation for the area as of March, 1997. Using this overlay, Metro then provided the allocated total population and number of households within each subzone for the year 2015. This data is shown in Table 2 - 3. The projections in Table 2 - 3 include all persons served by the West Linn water system, both inside and outside the current City limits. They do not include population for any future areas that have been designated by Metro as areas of future urban growth, called urban reserve areas (URAs). The URA which is adjacent to the City of West Linn and which Metro has identified as being served in the future from West Linn is Metro URA # 30.

**TABLE 2 - 3  
CITY OF WEST LINN  
METRO 2015 POPULATION ALLOCATION**

<b>Zone</b>	<b>Number of Households</b>	<b>Population</b>	<b>Calculated Average Population per Household*</b>
<b>Horton</b>	2169	<b>5837</b>	2.69
<b>Rosemont</b>	2145	<b>6028</b>	2.81
<b>Willamette</b>	1936	<b>5099</b>	2.63
<b>Bolton</b>	1963	<b>5479</b>	2.79
<b>Robinwood</b>	885	<b>2154</b>	2.43
<b>Bland</b>	416	<b>1134</b>	2.72
<b>TOTAL</b>	<b>9514</b>	<b>25,731</b>	<b>2.70</b>

\*NOTE: Statistics may not precisely calculate due to rounding of household and population data in tables.

## Maximum Build-out Projection

A projection of maximum build-out population for the City can be obtained using the land-use zoning for the City in effect at the time of the estimate. The City's zoning map was overlaid on the water system pressure zone map. The area of each zoning classification within the pressure zone was then calculated. Parks, schools, Interstate 205 and other special specific land uses were identified and subtracted. Table 2 - 4 summarizes the land use assumptions in this maximum build-out projection.

**TABLE 2 - 4  
MAXIMUM BUILD-OUT PROJECTION  
ASSUMED ACRES IN LAND USE CLASSIFICATIONS**

0	Total Acres	Commercial and Industrial Zones	R2.1 through R-7	R10	R15 and R20	Parks, Open Space, I-205, River
<b>Horton</b>	<b>1028.4</b>	0.4	117.5	852.4	0	58.1
<b>Rosemont</b>	<b>973.3</b>	0	130.7	668.9	155.7	18
<b>Willamette</b>	<b>1008</b>	68.1	59.5	715.6	0	164.8
<b>Bolton</b>	<b>1368.5</b>	183.3	163.5	467.9	0	553.8
<b>Robinwood</b>	<b>557.3</b>	21.1	14.9	383.5	31.4	106.4
<b>Bland</b>	<b>260</b>	5	33.6	221.4	0	0
<b>TOTAL</b>	<b>5195.5</b>	<b>277.9</b>	<b>519.7</b>	<b>3309.7</b>	<b>187.1</b>	<b>901.1</b>

Twenty percent of the land area in the non-open zones was assumed to be taken up by city streets and other public rights-of-way. Then, it was assumed that all land within each zoning classification would develop to the maximum density allowed by the zoning. That is, even if there is an existing dwelling on a piece of property, if it is not at the zoning density, it was assumed that the property would redevelop to the allowed zoning density. The zoning density times the number of acres within the zoning classification provided the estimate of the number of units in each pressure zone. Then, the Metro 2015 population densities for each pressure zone shown in Table 2 - 3 were applied to the calculated number of units to provide a population projection. The results of this analysis are shown in Table 2 - 5. Also shown in Table 2 - 5 is the build-out population assuming that the area only develops to 85%, 80% and 70% of the maximum zoning density. Until November 1997, the City's policy was to require that any new development be at least at 85% of zoning density. Metro mandates that all conforming local comprehensive plans require development to at least 80% of zoning density. In November 1997, the City adopted a new policy to require development to 70% of zoning density. However, market forces will likely drive the actual densities that will occur over time.

**TABLE 2 - 5  
CITY OF WEST LINN  
BUILD-OUT POPULATION PROJECTION**

Zone	100% Den. Pop.	100% Den. HH	85% Den. Pop.	85% Den. HH.	80% Den. Pop.	80% Den. HH	70% Den. Pop.	70% Den. HH
Horton	10,306	3,831	8,760	3,257	8,245	3,065	7,214	2,682
Rosemont	10,842	3,858	9,216	3,280	8,674	3,086	7,589	2,701
Willamette	7,580	2,882	6,443	2,450	6,064	2,306	5,306	2,017
Bolton	8,753	3,137	7,440	2,667	7,002	2,510	6,127	2,196
Robinwood	3,705	1,525	3,149	1,296	2,964	1,220	2,594	1,068
Bland	2,616	962	2,224	818	2,093	770	1,831	673
<b>TOTAL</b>	<b>43,802</b>	<b>16,195</b>	<b>37,232</b>	<b>13,768</b>	<b>35,042</b>	<b>12,957</b>	<b>30,661</b>	<b>11,337</b>

## Rate of Growth Projection

Another method of population forecasting for the City is to assume that future growth will be similar to past growth. In making such a projection, the historical growth in the City could be viewed from two perspectives. Over the period between 1980 and 1994, the population served by the City's water system grew from 13,256 to 19,287, for an average of 431 persons per year. If that same average were to continue to the year 2015, then the 2015 population would be a bit over 28,000. However, over the five year period of 1991 through 1996, the population increased more rapidly, at an average of 560 persons a year. If that trend were to continue to the year 2015, then the 2015 population would be 30,000.

## Open-Lot Projection

The maximum build-out analysis assumes that all existing land will redevelop to the current zoning density, even if a lower density unit is already present on a parcel. Another approach to forecasting population is to assume that the only lots that will develop are those lots that are currently undeveloped. This estimate will be less than the maximum build-out number. It may represent a good approximation of what the development will be to the year 2015 as development of adequately available open land will be less expensive and therefore more likely to occur, than redevelopment of currently occupied land.

For this open-lot projection, tax lot information for the City was obtained from Metro. Only those lots that were totally or partially vacant at the time of the estimate, or were above one acre in size, were assumed to develop to the current zoning density. The same assumptions on the number of persons per unit as for the maximum build-out projection were used. Table 2 - 6 presents the city-wide results of this analysis. For this open-lot analysis, the usual assumption that 20% of the land would be streets and other public rights-of-way may be overly conservative because for some of the identified tax lots, the public rights-of-way have already been established and would not be a part of the tax lot designation. Thus, Table 2 - 6 shows the results both with and without this assumption. Similarly, Table 2 - 6 shows the results both with the assumption of development to 100% of density and with the assumption of development to 85%, 80% and 70% of density. This Table shows a range between approximately 27,000 and 32,000 depending on which assumptions are used.

**TABLE 2 - 6  
CITY OF WEST LINN  
OPEN-LOT BUILD-OUT PROJECTION**

<b>ASSUMPTION</b>	<b>LOT-SPECIFIC BUILD-OUT PROJECTION</b>
100% Land; 100% Density	32,000
80% Land; 100% Density	29,350
100% Land; 85% Density	30,000
80% Land; 85% Density	28,000
100% Land; 80% Density	29,750
80% Land; 80% Density	27,600
100% Land; 70% Density	28,600
80% Land; 70% Density	26,700

## RECOMMENDED POPULATION FORECAST

### Maximum Buildout Projection

The results of all the various population forecasts are summarized in Table 2- 7. Of the build-out forecasts, the 1982 Water Master Plan forecast is out-of-date and should be discounted. The 1989 Sewer Master Plan gave a population projection of approximately 38,000. The current build-out forecast based on existing zoning yields a forecast between 30,600 at 70% of density and 43,800 at 100% of density. Because Metro’s policy is to require development to at least 80% of density, in the long run it is unlikely that the build-out population would be less than this figure, or about 35,000. However, a build-out assumption of 38,000 as used in the Sewer Master Plan and the SDC study would assure consistency in water and sewer planning. It would be consistent with what until recently had been the City’s policy on development density and with long-term regional trends to higher densities. It would also assure that needed facilities will be there in the long-run if the higher end of the spectrum of potential build-out populations occur. **Thus, it is recommended that a population of 38,000 be considered the build-out projection for the purposes of this Water System Master Plan.** It must be recognized that this estimate is a prediction based on the best information available at this time, and should be subject to continuous updating and adjustment based on the actual population growth that the City experiences over time.

**TABLE 2-7  
CITY OF WEST LINN  
SUMMARY OF POPULATION FORECASTS**

SOURCE	2015	BUILD-OUT
<b>1982 Water Master Plan</b>	Na	58,000
<b>1989 Sewer Master Plan &amp; 1996 SDC Study</b>	32,470	38,000
<b>Metro 2015 Allocation</b>	25,731	na
<b>Historic Rate of Growth</b>	28,000 - 32,000	na
<b>Build-out Forecast</b>	na	30,600 - 43,800
<b>Open-Lot Build-out Forecast</b>	26,700 - 32,000	na

**2015 Population Forecast**

While there is uncertainty in the build-out projection, there is even more uncertainty in the rate at which or the pattern in which this build-out will be attained. Of all the forecasts for the year 2015, the Metro 2015 allocation provides the lowest estimate, at less than 26,000 persons. The historic rate of growth in the City provides an estimate of between 28,000 and 32,000 persons by 2015. The analysis of potential for development of open lots within the City provides an estimate of between approximately 27,000 and 32,000 people by 2015. An estimated population of about 32,000 for 2015 is also consistent with the 1989 Sewer Master Plan. While the Open-Lot forecast does not predict when the lots will develop, it indicates that the City has readily available land that is appropriately zoned and which can be developed to continue the City’s historic rate of growth. Thus, a population range of 28,000 to 32,000 is a reasonable population forecast to the year 2015. It must be recognized that this estimate is a prediction based on the best information available at this time, and should be subject to continuous updating and adjustment based on the actual population growth experience which the City experiences over time.

There are a couple of factors that may make it reasonable to view the lower end of this range as the appropriate population forecast. First, the longer-term historic rate of growth projects to the lower end of the range. While recent years have seen extraordinary growth in the City, it is unlikely that this rate of growth will continue unabated for the next twenty years. Second, Metro’s allocation of 2015 population for the City is less than the projected range and the policy which the City adopted in 1997 to only require

development at 70% of zoning density gives a result less than the projected range, and thus there may be opportunities for rezoning to reduced densities. Given these reasons, it is recommended that the lower end of the historic rate of growth projection be used. **The recommended 2015 population projection then becomes 28,000.** Table 2 - 8 summarizes the population and household projections for the 2015 and buildout recommendations. However, **in reviewing the water system facilities for the year 2015, it is also recommended that the impact of a 32,000 population on the sizing of facilities be reviewed.** This will assure that if the population increases at the higher end of the projection, a plan for increased facilities, if needed, will be available.

**TABLE 2 - 8  
SUMMARY OF RECOMMENDED  
POPULATION FORECAST**

<b>ZONE</b>	<b>2015 POPULATION</b>	<b>2015 NUMBER OF HOUSEHOLDS</b>	<b>BUILD-OUT POPULATION</b>	<b>BUILD-OUT NUMBER OF HOUSEHOLDS</b>
Horton	6200	2129	8,950	3,327
Rosemont	6200	2041	9,400	3,345
Willamette	6500	2251	6,575	2,500
Bolton	5600	1938	7,600	2,724
Robinwood	2100	781	3,225	1,327
Bland	1400	467	2,250	827
<b>TOTAL</b>	<b>28,000</b>	<b>10,370</b>	<b>38,000</b>	<b>14,050</b>

#### **URBAN RESERVE AREA**

Metro has identified one area adjacent to the City of West Linn's current urban growth boundary as an area of future urban growth. This Urban Reserve Area (URA) is an approximately 96 acre area of land adjacent to the Rosemont and Horton pressure zones. Zoning and population forecasts for this area are not available. However, under the assumption that this area would be zoned similar to the Rosemont Zone and have similar densities, then the build-out population for this URA would be 418 dwelling units with a population of 1271 persons.

# Section 3

## Water Demand Projections

In Section 2, the population for the City of West Linn was forecast. In this Section, those population projections are utilized along with historical water demand information for West Linn to forecast future water demands. These demand forecasts will be utilized in the facilities planning for the Water System Master Plan.

The term “demand” refers to all the water requirements of a water system including domestic, commercial, municipal, irrigation, institutional and industrial as well as unbilled, unmetered and unaccounted-for water. Demands are discussed in terms of gallons per unit of time such as gallons per day (gpd), million gallons per day (mgd) or gallons per minute (gpm). Demands are also related to per capita use as gallons per capita per day (gpcd).

As indicated in Section 2, the level of effort and sophistication that goes into estimating water demands can vary substantially. The demand projection in this Section relies upon historical information from the City and engineering judgment. In making a projection, it is important to understand the use of that projection. For this Water System Master Plan, the demand projections must be large enough so that the facilities that are planned will be adequate to cover future water needs in the community. At the same time, the demand forecast must not be too large, as then the planned facilities will also be too large, and unnecessarily expensive. The balance between these two concerns must be found. It is also important to understand that these projections are for planning purposes only. The final sizing and capacity of the recommended facilities should be evaluated against growth trigger points and reviewed during individual project predesign to determine their appropriate sizing and other design criteria.

### **HISTORICAL WATER DEMANDS**

As described in Section 1, the City of West Linn receives its water supply from the South Fork Water Board (SFWB). Table 3 - 1 summarizes the SFWB's supply meter records for West Linn from 1991 through 1998.

Water supply from the SFWB to the City of West Linn is metered through a master meter owned by the City. The City of West Linn's Supervisory Control and Data Acquisition (SCADA) system records daily total flows as well as instantaneous minimum and maximum daily flows. Annual, maximum monthly and maximum daily production data are shown in this Table. The population values in this Table are from the Center for Population Research and Census at Portland State University, for the city limits of West Linn as listed in Table 2 - 2, with the addition of an estimated 560 persons served by the water system outside the City limits added for 1995 and 1996. Per capita demands are calculated by taking the production numbers and dividing by the corresponding populations. Included within these per capita usage rates are all water uses including residential, commercial, municipal, industrial, institutional, and unaccounted-for water.

These per capital consumption figures are calculated as a City-wide average. There may be significant variation in per capita consumption within areas of the City depending on nature of the development present, the amount of new development compared to established development, and other factors. Per capita consumption figures could be developed by individual service zone areas if the City's water system had supply meters to record the amount of water used in each zone. While the City has several such meters at the outlet of pump stations, it does not have these meters system-wide. While such meters

would be useful from the perspective of understanding system operation, they are unlikely to be cost-effective to install solely for this purpose.

As can be seen in Table 3 - 1, the peak day per capita consumption in West Linn varies considerably over this period, from a low of 249 gpcd to a high of 335 gpcd. For comparison purposes, the peak day per capita consumption over the same period for Oregon City varied from 285 to 381 gpcd. For 1994, the per capita consumption in the South service area of Clackamas River Water was 342 gpcd.

**Table 3 – 1  
West Linn Historical Water Demand Summary**

Year	Population Served	Annual Average of Daily Demand (mgd)	Maximum Monthly Demand (mgd)	Maximum Daily Demand (mgd)	Ratio of Maximum to Avg. Annual Demand		Per Capita Demand, gpcd		
					Max. Monthly	Max. Daily	Average Annual	Maximum Monthly	Maximum Daily
1991	17,160	2.51	4.25	5.33	1.69	2.12	146	248	311
1992	17,645	2.62	4.53	5.59	1.73	2.13	148	257	317
1993	18,165	2.47	3.67	4.52	1.49	1.83	136	202	249
1994	18,860	2.85	4.92	6.31	1.73	2.21	151	261	335
1995	19,930	2.72	4.47	5.72	1.64	2.10	136	224	287
1996	20,520	2.84	4.75	6.50	1.67	2.29	138	231	317
1997	20,975	2.79	4.52	6.00	1.62	2.15	133	215	286
1998	21,965	2.91	5.51	6.54	1.89	2.25	132	251	298

Water consumption is primarily residential. The approximate distribution of water consumption by customer class over the period of 1990 to 1995 is shown in Table 3 - 2.

**Table 3 -2  
Distribution of Water Consumption by Customer Class**

Customer Class	Percent of Total Consumption
Single Family	80
Multi-Family and Apartments	9
Commercial	5
Irrigation	1
Public Facilities	5

## WATER DEMAND FORECASTS

### Per Capita Consumption

The water demand forecasts that are developed in this study will be used in the planning of future upgrading and expansion of the City of West Linn's water supply system. If the water demand forecasts are too far above the actual future water demand, then there is a danger that the facilities that are planned for the future will be larger and more expensive, than needed. If the demand projections are too far below the actual future water demand, then there is the danger that the facilities that are planned for the future will be inadequate.

Predicting future water use has several inherent uncertainties. Per capita consumption in a community is influenced by many factors and can vary widely even between adjacent neighborhoods. Among the factors which cause this variability are the relative mix between residential, commercial and industrial users; the amount and type of landscaping; the area of lots which is irrigated; the use of automatic irrigation systems; the kind of irrigation systems that are used; the age of plumbing facilities in homes; the size of families in the neighborhood; and the amount of multifamily housing compared to single family housing. Indeed, a recent calculation of peak day per capita demand in the Horton and Rosemont pressure zones within the City showed a variation of approximately 225 to 375 gpcd between the two zones. In addition, the peak demand in any given year is greatly influenced by the weather. The amount and frequency of summer rains and the temperature and duration of summer hot spells will vary substantially from year to year. Thus, the per capita consumption in any community can vary significantly from year to year as shown in Table 3 - 1.

Possible future changes in per capita consumption can occur due to conservation programs, the reduction (or increase) in unaccounted-for water, and changes in the mix of residential, industrial, and commercial water use. This latter change can occur if a large manufacturing facility were to locate in or leave the City. The water demand characteristics of future residential growth also may not replicate the water demand characteristics of historical residential use, due to differences in lot sizes, landscaping, and the number and nature of water using fixtures. Denser development tends to have lower per capita consumption than more spread out development. New neighborhoods tend to have higher per capita consumption than more established neighborhoods due to the construction activity, new lawns, and a greater prevalence of automatic sprinkling systems.

As shown in Table 3 - 1, the recent historical average daily per capita demand ranges from approximately 132 gpcd in 1998 to approximately 151 gpcd in 1994, a variation of about 10%. As can be also be seen from this Table, the estimated peak day per capita consumption for the City as a whole varied from a low of 249 gpcd in 1993 to a high of 335 gpcd in 1994, a variation of about 25 - 30 %. Three of the eight years shown in this Table have a City-wide peak day consumption of around 315 gpcd and seven of the eight years have peak day per capita consumption of less than 335 gpcd.

While the peak day per capita consumption can vary significantly from year to year due to the weather, there tends to be an upper limit in a community to the per capita consumption. Based on the distribution of the citywide values, it would not be unreasonable to expect peak day per capita consumption values up to approximately 5% higher than shown in this Table 3 -1 under extreme weather conditions. Thus, the City-wide peak day per capita consumption could be as high as around 350 gpcd in a particularly hot year, even though the historical high over the last several years has been 335 gpcd.

### **Recommended Per Capita Consumption**

The decision as to which peak day per capita consumption value to use relates to the desired level of system reliability. There is often a relationship between the level of reliability and cost - higher levels of reliability require higher costs. The reliability of local distribution system components, such as transmission and distribution pipelines and local pump stations and tanks, tend to be designed toward the upper end of a reliability range. Using a higher level for peak day per capita consumption provides a higher degree of certainty that even in the most extreme weather conditions, adequate water will be available. This higher consumption value will result in more costly facilities, however. Other methods of dealing with extreme peaks in demand include reliance on temporary curtailment of water use or interties to other sources.



If the high peak day demand of 335 gpcd that has been seen in the last six years were to be used for design purposes, it is likely that between one year in 10 and one year in twenty will see a peak day per capita consumption higher than that value. If the 350 gpcd figure were to be used, it is likely that not more than one year in twenty would see a peak day per capita consumption greater than that value.

**For the purposes of this plan, it is recommended that for the peak day, the 350 gpcd figure be used for the year 2015 demand projection.** This figure allows for relatively high consumption due to new construction and development in the City over this period. It also assures that even if the actual population growth is greater than the projected population growth, there is unlikely to be an extreme shortage of water supply and the need for curtailment.

However, it is also anticipated that as denser development continues in the City and the effects of regional conservation measures take place, this level of per capita use should likely decrease. **Thus, for the ultimate build-out population projection for the City, the lower peak day per capita consumption figure of 335 gpcd is recommended.**

**TABLE 3 - 3  
CITY OF WEST LINN  
SUMMARY OF PROJECTED WATER DEMANDS**

YEAR	2015	BUILD-OUT
POPULATION	28,000	38,000
PEAK DAY PER CAPITA CONSUMPTION (GPCD)	350	335
AVERAGE DAY PER CAPITA CONSUMPTION (GPCD)	143	143
AVERAGE DAILY DEMAND (MGD)	4.00	5.43
PEAK DAY DEMAND (MGD)	9.80	12.73

**For the purposes of this plan, it is also recommended that the future average daily per capita demand be assumed to be 143 gpcd.** This is approximately the arithmetic average of the average daily per capita demand over the six year period of 1991 through 1996.

It must be recognized that these estimates are predictions based on the best information available at this time, and should be subject to continuous updating and adjustment based on the actual water demand that the City experiences over time.

### **Projected Demand**

The future water demand forecast is obtained by multiplying the recommended per capita usage rate discussed above times the recommended population forecast from Section 2. The results of this calculation are shown in Table 3 - 3.

### **Urban Reserve Area**

In Section 2, a population forecast of 1271 persons was estimated for the Metro designated Urban Reserve Area (URA) adjacent to the City's current urban growth boundary. Using a build-out per capita peak day demand of 335 gpcd, this equates to 0.425 mgd, or 295 gpm, of demand on a peak day. At 143 gpcd for the average day, this population equates to 0.182 mgd, or 126 gpm, average day demand.

## Section 4

# Planning Criteria

This Section presents the planning and analysis criteria that are recommended for the evaluation of the existing facilities and in planning any new facilities for the City of West Linn. It must be recognized that these planning criteria are not hard and fast rules that must be exactly adhered to in order to provide a reliable water system. They are simply standards by which the system can be judged for the purposes of planning capital improvement and capital maintenance projects under most circumstances. There may be instances where deviations from these criteria are reasonable and justifiable based on specific circumstances. In addition, it may be appropriate for the City to have specific Design Code requirements that deviate from these master capital planning criteria. The City should review its Design Code and determine whether changes are appropriate to it once this Water System Master Plan has been adopted.

### **PLANNING PERIOD**

This Water System Master Plan considers three planning horizons. First, deficiencies of the existing system are identified. Then, a detailed evaluation is conducted for the expected population to the year 2015. The impacts on the water system of growth and development in the community are analyzed over this time period. Over the period to 2015, staging of facilities corresponding to incremental levels of growth are evaluated. Two population projections, a low and a high, were prepared for the year 2015. The Master Plan evaluates the system for both of these projections. Finally, the impacts of growth and development at anticipated ultimate build-out population and development of the City are analyzed. The population and water demand forecasts for these periods are given in Sections 2 and 3, respectively. While the year 2015 is used throughout this Water System Master Plan in discussions of the planning period, that year should be viewed as a surrogate for the population forecast that is associated with it. That is, improvements should be timed based on the actual population growth which occurs and not on the specific years listed in this Water System Master Plan.

### **PLANNING AREA**

The planning area for the Master Plan is the limit of the current City of West Linn water system. This includes all areas within the City limits and areas outside the City limits but within the Metro Urban Growth Boundary (UGB) in the Tanner Basin. The Master Plan examines the impacts on the current water system of service to land in the Metro Urban Reserve Area (URA) which is adjacent to the City of West Linn. The details of water system development in the URA are not evaluated. However, the additional

supply, transmission, and storage facilities that would be needed to serve the area are determined.

## **DESIGN CRITERIA**

### **Service Pressure**

The minimum pressure that must be maintained in the system per State of Oregon Health Division (OHD) standards is 20 pounds per square inch (psi) (46 ft). This pressure must be maintained even during a fire flow event on a peak demand day. The existing system has been designed around tank and reservoir elevations that typically provide maximum and minimum service pressures between 170 psi (393 ft) and 45 psi (104 ft) respectively. The typical operating pressures obtained from the existing tanks and reservoirs should be maintained. Each of these pressure conditions will be evaluated with system reservoir/tank levels three-fourths full.

### **Source**

The main source of supply should be capable of providing the projected peak day demand. It should meet this demand with firm capacity - that is, with the largest pump, filter or other component of the system out of service. The City should also have an emergency source of supply that is capable of providing the average day demand for the length of time that the primary source of supply is out of service, such period lasting up to a week. This emergency source could be provided through an intertie, storage, a secondary source, or other methods.

### **Transmission Pipelines**

Transmission pipelines are considered as those greater than or equal to 10-inches in diameter. Pipeline flow velocities in transmission pipelines should be less than 5 feet per second (fps). All water transmission pipelines greater than or equal to 24-inches in diameter should be capable of providing peak day demands. All other transmission pipelines should be capable of supplying peak hour demands.

### **Distribution Pipelines**

Distribution pipelines should be sized to serve peak hour demands and fire flow requirements with system reservoirs/tanks three-fourths full. Flow velocities for a distribution system pipeline should be below 10 fps and headloss in the pipeline should be below 10 ft per 1000 ft of pipeline. Minimum pipeline diameter for new distribution pipes will be 6-inches. Pipeline diameters smaller than 6-inches will be identified as inadequate for fire flow conditions. Any pipeline below 6-inches should be upgraded before being equipped with a fire hydrant. A 6-inch line with a fire hydrant should be part of a looped system or be no more than 500 feet in length.

## **Pressure Reducing Stations**

Pressure reducing stations should meet the criteria of supplying the peak hour demand within the continuous flow rating of the valve. The fire flows through a pressure reducing station should be adequately delivered within the intermittent flow rating of the valve.

## **Pump Stations**

Pump stations should be sized for a firm capacity equal to the peak day demand. Firm capacity is defined as the capacity of the pump station with the largest pump out of service.

For reliability, power supplies to pump stations should have either two sources of primary power feed, or one main source and standby or emergency power. The secondary power supply should be sized so that available pumping capacity is equal to average day demand, or fire flow, whichever is greater.

## **Storage**

Storage facilities in water systems are generally provided for four purposes - equalization storage, operational storage, fire storage, and emergency storage. The total storage required in any tank or reservoir is the sum of these four components plus the dead storage (the volume of the tank that is unavailable to use due to physical constraints). The components of storage are described as follows:

### Equalization Storage

This storage is needed in a water system to meet water system demands in excess of the transmission/pumping delivery capacity from the supply source to the reservoir. The volume of equalization storage required is a function of supply system capacity, transmission piping capacity between reservoirs and pump stations, and system demand characteristics. Equalization storage is generally less expensive to provide than increased treatment, pumping and transmission piping capacity beyond that required to meet maximum day demands. Equalization storage volume should be sufficient to meet demands in excess of the maximum daily demand. Equalization storage volume in the amount of 20 to 30 percent of maximum daily demand is typical, and for this Master Plan, 25 percent of peak day demand is assumed for equalization storage.

### Operational Storage

This storage may be needed if the supply source does not continuously deliver supply. Operational storage would be required, for example, if the supply system were only operated over part of a day with the supply coming from storage during the remaining part of the day. Indeed, the SFWB operates the supply system in this manner much of

the year, running its water treatment plant overnight to take advantage of lower power rates, and then shutting the plant off during the day and supplying water to West Linn from storage. SFWB maintains storage for this purpose. The City of West Linn, however, does not operate its distribution system in a manner that requires additional operational storage beyond equalization storage, and thus, no additional operational component of storage is recommended in this Master Plan beyond that supplied by the SFWB.

**Fire Storage**

Fire storage is provided to meet the single most severe fire flow demand within the system or pressure zone served by the storage facility. The fire storage volume required is determined by multiplying the fire flow rate by the duration of that flow.

Residential fire flows are 1000 gpm for 2 hours and can be applied at any fire hydrant in the pressure zone. Commercial, industrial, and multi-family fire flows can be applied at any fire hydrant within areas that have appropriate land use zoning and may be specific to the zoning and actual facilities in place. The City has recently established a 3,000 gallons per minute (gpm), three-hour duration, fire flow throughout the City for commercial, industrial, and multi-family areas (Joiner, 1998). The current fire flow requirements are the result of recent building and fire code changes and efforts to retrofit West Linn schools with sprinklers that have allowed lower fire flows in some zones of the City. Residential areas in the Bland and Robinwood Zones, which previously had fire flow requirements less than 3,000 gpm, will be allowed to maintain those same fire flow requirements.

Previously, fire flow demands were established by individual pressure zone. These previous fire flows are shown in Table 4 - 1. The implications of these fire flow requirements will be evaluated in this Water System Master Plan.

**TABLE 4 - 1  
PREVIOUS MAXIMUM FIRE FLOW DEMANDS BY PRESSURE ZONE**

<b>ZONE</b>	<b>FLOW RATE (GPM)</b>	<b>DURATION (HR)</b>	<b>VOLUME (MG)</b>
Horton	4,000	4	0.96
Rosemont	3,000 / 2500	3 / 2	0.54 / 0.30
Willamette	4,000	4	0.96
Bolton	6,000	4	1.44
Robinwood	2,000	2	0.24
Bland	2,000	2	0.24

**Emergency Storage**

This storage is provided to supply water from storage during emergencies such as power outages, equipment failures, pipelines failures or natural disasters. The amount of emergency storage provided can be highly variable and is dependent upon an assessment of risk and the desired degree of system reliability. Detailed vulnerability analysis and risk assessments are not within the scope of this study. However, a summary level vulnerability analysis and risk assessment was conducted for this Master Plan (see Section 6). An emergency supply equal to one day of average demand within a pressure zone is considered typical for most distribution systems and is appropriate for the City of West Linn's system based on the summary vulnerability analysis.

It is also desirable, although not required, that storage be provided from at least two separate storage reservoirs or is available through pumping or gravity from a secondary reservoir at a different elevation. This provides for continuous operations during maintenance, repairs or reconstruction or modifications to any single reservoir.

### Summary of Storage

Based on the above criteria, the required storage in each pressure zone will consist of 25% of projected peak day demand for equalization plus the fire flow demand plus one average day demand for emergencies. This compares with the storage criteria under the 1982 Master Plan of fire flow plus 20% of peak day demand. The proposed new criteria are typical of urban water systems. Although no longer required by regulation, for many years the Oregon Health Division's (OHD) drinking water standards required three average days of storage in water systems. Meeting the three days average demand criteria would generally result in even greater storage volumes being required than the criteria being recommended in this Master Plan. The existing 1982 Master Plan storage criteria would be considered the minimum level that would be acceptable in a water system. The impacts of these various criteria on the storage requirement will be identified in Section 6.

# Section 5

## Existing System Description

### GENERAL DESCRIPTION

As described in Section 1, the City of West Linn currently receives its water as a wholesale customer of the South Fork Water Board (SFWB). The City then maintains and operates the transmission and distribution system to its water customers.

### SUPPLY SYSTEM

#### History of the SFWB

Prior to 1915, drinking water for the Oregon City area came from the Willamette River. As a consequence of a serious outbreak of typhoid in 1913, the Oregon City Commission formed the "Pure Mountain Water League" and directed it to find a new source of drinking water. In January 1914, the League recommended that the city draw its water from the South Fork of the Clackamas River by constructing a new water line from the proposed diversion to Oregon City. In March, the Oregon City Commission accepted the City of West Linn's request for a one-third share in the project. As a result, the South Fork Water Board (SFWB) was formed and voters passed a \$325,000 water bond measure to construct the pipeline.

Under the supervision of the newly created SFWB, an 18-inch diameter pipeline was constructed to a site near Memaloose Creek, about 3,000 feet upstream from the confluence of the South Fork and the main stem of the Clackamas River, at an elevation of 820 feet. The first water began to flow by gravity through the system on October 7, 1915, supplying up to 3 million gallons per day (mgd). The only treatment provided to the water was chlorination.

In 1939 and 1940, the SFWB joined with the federal Works Projects Administration (WPA) to extend a new 24-inch pipeline upstream from Memaloose Creek to a point above a waterfall known as "high falls" by means of a series of tunnels through the rock bluffs. This effort raised the system's intake to an elevation of 1,050 feet, increasing the water pressure and capacity available to users of the system.

By the early 1950's, population growth was causing a greater demand for water than could be satisfied by the capacity of the "Mountain Line". The option of constructing additional pipelines to the South Fork of the Clackamas River and to Memaloose Creek was compared to the option of constructing a new intake on the lower Clackamas River and a water treatment plant. Voters chose the lower Clackamas River option as less expensive and more practical. The new water treatment plant was constructed in 1958 in the Park Place area near the intersection of Hunter Avenue and Forsythe Road. In addition to the treatment plant, facilities at that time included an intake just off Clackamas River Road, a pipeline up the hill from the river to the treatment plant site, a transmission pipeline from the treatment plant to Oregon City and West Linn, and a pump station to boost treated water to higher elevations of both Oregon City and West Linn.

The "Mountain Line" continued to supplement the SFWB water supply until October, 1985. At that time it was shut down because of escalating repair costs to the pipeline and because of failure of that water supply to meet strengthened federal and state drinking water quality standards for turbidity without costly treatment improvements. The water treatment plant on Hunter Avenue was expanded and modified in



1975 and 1986. In late 1996, a new water intake on the Clackamas River sized for 42.6 mgd with an initial firm pumping capacity of 21 mgd and improvements to the Division Street Pump Station for a firm pumping capacity of 17 mgd, were completed.

### **Clackamas River Basin Characteristics**

The Clackamas River basin, which is used for supply by the SFWB, covers approximately 936 square miles south and east of metropolitan Portland. From its headwaters in the Cascades just south of Mt. Hood, the Clackamas River flows approximately 60 miles northwesterly to its discharge into the Willamette River near Oregon City. The basin extends to the divide of the Cascade Range.

There are a few reservoirs along the Clackamas including the largest, North Fork Reservoir, which are operated by Portland General Electric for hydropower. It is estimated that the average flow in the river is in excess of 1,550 cfs (1,000 mgd) and the minimum flow is approximately 450 cfs (290 mgd). In addition to the SFWB, the City of Lake Oswego, Clackamas River Water and the City of Estacada all use the river for drinking water.

While the drainage basin of the Clackamas River is significantly smaller than the drainage basins of the Columbia and Willamette Rivers, the basin is still subject to influences such as forestry, agriculture and urban land uses. Approximately 70 percent of the drainage basin is within National Forest areas. Forestry practices occur within these areas. Some agricultural activity is found within the basin as are some cities and industries. The lower reaches of the Clackamas are experiencing rapid growth and development which can influence overall water quality.

Information from Oregon Department of Environmental Quality (ODEQ) (Montgomery Watson, February, 1994) indicates there are no major point source discharges to the Clackamas River. Major domestic facilities are defined as discharging more than 1 million gallons per day (mgd) and/or serving a population greater than 10,000. However, ODEQ does identify 31 minor discharges from the various classifications (agricultural, domestic and industrial), 11 of which are stormwater industrial discharges and four are wastewater treatment plant effluents. All of the discharges are within the lower reach (30 miles) of the river. The upper reaches are entirely within National Forests.

“Nonpoint source” pollution can be a significant contributor of the overall pollutant load to the Clackamas River and its tributaries during periods of rainfall. Forestry practices can introduce sediment from erosion and also herbicides and fertilizers associated with replantings. Although it has not been well documented in the Clackamas River system, agricultural land use has the potential to create water quality problems as well. These agricultural uses can include nurseries, crops, animal feed lots and dairies.

### **Raw Water Quality**

The most comprehensive summary of information on the quality of the raw Clackamas River water is contained in the Regional Water Supply Plan (Montgomery Watson, February, 1994). General physical, inorganics, dissolved oxygen and nutrients,

ES - 37

microbiological, organics, radionuclides, and taste and odor causing compounds for the period of 1988 through 1993 were summarized in that report.

The turbidity of the Clackamas River water is relatively low during the dry season and can fluctuate widely during the rainy periods of the year. During the floods in February 1996, the maximum turbidities that were recorded were over 500 NTU at river intakes. Typically, these high turbidities last for a few days depending upon the severity and duration of the rainfall event. Minimum turbidities are approximately 1 to 2 NTU during the summer months. The pH of the Clackamas River fluctuates throughout the year. Typically, the pH decreases during winter as rainfall increases and the pH increases during the summer months. Normal pH values appear to fall within the range of 7.0 to 8.3 most of the year. The temperature of the river water varies according to the season. Normal wintertime lows are 5°C and normal summertime highs are 21°C, but extreme temperatures of 1.0°C and 24°C have been recorded.

Tables 5 - 1 and 5 - 2 present summaries of inorganic water quality parameters for which monitoring occurs on the Clackamas River. The inorganic parameters of concern include some which are regulated under Federal and State drinking water regulations and some which are not.

The primary sources of bacterial loading to the river include wastewater treatment plant discharges, surface runoff from urban and agricultural sources, and storm water discharges. Currently, there are no on-going water quality monitoring stations on the Clackamas River which collect bacteriological water quality data. The three water treatment plants do not monitor the raw water bacteriological water quality, just the finished water quality. Limited monitoring data collected by ODEQ in 1987 at the Highway 213 bridge indicated that fecal coliform concentrations in the river ranged from 3 organisms per 100 mL in June to 2,400 per 100 mL in September.

**TABLE 5 - 1**

**GENERAL INORGANICS CONCENTRATIONS  
IN THE CLACKAMAS RIVER**

**Data From Water Treatment Plants (1988 - 1993)**

<b>Parameter</b>	<b>Observed Range (mg/L)</b>	<b>MCL (mg/L)</b>
Alkalinity	6.0 - 31.5	NA
Hardness	9.0 - 26.0	NA
Calcium	NR	NA
Magnesium	NR	NA
Sodium	2.13 - 4.1	NA
Potassium	NR	NA
Sulfate	NR	250*
Phosphorus	NR	NA
TKN	NR	NA
Ammonia	NR	NA

ES - 38

Chloride	0.5 - 5.3	250*
Manganese	0.005 - 0.01	0.05*
Silica	NR	NA
Iron	<0.005 - 0.087	0.3*
Aluminum	NR	0.05 - 0.2*

\* These are secondary regulated compounds with suggested maximum limits.  
Aluminum was added as part of Phase II.

NA: Not Applicable

NR: Not Recorded

---

TABLE 5-2

REGULATED INORGANICS CONCENTRATIONS  
IN THE CLACKAMAS RIVER

Data From Water Treatment Plants On River (1988 - 1993)

Parameter	Observed Range (mg/L)	Federal MCL (mg/L)
<b>Inorganics (Primary)</b>		
Arsenic	<0.005	0.05
Lead	NR	treatment technique
Barium	<0.005	2
Cadmium	<0.002	0.005
Chromium	<0.005	0.1
Fluoride	<0.14	4
Mercury	<0.0002	0.002
Nitrate (as N)	NR	10
Nitrite (as N)	NR	1
Total Nitrate&Nitrite (as N)	0.13 - 1.3	10
Selenium	<0.002	0.05
Antimony	NR	0.006
Beryllium	<0.0005	0.004
Cyanide	NR	0.2
Nickel	NR	0.1
Thallium	NR	0.002

NR: Not Recorded

The only available data regarding radionuclides in the Clackamas River are routine laboratory tests for gross alpha radiation at the WTPs. All test results have indicated 0.0 pCi/L with a acceptable counting error of +/- 0.3 pCi/L. Routine samples of the finished waters have been analyzed for various pesticides, all of which were below detection limits.

Many regulated and many unregulated volatile organic compounds are routinely analyzed in the finished waters from the water treatment plants on the Clackamas. Test results indicate that all compounds have been below detection limits. Other toxins like dioxins and furans have been monitored in the finished water at some of the water treatment facilities. None have been detected.

### Watershed Management

During the late 1980s, various entities formed the "Clackamas River Watershed Management Program Task Force". These entities included the public water systems in

Clackamas County, OHD and Clackamas County. The purpose of this task force was to develop a program for the Clackamas Watershed and to maintain and improve the watershed, which should result in the protection for the present and future generations. As a consequence of those efforts, a Watershed Council has now been formed. This Council has representatives of various stakeholders with an interest in watershed management in the basin, including several water suppliers. The Council now has funding for a part-time staff support person.

### **Water Rights**

The South Fork Water Board holds five water rights on the Clackamas River and its tributaries. These rights are the most senior municipal rights on the river and its tributaries except for a small intervening right on the Clackamas River held by the City of Gladstone. All of the SFWB's rights pre-date a major instream right held by the Oregon Water Resources Department (OWRD). The total permitted withdrawal rate for all of the permits is 116.0 cubic feet per second (cfs) or 74.98 million gallons per day (mgd). During periods of low natural streamflows (summertime), the permitted withdrawals cannot be accomplished as there are insufficient streamflows to support the authorized withdrawal amounts. It is estimated that the actual maximum withdrawal rate for all five rights during such periods is 80.0 cfs or 51.71 mgd. At the present time, the SFWB has the right to withdraw at the new intake up to 66.0 cfs or 42.6 mgd. The SFWB is presently in the process of applying to OWRD for alternate points of diversion for some of its water rights on the South Fork of the Clackamas River and Memaloose Creek. The SFWB is pursuing these actions to maximize the usability and legal status of its present rights.

### **Existing SFWB Facilities**

The South Fork Water Board owns and operates water supply facilities consisting of two river intakes on the Clackamas River, both of which include a raw water pumping station, a water treatment plant located in the Park Place area of Oregon City, a finished water pumping station, and raw and finished water transmission pipelines. The SFWB also has a system control and data acquisition (SCADA) system to provide for system operation and control.

The SFWB recently (1996) completed construction of a new intake and raw water pumping station on the south bank of the Clackamas River directly north of the water treatment plant. The new intake is located on South Clackamas River Drive approximately 500 feet downstream of the old intake. The intake diverts water from the river and pumps it to the water treatment plant. The intake screens, structure, mechanical, piping and electrical systems were designed for an ultimate nominal capacity of 42.6 mgd.

The raw water pumping station contains four vertical turbine pumps with space for a fifth pump. The present firm pumping capacity of the station with one of the largest pumps out of service is approximately 21 mgd. The intake structure is equipped with fish screens to prevent fish from entering the pump station wetwell. Under present regulatory requirements, up to 82 cfs or 53 mgd can be passed through the screens.

The SFWB's old intake and raw water pump station is located approximately 500 feet upstream of the new intake on the south bank of the Clackamas River. Presently, the SFWB is maintaining the facility in operating condition as an emergency standby intake facility to backup the new intake.

A raw water transmission main connects the new and old intakes to the water treatment plant. As part of the original system development in 1954, a 27-inch concrete cylinder pipe raw water transmission main approximately 1,800 feet in length was constructed between the old intake and the water treatment plant. This main is presently in service. As part of the construction of the new intake, a new 42-inch diameter

steel raw water transmission main approximately 600 feet in length was constructed from the new intake easterly along South Clackamas River Drive, connecting to the 27-inch main.

The SFWB water treatment plant (WTP) is located along Hunter Avenue on a bluff to the south of the Clackamas River intake/pump station. The WTP, which has a rated production capacity of 20 mgd, was originally constructed in 1958 and improvements/modifications were made in 1975 and in 1986. Historically, the maximum day treated water production has been 18.3 mgd on August 11, 1996.

A 30-inch diameter finished water transmission main approximately 8,200 feet in length connects the water treatment plant to the Division Street Pump Station. The Division Street Pump Station, which was recently upgraded (1996), is located in Oregon City near the intersection of Division Street and Penn Lane. The station pumps finished water to Oregon City's Reservoir No. 2 through a 24-inch diameter transmission main. The present firm pumping capacity of the station with one of the pumps out of service is 17.0 mgd.

### **Transmission to the City of West Linn**

The City of West Linn's connection to the SFWB system occurs on the discharge side of the Division Street Pump Station, through a master meter currently owned by the City and a 24-inch diameter transmission main. West Linn's data management system and the SFWB's SCADA system record daily total flows as well as instantaneous minimum and maximum daily flows. As part of the recent pump station upgrading, the SFWB constructed a pressure control station on the supply main to the City of West Linn directly across Division Street from the station. This system limits the maximum pressure of the SFWB's supply at its point of delivery to West Linn so that the West Linn gravity system is not overpressurized during operation of the pump station.

The 24-inch diameter transmission main proceeds across the Interstate 205 bridge from the Division Street Pump Station and connects to the City of West Linn's distribution system at the west end of the bridge. The transmission system was designed to have a capacity of approximately 13 million gallons per day.

### **Emergency Intertie**

In 1984, the Cities of West Linn and Lake Oswego and the SFWB entered into an intergovernmental agreement to construct, operate and maintain an intertie between the Lake Oswego water supply system and the West Linn and SFWB system. An 18-inch diameter intertie between the Lake Oswego system and the 24-inch diameter transmission line in West Linn was constructed. This intertie is designed to provide up to 3,750 gallons per minute, or 5.4 mgd, to West Linn from Lake Oswego. Activation of the intertie may be accomplished only by the mutual consent of the involved parties. Over the four year period of 1992 through 1996, the City of West Linn received water twice from Lake Oswego and Lake Oswego received water five times from West Linn.

## **DISTRIBUTION SYSTEM**

### **Distribution System Water Quality**

As a public water supply system (ID Number 4100944), the City of West Linn must comply with the drinking water regulations administered by the Oregon Health Division (OHD). Part of these regulatory requirements include a periodic sanitary survey conducted by the State of Oregon to review the operating condition of the water system. The most recent survey was completed by the State in April, 1995 and concluded that (Letter dated April 28, 1995 from Kari Salis, to Lyle Ulrich):

"The system appears to be in excellent operation condition. I have no recommendations at this time for improving the operation or reducing the risk of contamination. You're all doing a great job."

Among the items cited in the survey as important were the covering of the Bolton Reservoir and the installation of emergency generators at the Willamette Pump Station. The Bolton Reservoir has since been covered. The building provisions for the emergency generator at the Willamette Pump Station have been installed, but the generator itself has not been obtained.

The City completes all the distribution system monitoring which is required by the State as well as additional tests which are needed to confirm adequate system operation:

- Distribution coliform samples are taken twice a month from twelve sites spread throughout the City. No violations of the coliform rule have ever occurred.
- Chlorine residuals are taken along with the coliform monitoring. One chlorine residual and one pH measurement is taken in the distribution system daily. Chlorine residuals typically range from 0.7 to 1.2 mg/l, with the low in 1996 of 0.3 mg/l. This is well above the regulatory requirement of maintaining a detectable residual at all times.
- Synthetic organic compounds, pesticides, herbicides, asbestos, inorganic contaminants, and radionuclides have all been monitored for as required by the State, with no problems detected.
- West Linn has received approval along with Oregon City and the SFWB for consolidated monitoring and compliance with the Lead and Copper Rule. The systems have qualified for reduced levels of monitoring based on the low levels found in previous samplings. Ongoing pH monitoring is being used to assure operational adequacy of the corrosion treatment.
- Over the period of 1992 through 1996, Total Trihalomethane levels in the distribution system of West Linn ranged from 15 to 40 ug/l, with most of the values in the range of 20-30 ug/l. Current regulatory requirements are 100 ug/l, but this limit will likely drop to 80 ug/l in 1998. It is possible that the limit will reduce even further sometime between the years 2000 to 2002. The City does not have data on Haloacetic Acids (HAA's) which are not currently regulated, but which will likely become regulated in 1998.

The Safe Drinking Water Act (SDWA), the federal legislation which governs all water systems, was reauthorized in 1996. Over the next several years a number of new regulatory requirements for the City will come into effect as a consequence of the revised statute. Examples include the HAA regulations referred to above and a requirement for distribution of a Consumer Confidence Report summarizing water quality information about the water system, to all customers starting in 1999.

The City conducts a water quality customer complaint program. When customers call with complaints, a complaint form is completed which records the type of complaint, location, and other pertinent information. A field investigation may be conducted if warranted. The City also maintains a cross-connection control program. It has adopted standards by ordinance and maintains an annual testing and inspection program using certified testers.

## Pipelines

The distribution system network is comprised of over 104 miles of pipes in sizes up to 24-inches in diameter. The pipe types include asbestos cement, cast iron, ductile iron, copper, steel, polyvinyl chloride, and galvanized iron. The oldest pipes in the system probably date back to 1915 when the SFWB was first developed. Table 5-3 summarizes the amount of pipeline which is present in the system by the diameter of the pipe.

**Table 5 - 3  
Summary of Pipeline Sizes**

Diameter	Lineal Feet in System	% of Total Pipeline
<b>Less than 6-inch</b>	70,145	13.0
<b>6</b>	253,812	46.2
<b>8</b>	108,300	19.7
<b>10</b>	33,780	6.0
<b>12</b>	16,503	3.0
<b>14</b>	14,742	2.7
<b>15</b>	9,659	1.7
<b>16</b>	16,159	2.9
<b>20</b>	3,447	0.6
<b>24</b>	14,626	2.7
<b>30</b>	8402	1.5
<b>TOTAL</b>	549,575	100

## Reservoirs and Tanks

The system has a total storage capacity of 6 million gallons spread across six storage reservoirs and tanks. Table 5 - 4 summarizes information about these reservoirs.



**Table 5 -4  
Summary of Reservoir Capacities**

Name	Year Built	Capacity (million gallons)	Type	Overflow Elevation (ft)	Diameter (ft)	Height (ft)
Bolton	1913	2.5	Concrete on grade, with liner and cover	440		
Horton	1974	1.5	Steel, On Grade	730.5	80	40
Rosemont	1991	0.4	Steel Tower	860	53	110
Bland Circle	1981	0.5	Steel, On Grade	585	43	48
Willamette	1970	0.6	Steel, On Grade	351	48	43
View Drive	1967	0.5	Steel, On Grade	328	60	24

The Bolton Reservoir, located on Skyline Drive, was constructed in 1913 as part of the original supply from the SFWB. It is a concrete slab-on grade reservoir with 2:1 (horizontal : vertical) side slopes. A liner was installed in 1989. Prior to the liner placement the floor panels were patched on an ongoing basis. Areas of exposed rebar in the floor were patched just prior to the Hypalon liner placement. A Hypalon cover was placed over the reservoir in 1995. The floating cover is equipped with an access hatch. Piping serving the reservoir consists of an 18-inch steel inlet/outlet pipe. An old 10-inch connection was abandoned due to a landslide northeast of the reservoir. The reservoir water surface is normally below the hydraulic grade line of the transmission line from the SFWB. All electrical and telemetry associated with the reservoir is at the Bolton Pump Station. The reservoir supplies water to the Bolton Pump Station in addition to its own Bolton Pressure Zone service area.

The Horton Reservoir is located at the intersection of Horton Road and Santa Anita Drive. It is a ground level steel reservoir. The inlet pipe is 14-inch diameter and extends from the distribution system to the reservoir. A 14-inch outlet /suction pipe extends from the wall of the reservoir to the adjacent Horton Pump Station. This pipe exits the reservoir and goose-necks up to the Horton Pump Station at 4 to 5 feet above the floor elevation of the Reservoir. This configuration reduces the effective pump storage by approximately 190,000 gallons. A 10-inch pipe connects the inlet and suction pipes. The existing light for the reservoir site has been abandoned and a street light provides lighting for the reservoir. Telemetry consists of a level transducer located in the pump station instead of in the reservoir itself. The level has to be mathematically adjusted to read true water elevation. The reservoir is filled by the Bolton Pump Station and supplies water to the Horton Pump Station in addition to its own Horton Pressure Zone service area.

The Rosemont Tower is an elevated steel, spheroid tower located on Suncrest Drive. It supplies water to the Rosemont Pressure Zone service area. The enclosed area of the reservoir pedestal is used to house all electrical and telemetry systems for the reservoir. The apron also houses radio broadcasting equipment for fire and emergency calls. Piping for the elevated reservoir includes a single 18-inch ductile iron pipe from Suncrest Drive, a steel inlet/outlet and an overflow pipe inside the reservoir. The pipes extend vertically up into the spheroid. All visible piping systems appear to be in good condition and operating properly. Site access is through a small landscaped area. Site security is provided at the base of the pedestal with a locking door.

The Bland Circle Reservoir is a ground level steel reservoir located on Bland Circle and serves the Bland Pressure Zone. It is supplied by the Willamette Pump Station from the Willamette Reservoir. A 10-inch common inlet/outlet pipe serves the reservoir. A 10-inch gate valve is used to isolate the reservoir.

The Willamette Reservoir is a ground level steel reservoir located on Salamo Road in the Willamette area. Flow to the reservoir is through a 10-inch pipe. The reservoir serves the Willamette Pressure Zone and the Willamette Pump Station. A new altitude valve and vault were constructed on the inlet/outlet pipe to control flow into the reservoir. A 16-inch suction pipe extends out the south side of the reservoir and serves as the main suction for the pump station. A 14-inch by 10-inch cross has also been cut into the 10-inch inlet/outlet pipe and provides suction for the adjacent pump station if the reservoir is taken out of service. Site lighting is provided by a light mounted on the roadway above the reservoir and pump station. A chain link security fence extends only partially around the site.

The View Drive Reservoir is a ground level steel reservoir on View Drive in the Robinwood area. It serves the Robinwood Pressure Zone. Piping includes a common 10-inch inlet/outlet pipe which connect to a valve box near the reservoir. The vault contains two 10-inch pipes which tee off from the inlet/outlet pipe. One of the pipe runs includes an altitude valve to close the reservoir when full. The other pipe includes a check valve to allow water to flow out of the reservoir when the pressure in the system drops. The tank flow is regulated using an adjacent PRV and altitude valve located in the distribution system. Site improvements include a short gravel access and parking area and a chain link security fence. Limited access exists around the reservoir.

## **Pump Stations**

The water system includes three pump stations. Information about those stations is summarized in Table 5 - 5. The nominal firm capacity is the capacity of the pump station with the largest pump out of service. The actual firm capacity may be less than the nominal capacity due to the fact that the rated flow of each pump individually may not be achieved when all pumps are in operation.

The Bolton Pump Station is located adjacent to the Bolton Reservoir and was constructed in the early 1970's. The facility consists of four (4) vertical turbine pumps mounted in the floor above a concrete clearwell. The clearwell of the station and the Bolton Reservoir are interconnected and supplied from an 18-inch transmission main which is connected to the 24-inch diameter transmission main from the SFWB. Above grade portions of the station are frame construction, with a wood truss roof and composition shingles. The roofing was upgraded in 1992. Upgrades to the pumps were performed in 1983. The Station pumps water to the Horton Reservoir through a 14-inch diameter transmission main. The level in the Horton Reservoir controls the pumps. The 6-inch pump discharge pipes include a plug valve for isolation and an angle pump control valve that provides the necessary startup head for the pumps.

Improvements to expand the Bolton Pump Station to meet future demands were completed in March 1999. These improvements consisted of constructing a new pump station at the site of the existing pump station. This new pump station was initially equipped with two, 1,500 gpm pumps, along with space for future addition of two more 1,500 gpm pumps. The pump station also included a emergency, standby diesel generator to provide power in case of a power failure.

**Table 5 -5  
Summary of Existing Pump Station Capacities**

Name	Pump Configuration (gpm)	Total Installed Capacity (gpm)	Nominal Firm Capacity (gpm)*
Bolton**	3 @ 750; 1 @ 500; 2 @ 1,500	5,750	4,250
Horton	3 @ 1000; 1 @ 350	3,350	2,350
Willamette	3 @ 500	1,500	1,000

\*Actual firm capacity may be less than nominal firm capacity because rated pump flow may not be achieved when all pumps are in operation.

\*\* Includes capacity of both existing and new Bolton Pump Stations.

The Horton Pump Station is a concrete and frame structure located adjacent to the Horton Reservoir. Pumps No. 1, 2, and 3 were placed in service in 1974. Pump No. 4 was installed in 1991. A new composition roof was installed on the structure in 1996. The station pumps to the Rosemont Tower. The level in the Tower controls the operation of the pumps. Suction for the station is taken from the Horton Reservoir at a point 4 to 5 feet above the reservoir floor. Site improvements include the graded parking area around the pump station and the gravel access road. The back wall of the pump station serves as a retaining wall to support the back slope of the site.

The Willamette Pump Station is a concrete structure constructed in 1994 and located adjacent to the Willamette Reservoir. It pumps water to the Bland Circle reservoir that controls the operation of the pumps. The station has three vertical turbine pumps, which sit in pump cans mounted in the floor. The roofing system is a pitched truss support system with ribbed metal roofing. Suction for the station is taken directly off of the Willamette Reservoir, through a 16-inch pipe. A 14-inch pipe directly off of the reservoir inlet/outlet pipe can provide secondary suction flow.

### Other Facilities

The system includes 17 pressure reducing stations, creating 13 subzones. These stations reduce the pressure from the main zones within the system to acceptable levels in areas of lower elevation. These areas would have unacceptably high pressures if operated directly off the pressures of the main zones.

### Instrumentation and Controls

The City recently completed installation of a new System Control And Data Acquisition (SCADA) system. This system is used to control and monitor the pumps, tanks, and other components of the water system. The SCADA system records flows, pressures, elevations and other information that is useful in controlling daily operations and understanding how the system works.

### Meters

There are approximately 7,000 water meters throughout the water system. Over 96% of these meters are residential, 5/8 X 3/4-inch meters. Most of the remaining meters are 1-inch, 1 1/2 -inch, and 2-inch meters which serve multifamily, apartments, commercial, and public facilities. There are less than 20 meters system-wide that are 3 -inches or greater in size.

## ORGANIZATION AND MANAGEMENT

### Staffing

The West Linn system is operated by a Water Crew Chief, a water quality control person, and four water distribution system operating personnel. The Water Crew Chief reports to an Operations Manager, who has responsibility for sanitary sewers, storm water, solid waste and recycling, transportation, and vehicle

maintenance in addition to water operations. Engineering support is provided by the Engineering Division of Public Works, which also supports the other operating functions of the City. Overall system management responsibility extends from the Public Works Director to the City Manager and the City Council.

The water system is classified by the State Health Division as a Water Distribution System - Level 3. The State requires that the operator of such a system have a Level 3, Water Distribution operator certification. The current Water Crew Chief has this level of certification. Other members of the water operations staff have Level 1 and Level 2 certification. Three of the operations personnel are also certified as Cross Connection Control Testers and one of them is certified as an Inspector.

### **Standards, Codes, and Plans**

The City maintains several sets of standards, codes and plans that are important for the long-term operation of the system. The City maintains Utility Design and Construction Standards that govern the installation of pipelines, fire hydrants, and other system components by developers and others who build pieces of the water system. It also maintains Water Regulations which describe rates, water shut-off procedures, water curtailment authorities, and cross connection control authorities. The City has adopted an operational policy for emergency response in the event of contamination of the City's water distribution system. The City also has a water curtailment plan for use in times of water shortages that describes which water uses will be curtailed under various circumstances.

### **Budget**

The total yearly operating and maintenance budget for the water system is approximately \$2,000,000. For the 1997 - 98 fiscal year, over 40% of that budget was for payments to the South Fork Water Board for purchase of the water supply. The remainder of the budget goes to personnel costs for the water system employees and required ongoing training and certification (21%); utility bills to run the pump stations and other facilities (4%); materials for meter installation, main repair, facility repair and vehicle upkeep (6%); accounting and billing (4%); engineering and administrative support (11%); outside professional services (4%); and various miscellaneous administrative and other costs (10%). In addition to the operating and maintenance budget, approximately \$350,000 has generally been budgeted for Capital Maintenance Projects such as main replacement and reservoir painting.

### **Rates**

The City currently bills its customers every other month. The units of measure which is used is a hundred cubic feet, or "ccf" (1ccf = 100 cubic feet = 748 gallons. The bimonthly charge by water meter size is shown in Table 5 - 6. A typical residential home has a ¾" meter. Included in the bimonthly charge is use of up to 14 ccf (10,472 gallons) of water. For each addition ccf of water use, a commodity charge of about \$1.14 is incurred.

**Table 5 - 6  
Approximate City of West Linn Water Rates**

<b>Meter Size</b>	<b>Bimonthly Charge*</b>
3/4"	\$ 19.70
1"	23.33
1 1/2"	28.00
2"	45.11
4"	60.66
6"	90.74
8"	119.77
10"	150.36

\* Includes 14 ccf per bimonthly period. Additional water use is about \$1.14/ccf

A recent survey conducted for the SFWB (Economic and Engineering Services, Inc., January 13, 1997) compared the water bills of communities, including the City of West Linn, which purchase water from a wholesale supplier. The comparison was as of November 13, 1996. Table 5 - 7 summarizes the results from that survey and is adapted from a similar table in it. This comparison included all charges in each community for a typical residential and commercial customer. Also shown for comparison purposes in the survey are the wholesale water rates that the community pays. This survey shows that the wholesale water rate which West Linn pays to the SFWB (\$0.5510) is at the upper end of a relatively narrow range (from about \$0.46 to \$0.55) within which most of the wholesale rates fell. However, the typical residential and commercial water bill that is paid in West Linn is among the lowest of the communities which were surveyed.

**Table 5 - 7**  
**Comparison of Water Bills and Wholesale Water Rates**  
**As of November 15, 1996**  
**(Source: EES, January 13, 1997)**

Community	Wholesale Rate (\$/ccf)	Typical Residential <sup>(1)</sup> (10 ccf) Bill (\$)	Typical Commercial <sup>(2)</sup> (50 ccf) Bill (\$)
<b>South Fork Water Board</b>			
Oregon City	0.5290	26.05	91.25
<b>West Linn</b>	<b>0.5510</b>	<b>12.80</b>	<b>58.55</b>
CRW - South <sup>(3)</sup>	0.4998	25.90	110.75
<b>Portland</b>			
Gresham <sup>(4)</sup>	0.3920	18.06	60.16
Lorna Water Co	0.4670	16.50	66.50
Pleasant Home WD	0.4800	17.25	78.70
Powell Valley WD	0.3920	15.10	59.00
Rockwood WD	0.4710	14.00	57.30
Burlington WD	0.5470	40.50	160.50
Valley View WD	0.8670	18.50	72.50
West Slope WD	0.7990	17.00	72.50
Tualatin Valley WD <sup>(5)</sup>	0.5370	16.78	67.87
City of Tualatin	0.5190	18.40	69.65
<b>Clackamas WD</b>			
Mt. Scott	0.53588	15.50	65.50
Oak Lodge	0.48926	11.00	57.00
Gladstone	0.46490	12.50	56.10
CRW - North <sup>(3)(6)</sup>	na	14.56	58.05

- (1) Assumes a 5/8 x 3/4" meter
- (2) Assumes a 1" meter
- (3) Rates effective February 1, 1997
- (4) Rates effective January 1, 1997
- (5) Commercial rates assume monthly use is less than 1.4 x average water consumption
- (6) Commercial rates assume monthly use is less than 1.5 x average water consumption

**Fiscal Policies**

The City most recently amended its fiscal policies in February, 1995. These policies call for the water enterprise fund to meet the operating obligations of the water system and for system development charges to fund additional increments of capital improvements to meet the needs of growth. The City is to adopt a Five Year Capital Improvement Plan each year.

## Section 6

# Evaluation of the Existing System

The City of West Linn's water system which was described in Section 5 was evaluated in several ways in this Water Master Plan. These methodologies included field inspection of key facilities; a comparison of key facilities to the planning criteria; an hydraulic model of the system; an unaccounted for water survey and leak detection pilot test; and a review of other issues and information. The results of these evaluations are given in this section. Capital improvements and other recommendations based on this evaluation are given in Sections 8 and 10.

## FIELD OBSERVATION OF KEY FACILITIES

Elements of the City of West Linn's water system have been in service since 1913. As with any water system, on-going operations and maintenance efforts are required to keep the system functioning. As time goes by, system elements such as motors and control systems, valves and coatings can wear out or become obsolete, thus reducing the effectiveness of that segment of the system. In order to evaluate the current condition of some of the key components of the City's water system, qualitative, field observations were conducted on these key elements by Montgomery Watson personnel. Input was also obtained from West Linn water operations personnel, who accompanied Montgomery Watson on the field visits. The purpose of the evaluation was to observe the general condition of the facilities and to provide recommendations for potential improvements that need to be performed as part of the Capital Improvement and Capital Maintenance Programs. The observation reflects conditions as noted at the time of the fieldwork, July 1997. The observations are not intended to be a detailed evaluation, a safety inspection, or to serve any other purpose.

Criteria were defined for the evaluation prior to the inspection of the facilities. In general, the key elements of each type of facility, i.e. reservoir, were listed and a scoring system from 1 (worst) to 10 (best) was defined for each element. The elements of each facility were then field observed and rated. The field work sheets for each facility are included in Appendix C.

Facilities in the City of West Linn water system that were observed were the Bolton, Horton and Willamette Pump Stations; the Bolton, Horton, Rosemont, Willamette, Bland Circle, and View Drive Reservoirs; and two Pressure Reducing Valve Stations (PRVs). Also reviewed was a March 1996 report on the transmission pipeline on the I-205 Bridge.

## **Transmission Main**

In early 1996, an analysis was conducted of the existing 24-inch diameter water transmission pipeline located on the I-205 bridge (MSA, 1996). This analysis identified several deficiencies to the pipeline, including excessive bowing of pipe support beams, potential inadequacy of the pipe support system under earthquake conditions, lack of catwalks and access ladders for personnel access on major portions of the pipeline, leaking pipe joint couplings, and the need for painting. A two-phase plan for repairs was proposed. The first phase would complete work that could be conducted with only minor shutdowns of the pipeline. The second phase would conduct work which requires extensive pipeline shutdown, but could not be accomplished until the City has adequate storage in West Linn, an alternative supply or agreement to use its intertie with the City of Lake Oswego for an extended period.

## **Reservoirs**

### Bolton Reservoir

Both the liner and floating cover for the Bolton Reservoir appear to be in good condition and have 15 to 20 years of service life remaining. Exposed concrete shows some spalling and some localized cracking that may warrant some surface patching.

A separate inlet and outlet pipe would enhance circulation in the reservoir and possibly improve water quality, although maintenance personnel indicate the reservoir currently maintains a 0.8 mg/l chlorine residual. One method to enhance circulation of flow would be to extend the 18-inch inlet/outlet pipe farther into the reservoir and place a flap gate on the end of the pipe. A tee with a check valve would be placed in the pipe near the entrance to the reservoir. Inflow would enter the reservoir at the flap gate and outflow would exit at the check valve. The location of the discharge of the underdrains from the reservoir needs improvement.

The most serious issue concerning the Bolton Reservoir is the instability of the north slope of the reservoir, which exhibits evidence of previous landslide movement. This slope should be investigated and methods to stabilize the slope movement should be implemented to prevent potential future damage to the reservoir and possible long-term failure.

### Horton Reservoir

The Horton Reservoir was originally constructed with a ring footing. It appears the ring footing was not level, and grouting for the tank steel base ring was required. This grout has fallen out leaving the underside of the base ring exposed. Approximately 50 percent of the ring has rusted away, leaving only 1/8" to 3/16" of steel remaining. The minimum allowable thickness by AWWA D100-is 1/4". The base ring is now sagging between the shims placed to level the ring. The concrete 96-ring footing is also cracked. Repair of the base ring is critical to the continued life of this facility. Seismic



anchors were also not observed on this reservoir and should be installed when the ring repair is conducted. Exposed piping appears to be in good condition. Operations staff indicated that the piping and valves are all operating correctly.

The exterior paint coating is showing large areas of oxidation and biological attack from algae growing in the shaded sections. In several areas the surface coating is completely oxidized leaving exposed primer. The primer paint coat appears to be in good condition. Existing coating systems on the reservoir are likely to contain lead in the paint. Special removal techniques will be required to reduce health hazard exposures to workers. Condition of the reservoir lining is unknown, as the reservoir has not been drained for inspection.

Large trees are on site behind the reservoir. Roots from these trees are growing under the reservoir and are beginning to affect the reservoir, lifting the ring footing. This condition should be addressed. A probe style pressure transducer should be installed in the reservoir and the existing level indicator in the Horton Pump Station should be decommissioned.

#### Rosemont Reservoir

The ring footing, steel support columns, and steel shell of the Rosemont Reservoir all appear to be in excellent condition. The electrical and telemetry systems also appear to be in good condition. All visible piping appears to be in good condition and operating properly. Both the lining and coating system appear to be in good condition. A very small amount of biological growth (algae) is visible on the north side of the spheroid and pedestal.

#### Willamette Reservoir

The steel tank of the Willamette Reservoir appears to be in good condition. The steel plate and welds for the wall are in serviceable condition. Some slight spalling of the ring footing concrete is occurring. No cathodic protection system exists for this reservoir.

Exposed piping appears to be in good condition. Operations staff indicated that the piping and valves were all operating correctly. The site lighting provided by a light mounted on the roadway above the reservoir has limited effectiveness due to its location and a security fence extends only partially around the site. These could be improved.

The reservoir has a paint coating system, which is showing slight oxidation and some surface rust. Maintenance personnel indicate the interior lining system needs to be replaced. Existing coating systems on the reservoir are likely to contain lead in the paint. Special removal techniques will be required to reduce health hazard exposures to workers.

#### Bland Circle Reservoir

The steel tank of the Bland Circle Reservoir appears to be in good condition. The steel plate and welds for the wall are in serviceable condition. This reservoir has a cathodic protection system. Field observations of the structure indicated some cracking of the ring footing concrete. The seismic anchor straps are located within 2 inches of the outside edge of the ring footing and do not appear to have adequate cover to avoid damage to the footing in a seismic event. Operations staff indicated that the piping and valves were all operating correctly.

Connections/splices for the area light wiring is exposed and may not meet code. An intrusion alarm is not included in the reservoir monitoring and should be added. The pressure transducer for level monitoring is mounted 4 feet above the reservoir floor and must be manually adjusted to true zero. This could be corrected.

The reservoir coating system is being attacked by biological growth (algae) and oxidation (UV and oxygen). Areas of the coating are showing rusting of the steel reservoir shell. Access around the tank is limited and a new ring road around the tank would help with maintenance.

### View Drive Reservoir

The reservoir steel shell and concrete ring footing of the View Drive Reservoir appear to be in very good condition. Seismic anchors are included in the ring footing and also appear to be in good condition. Piping for the reservoir appears to be operating adequately. All elements of the electrical/telemetry system appear to be operating correctly. The exterior coating that was applied in 1991 appears to be in good condition. However, overhanging tree limbs are adding to the deterioration of the coating system. These limbs should be cut back to avoid potential problems.

## **Pump Stations**

### Bolton Pump Station

The existing Bolton Pump Station is a concrete and frame structure. It was undersized for current demands and was slated for improvement and expansion. The concrete condition appears to be good in the Bolton Pump Station for the age of the structure. The original plans do not show baffling between the pump suction. Baffles would reduce the possibility of interference (formation of vortices) between the pump suction, which are spaced close together.

The electrical system for the existing pump station was old and did not meet the latest Electrical Code requirements. Improvements were also needed to the power supply. The existing service was only 500 amps. Pump No. 1 has an older motor design that requires approximately twice the power as pumps No. 2 and 3. Backup power source was inadequate. The construction of a new pump station at the site addressed these problems with the existing pump station. The telemetry system was recently upgraded and only needed to have the additional contacts for the new pump station improvements

The Bolton Pump Station shares the problem with the Bolton Reservoir of an unstable slope to the north. This slope should be stabilized.

### Horton Pump Station

The Horton Pump Station is a concrete and frame structure that appears to be in good condition. Pump No. 1 is the smaller pump and does not have enough discharge head to pump its rated flow in the discharge piping. This pump should be replaced with one with higher head. Two of the larger pumps include natural gas drives to run them under power failure. This provides an emergency capacity of 2000 gpm.

The electrical starters and controls for Pumps No. 1, 2, and 3 were placed in service in 1974 and will need to be upgraded. The telemetry system appears to be functioning properly.

Suction for the pump station comes from the Horton Reservoir through a suction pipe that exits the reservoir 4 to 5 feet above the reservoir floor. Lowering the suction to pull water off the bottom of the reservoir would add reservoir capacity under pumping conditions.

### Willamette Pump Station

The Willamette Pump Station is a concrete structure constructed in 1994. It appears to be in good condition, with electrical, telemetry, piping, and pumps systems functioning well. The station has provisions for an emergency generator, but a generator is not in place and should be purchased to provide back-up power.

### **Pressure Reducing Valves (PRV's)**

While only two of the PRV stations in the system were inspected, operating personnel report that these facilities are, in general, functioning well. However, PRV's located below elevation 175 feet are experiencing flooding from high groundwater. Under flooded conditions it would be difficult to perform routine maintenance. Submerged water piping provides a potential for contamination entering the water system if leaks or other problems occur. Sealing PRV vaults and providing sump pumps to dry the vaults would improve this situation.

## Recommended Improvements

Based on the field evaluation of these facilities, the following recommendations are made for Capital Maintenance and Capital Improvement Projects. It is recommended that several categories of ongoing projects be defined to implement the recommendations over time. Other, specific one-time projects are recommended and are listed below. In addition to these Capital projects, several ongoing operational and maintenance recommendations are made. These include pressure washing of reservoirs to remove biological growth, removal of tree roots and overhangs, lowering of level transducers to read reservoir level directly without adjustments, and routine exercising of key valves and natural gas drives.

**I-205 Transmission Main Repairs** - The two phased repair program for the I-205 Transmission Main as recommended in the March 1996 report should be implemented. Initial work would consist of installation of new catwalk and support and an overhead cable fall-prevention system, plus other miscellaneous repairs that can be accomplished without taking the line out of service for an extended period. Total cost of this work is estimated at \$400,000. The second phase would consist of all the remaining work identified in the 1996 report, at a total cost of approximately \$500,000. This second phase of repairs would be conducted when the pipeline could be taken out of service for a period of time. It is therefore not scheduled currently in the Capital Maintenance Program as the line currently cannot be taken out of service.

**Reservoir Lining and Coating Evaluation and Repair** - Aging lining and coating systems on the reservoirs need to be evaluated to determine if they contain lead paint. The existing systems have been in service for more than 20 years. Most coating systems have a normal service life of 15 to 20 years and thus, the coatings on most all of the reservoirs are at the upper end of their service life. Paint systems of the 1970's were usually high in lead content. Recent health regulatory requirements limit the use of lead in paints and define rigid removal and disposal requirements for replacement of such coating systems. Coal tars were also used extensively in the 70's for lining systems. Coal tar does not now have approval for use in contact with drinking water systems due to carcinogens that may leach from the coatings.

The first step in upgrading the coatings on the reservoirs is an evaluation of the existing lining and coating material used for each reservoir. The evaluation would determine the potential hazards at each reservoir and look at the effort and costs for upgrading the coatings. Then, the coatings on each reservoir can be upgraded according to a defined schedule.

**Reservoir Seismic Evaluation and Repair** - The current level of structural restraints for seismic events varies considerably from reservoir to reservoir. A site-specific evaluation for each reservoir needs to be performed using the most recent seismic zone criteria. The evaluation would verify the structural anchorage needed to protect the reservoirs from damage or movement during a seismic event. Once the evaluation is complete, the repairs needed for each reservoir should be made.

**Reservoir Cathodic Protection Evaluation and Improvement** - While several of the reservoirs have a cathodic protection system installed, not all do. Corrosion potential may be high at the other reservoirs and applying a properly designed cathodic protection system could extend the life of the reservoirs. Additional evaluation of each reservoir for cathodic protection needs is recommended. If additional reservoirs require installation of cathodic protection, then this can be scheduled accordingly.

**PRV Vault Improvements** - All of the Pressure Reducing Valves vaults that have high levels of groundwater in them should be sealed and equipped with sump pumps to dry the vaults. A paint coating system to protect valves and piping in the vaults from corrosion should be provided.

**Bolton Reservoir Slide Stabilization and Other Landslide Monitoring** - The north slope of the Bolton Reservoir site should be investigated concerning the land movement. Improvements to stabilize this slope from further movement and potential failure should be undertaken. Landslides along the 24-inch transmission main on Abernathy in Oregon City and above the County Shops should be monitored for potential movement and the need for stabilization.

**Bolton Reservoir Improvements** - Site drainage should be collected and conveyed away from the slope failure area to the north. Improvements to the inlet piping to improve circulation should be constructed. A simple method to enhance circulation is to extend the 18-inch inlet/outlet pipe further into the reservoir and equip it with a tee and check valve at one end and a flap gate at the other. Improvements to the altitude valve at the reservoir should be conducted.

**Horton Reservoir Repair** - The steel base support ring of the Horton Reservoir must be repaired or replaced and grout which has fallen from the area between the base ring and the ring footing needs to be replaced. Cracked sections of the ring footing must be repaired. A new level transducer should be installed in the reservoir. Seismic evaluation and anchoring of this reservoir could be conducted at the same time as these repairs are completed. Installation of a new outlet pipe from the base of the reservoir to the pump station to eliminate the existing goose-neck would add capacity during an emergency. Cathodic protection and coating replacement may also be needed, and could be evaluated at the same time.

**Bolton Pump Station Improvement** - The Bolton Pump Station must be expanded. Improvements to the existing station to correct the electrical and other deficiencies that have been noted should be undertaken with the expansion. These were completed in March, 1999.

**Horton Pump Station Improvement** - Pump No. 1 does not provide enough head and should be replaced with a higher head pump. Pump controls for pumps No. 1, 2, and 3 will need to be upgraded in the near future.

**Willamette Pump Station Generator** - An emergency back-up generator for the Willamette Pump Station should be installed to provide back-up power.

## **COMPARISON OF SOURCE TO PLANNING CRITERIA**

The recent Water System Master Plan for the South Fork Water Board (SFWB) (Montgomery Watson, 1997) estimated that the combined ultimate buildout peak day water demand for Oregon City and West Linn was 51.6 mgd. This demand would not be reached until some time after the year 2050. As discussed in Section 5, the SFWB has water rights that will total to this amount, even in low flow periods. Thus, there is adequate water to serve the City of West Linn from this source to buildout of the City's population.

## **COMPARISON OF STORAGE RESERVOIRS TO PLANNING CRITERIA**

### **Alternative Planning Criteria**

Three different potential storage planning criteria are reviewed in this Master Plan. The planning criteria that is proposed in this Master Plan consists of 25% of projected peak day demand for equalization plus the largest fire flow demand plus one average day demand for emergencies. This compares to the existing 1982 criteria of 20% of peak day plus fire flow. Another alternative criteria, which used to be the State of Oregon's standard (but is not required any longer), is three times average day demand. The nominal total capacity of the existing West Linn system is 6.0 million gallons of treated water storage.

### **Storage Calculations**

Table 6 - 1 presents the storage calculation for each major zone with the system using the proposed planning criteria for the existing system demand. This existing system demand is that which is used in the hydraulic model for 1997 - a total of 6.6 MG citywide. A discussion of the allocation of demands throughout the water system is given later in this Section. Also shown in Table 6 - 1 is the storage deficit, if any, using the criteria in the 1982 Water Master Plan and using the three times average day demand criteria. Table 6-1 shows a 3 MG total deficit in storage needs under the proposed planning criteria and a 3.4 MG storage deficit under the three times average day demand criteria, but only a 1 MG deficit under the 1982 Master Plan criteria. Several points must be noted about this information:

- The Willamette, Bolton, and View Drive (or Robinwood No. 2) reservoirs all serve areas of the City which are served by the head of the SFWB supply system. Thus, these areas can also rely upon the 10 MG Mountain View Reservoir No. 2 in Oregon City that is part of the SFWB system, to meet the emergency storage needs of West

Linn. In addition to West Linn, the Mountain View Reservoir is relied upon by Oregon City, the SFWB and Clackamas River Water - South service area for storage needs. A recent water master plan for the SFWB (Montgomery Watson, September, 1997) indicated that this reservoir should be about 4.5 MG larger to meet all these communities' needs at the same time. However, if not all of the communities are drawing upon the Reservoir at once, it can provide storage on a temporary basis.

- Because of the piping arrangement at the outlet of the Bolton Reservoir, this reservoir serves primarily as a clearwell for pumping at the Bolton Pump Station. The Bolton Pressure Zone will always draw storage from the Mountain View Reservoir prior to drawing from the Bolton Reservoir. The Bolton Reservoir will only be drawn down when the Mountain View Reservoir is empty. Because of this situation, the storage requirement is shown both with and without relying upon the Mountain View Reservoir.
- While the planning criteria call for fire flow requirements to be met from storage, and not from pumping, the Rosemont system is currently designed so that some of the fire flow requirement would be provided, not from storage, but from excess capacity available in the Horton Pump Station. This capacity is not shown in Table 6-1. This issue is discussed in more detail later in this section.
- Table 6 - 1 shows the results for the 3,000 gpm city-wide fire flows as desired by the Fire Marshall. While the total volume of required storage city-wide would be about the same if the previous fire flows, which varied by zone, were to be used, the specific storage needs for each zone would be different than shown in Table 6-1.

Table 6 - 2 presents storage requirements by zone for the year 2015 low demand projection. Table 6 - 3 presents the information for the year 2015 high demand projection and Table 6 - 4 presents the information for the build-out demand projection. The same caveats exist for these tables as for Table 6 - 1. The total storage need by the proposed planning criteria grows to almost 10 MG by the low 2015 projection and to almost 12 MG by build-out. Thus the total storage deficit in the City would grow to about 4.6 MG by 2015 and over 6 MG at build-out under the proposed planning criteria.

If the three time average day demand criteria were used, then the storage deficit would be about 6.75 MG by 2015 and grow to approximately 10 MG at build-out. If the 1982 Master Plan criteria were maintained, then the total storage deficit in the City would be only 1.6 MG at buildout. If the 1982 Master Plan criteria were maintained, the Willamette, Bland Circle, Robinwood and Rosemont zones would all have storage deficiencies for the year 2015 projections.

Given the history of efforts to site a reservoir in the Rosemont Zone, it may not be feasible to find a location where a large new reservoir could be placed. If this were the case, then maintaining the planning criteria from the 1982 Master Plan for this zone would reduce the required storage need to 0.6 MG. Siting a tank this size might be more acceptable. Another option would be to continue to provide excess capacity from

the Horton Pump Station. This would result in the need for the construction of a new Horton Pump Station at a capacity of at least 3,000 gpm and an increase in the size of a new Horton #2 Reservoir by 0.6 MG at the 1982 criteria. The Parker Road Transmission Main would also have to be constructed. This is discussed in more detail later in this Master Plan.

**Table 6 - 5  
Summary of Storage Deficit  
Under Proposed Planning Criteria**

<b>Zone/Reservoir Name</b>	<b>Current Nominal Size (MG)</b>	<b>Existing Deficiency (MG)</b>	<b>Year 2015 Low Demand Deficiency (MG)</b>	<b>Buildout Deficiency (MG)</b>
<b>Willamette</b>	0.6	0.75	1.5	1.5
<b>Bolton</b>	2.5	-	-	-
<b>Robinwood/ View Drive</b>	0.5	0.4	0.5	0.75
<b>Horton</b>	1.5	-	0.6	1.2
<b>Rosemont</b>	0.4	1.5	1.6	2.2
<b>Bland Circle</b>	0.5	0.4	0.4	0.55
<b>TOTAL</b>	<b>6.0</b>	<b>3.0</b>	<b>4.6</b>	<b>6.2</b>

Table 6 - 5 summarizes the storage deficits by zone under the proposed Master Plan criteria and Table 6 – 6 summarizes the storage deficits under the 1982 Master Plan storage criteria. Both Tables 6- 5 and 6 – 6 assumes that all the storage needs are provided from a reservoir in the Rosemont Zone, and not from the Horton Pump Station. It does not include any storage volume from the Mountain View Reservoir for the Bolton Zone. The tables only shows the low demand projection for the year 2015, because the differences between the low and high demand projections for that year will not materially affect sizing of any proposed reservoirs. Reservoir size will be driven more by ultimate buildout capacity needs. The deficiencies shown are rounded.

Table 6 - 5 shows that the largest area of existing deficiency under the proposed planning criteria are in the Willamette, Horton, and Rosemont zones, but that at buildout, all zones except Bolton will need additional storage.



## Comparison of Storage Requirements to Other Communities

A survey of several local and regional utilities was made to determine how the City's proposed storage criteria compares. The local utilities surveyed include Beaverton, Lake Oswego, Oregon City, Sherwood, Tigard, Tualatin Valley Water District, Clackamas River Water, Eugene, and Corvallis. Table 6-7 summarizes the results. Five of the surveyed utilities have operational and fire storage component criteria, with varying volumes. Four of those utilities also have emergency storage criteria. Two of the surveyed utilities rely on the State of Oregon's previous standard of 3 times the average day demand to define their storage needs, and the remaining two have no defined storage criteria.

**Table 6 – 6  
Summary of Storage Deficit  
Under 1982 Master Plan Storage Criteria**

<b>Zone/Reservoir Name</b>	<b>Current Nominal Size (MG)</b>	<b>Existing Deficiency (MG)</b>	<b>Year 2015 Low Demand Deficiency (MG)</b>	<b>Buildout Deficiency (MG)</b>
<b>Willamette</b>	0.6	0.2	0.4	0.4
<b>Bolton</b>	2.5	-	-	-
<b>Robinwood/ View Drive</b>	0.5	0.15	0.2	0.25
<b>Horton</b>	1.5	-	-	-
<b>Rosemont</b>	0.4	0.5	0.6	0.75
<b>Bland Circle</b>	0.5	0.15	.15	0.20
<b>TOTAL</b>	<b>6.0</b>	<b>1.0</b>	<b>1.35</b>	<b>1.6</b>

Figure 6-1 shows the storage criteria for each utility in terms of the equivalent number of average demand days. For example, West Linn's proposed storage needs (averaged over time) are equivalent to approximately 2.3 times the average day demand. For comparison, storage needs based on criteria from the 1982 Master Plan are equivalent to 1.2 times the average day demand, well below storage criteria of surveyed utilities. The criteria that have been proposed for West Linn fall in the mid-range of storage criteria for the surveyed utilities. From this analysis, the proposed storage criteria appear reasonable.

## Emergency Storage Vulnerability and Risk Assessment

The largest component of the City's proposed storage criteria is the emergency storage component. In order to assess whether it would be likely that such emergency storage would be needed, a summary vulnerability and risk assessment of the City's system

was conducted. Several studies have been done on water system risk and associated supply outages and system demands in other locations. The most recent and most pertinent to West Linn's system is the on-going System Vulnerability Assessment (SVA) currently underway for the Portland Water Bureau (PWB). Findings from that Portland Water Bureau study were applied to West Linn's system to assess vulnerabilities and likelihood of loss of supply.

## **Hazards**

In order to identify the likelihood of loss of service, appropriate hazards applicable to the West Linn system must be evaluated. The following hazards have been identified for the West Linn system:

- Earthquake,
- Landslide,
- Floods,
- Volcanic activity,
- Large fire (wildfire or large commercial fire), and
- Loss of supply created by
  - Loss of Division Street pump station,
  - Loss of Willamette River transmission line crossing, and
  - Water quality event at SFWB plant.
  - Loss of Oregon City-shared storage,

Natural hazards, such as earthquake, landslide, volcanic activity and large fire are generally low likelihood, high impact events. However, events in Oakland (major fire), and San Francisco, and Los Angeles, California, and Kobe, Japan (earthquakes) have demonstrated the difficulty for water systems to meet water demands during these events, and the extended period of effects the damage has on the water systems. As a result, it is prudent to consider the risk and potential damage associated with these events.

Loss of supply could be created by natural events, such as earthquake damage to storage, pump station, or transmission facilities, or by operational stress caused by compromised water quality at the SFWB plant or depleted storage shared with Oregon City. These hazards are also addressed in this section.

The Portland SVA study considered hazard events within a 1,000-year recurrence interval. Portland decided that natural events outside the 1000-year recurrence interval would be too unlikely to plan for or design against. Portland decided that mitigation actions will be undertaken for all events with a 100-year recurrence interval or less. They also decided that for those events with a 100 to a 1,000-year recurrence interval,

mitigation would be evaluated on a case-by-case basis. Where costs are not too great and the impacts of the events are severe, then mitigation would be undertaken. These same recurrence intervals are assumed in this evaluation.

### Potential Loss Caused by Earthquake

The SVA Study for Portland summarized potential earthquake damage based on the recurrence interval of earthquakes. To extrapolate conclusions made in the SVA to facility vulnerability in West Linn, peak ground acceleration values for West Linn were compared to downtown Portland. The USGS National Seismic Hazard Mapping Project lists the probabilistic ground motion values by zip code. Assuming zip codes 97068 for the City of West Linn and 97201 for downtown Portland, the probabilistic ground motion values were found to be approximately equal. For the purposes of this initial evaluation, it is assumed the earthquake effects on the West Linn's system can be reasonably approximated by the conclusions made in the Portland water system. A more detailed evaluation of the potential for earthquake impacts, is recommended to validate the conclusions here.

The SVA study measured earthquake risk by recurrence interval instead of by Richter Scale. The peak ground acceleration produced by an earthquake is the factor affecting facility damage. An earthquake can occur at a lower Richter Scale near a given location and produce the same peak ground acceleration as a large Richter Scale event at a location farther away. As a result, recurrence intervals of peak ground acceleration were used in this evaluation.

#### *Minor Earthquake: 10 to 50 year recurrence interval*

The SVA found earthquakes with a 10 to 50 year recurrence interval are expected to be mild, with minimal impact on the PWB system components. It is expected that the West Linn system would have minimal impact from mild earthquakes. However, localized power outages could occur. The system's ability to respond to power outages is discussed in the power outage section.

#### *Moderate Earthquake: 100-year recurrence interval*

The SVA classified earthquakes with a 100-year recurrence interval as moderate magnitude events, and concluded that the Portland groundwater pump station and one or less Willamette River crossings could experience structural damage as a result. The SVA did not predict the likelihood of a regional power outage associated with a moderate earthquake. A loss of regional power is not assumed in this evaluation.

Typically, 100-year events such as storms and floods are the recurrence interval events used to design public facilities. An earthquake with a 100-year recurrence interval is a common event used for seismic design.

West Linn's Willamette River crossing has experienced stress and structural damage during the 1998-1999 winter season. A field inspection conducted as by Murray Smith and Associates in 1996 indicated excessive bowing of pipe support beams and potentially inadequate supports under earthquake conditions. Without structural enhancement, the pipeline is likely vulnerable to a moderate earthquake. The result would be a loss of the supply from SFWB for several days while the pipe is fixed; a complete break of the pipe would require several months to repair.

Field inspection in 1997 indicated the base ring of the Horton Reservoir is in need of repair and there are no seismic anchors installed. Without repair and seismic upgrade, Horton Reservoir is likely vulnerable to a moderate magnitude earthquake. Repair of the Horton Reservoir following a moderate earthquake is expected to take several weeks to repair.

The Bland Circle Reservoir is in good condition, but field inspection found the seismic anchor straps are located within 2 inches of the outside edge of the ring footing. Although damage to the footing could occur during a seismic event, the reservoir is expected to survive a moderate earthquake, with limited damage. However, reservoir outage may be required for a several weeks to repair any damage that occurs.

The hillside slope below the Bolton Reservoir has been identified to have a high landslide potential and movement of the slope has occurred as recently as the 1996-1997 winter season. The risk of further movement is not significantly affected by earthquake, however. The reservoir is expected to survive a moderate earthquake with minimal damage.

The vulnerable facilities discussed in this section are the Willamette River crossing, Horton Reservoir, and Bland Circle Reservoir. The Willamette River crossing could be out for several months to repair a complete break of the pipeline. The reservoirs could be out of service for several weeks for repair, depending upon the extent of damage.

The Bolton Reservoir, Willamette Reservoir, View Drive Reservoir, Rosemont Reservoir, Horton Pump Station, and Willamette Pump Station were found in good condition and with adequate seismic support during the 1997 field inspection. It is assumed that a moderate earthquake will have minimal impact on these facilities.

#### *Extensive Earthquake: 500-year recurrence interval*

The SVA concluded a large magnitude earthquake would cause extensive damage to the PWB system, including significant damage to 3 of 7 Willamette River crossings. The analysis also predicted highly probable regional power outages.

For the City of West Linn, an extensive earthquake is expected to result in serious damage to the vulnerable facilities discussed in the moderate earthquake section. The impact of an extensive earthquake would likely result in a regional power outage, likely for several days, and an extended period of facility outage on the order of months.

### Potential Loss Caused by Landslide

The raw water pipeline between the SFWB river intake and the plant is in a landslide area. Loss of the raw water pipeline could require several days for a temporary fix; a more permanent fix would require a few months to complete. The SFWB has recently had a geotechnical assessment and review of the pipeline route and has determined that the likelihood of losing the pipeline is low.

The Bolton reservoir site is in an area of slope movement. The slope is most vulnerable during very wet seasons when the hillside becomes saturated. Movement of the slope has been detected as recently as the 1997-1998 winter season. Significant movement of the slope could cause extensive damage to the reservoir, which would drain the stored water and remove the reservoir from service. Reservoir damage could range from structural cracks to extensive damage; outage could require as much as six months to a year to repair or rebuild the reservoir.

The Bolton Pump Station sits on the same site as the Bolton Reservoir. The new pump station sits on the opposite side of the reservoir from the slope and is not expected to be at risk from a landslide at the site. Since a back-up power supply is located at the Bolton pump station, it is expected to be a critical facility in the event of a power outage.

### Potential Loss Caused by Flooding

The source of supply is not at great risk of flooding. The SFWB river intake was designed above the 100-yr Clackamas River flood stage. The SFWB plant sits high above the flood stage; the plant is a conventional treatment plant capable of treating high turbidity events associated with flooding. The Division St. Pump Station and associated reservoirs sit high above the flood stage.

None of West Linn's distribution system facilities are expected to be at high risk of damage caused by flooding.

### Volcanic Activity

Volcanic activity is not expected to adversely affect the treatment capabilities of the SFWB conventional treatment plant. Ash fall from Mt. Hood would have to travel from the upper Clackamas River, through the reservoirs on the Clackamas River where a significant portion of the ash would settle out, and through the lower Clackamas River. It is expected that the SFWB treatment plant would be capable of handling the heightened turbidity following a volcanic event. In addition, the SVA found that the volcanic event that could affect the Bull Run supply would have to be greater than a 500-year event. Since the SFWB plant is significantly less vulnerable than Bull Run, the risk to volcanic activity is assumed to be very low.

### Storage Loss Caused by Large Fire

There are several areas of land to the west of West Linn and within the city limits that are covered by dense forest. In drought conditions these areas could be vulnerable to forest fire. However, the individual areas covered by forested growth are not large enough by themselves to be expected to spread out of the control of the West Linn fire system. The system is not expected to be at great risk of wild fire.

The system is designed to fight commercial and residential fires within the city limits. The system is not at greater risk of development fire than the typical utility. However, if a combination of peak demand conditions and loss of one or more facilities stressed the system, a fire demand within the system could be difficult to supply.

### Loss of Supply

A number of factors could result in the loss of water supply to West Linn. These include an adverse water quality event that would shut down the SFWB plant, loss of the Division Street Pump Station, or loss of the Willamette River crossing transmission line.

A water quality event capable of shutting the plant down would be either a *Cryptosporidium* or *Giardia* outbreak, or a chemical spill in the Clackamas River. It is anticipated that a plant outage caused by a water quality event could require several days to return the plant to operable conditions, depending on the event. Since the Lake Oswego supply is also the Clackamas River, it would also be vulnerable to these events. Therefore, it may not be a reliable back-up supply during a water quality event.

The vulnerability of the Division Street Pump Station was evaluated based on mechanical dysfunction, structural damage, or power outage. Mechanical dysfunction would have to be extensive to remove the entire pump station from service and is unlikely. Structural damage is also unlikely. The pump station is designed to meet seismic standards for the region and would be expected to withstand moderate to extensive earthquake events. The pump station has power feeds from two separate substations, which substantially reduces the risk of a loss of power. If one regional supply is lost, the power supply can be switched to the second substation. The Division Street Pump Station is at low risk of damage and loss of capacity. However, in the unlikely event the Division Street Pump Station is out of service, West Linn would have to rely entirely on its distribution system storage and its connection to Lake Oswego for the duration of the outage.

The Willamette River crossing experienced structural stress and leakage during this past winter season. The pipeline is the most vulnerable component in the West Linn system, at risk of further structural failure under current operating conditions. In addition, the pipeline is vulnerable to moderate to extensive earthquake activity. It is assumed a complete break of the pipeline would require approximately 30 days to repair. The repair would include removal of the damaged portion of pipe, replacement with a new section of pipe, and reattachment. Recent repair of leaks took the pipeline

out of service for one week. During that period, West Linn relied on its Lake Oswego connection and storage reservoirs to supply water to its customers.

### Depletion of Oregon City Reservoir Storage

Two reservoirs located within the Oregon City limits on the east side of the Willamette River, Oregon City Reservoirs Nos. 1 and 2, store SFWB water for Oregon City and West Linn use. The Division St. Pump Station pumps supply from the SFWB plant and the two reservoirs to supply flow to both cities. The Oregon City Reservoir No. 2, also known as Mountain View Reservoir, stores 10.5 mgal. The reservoir provides stored supplies for West Linn's Bolton zone in addition to the 2.5 mgal Bolton Reservoir capacity.

If the Mountain View Reservoir was drained or disconnected from the West Linn system, West Linn would have to rely entirely on the storage in the Bolton Reservoir in order to provide operational, fire, and emergency storage to the Bolton zone. Since projected storage needs in the Bolton zone are not expected to exceed the 2.5 mgal Bolton Reservoir capacity, loss of the Oregon City reservoir storage would not impact the system, as long as water could still be supplied to the Division St. Pump Station.

### Role of Intertie with Lake Oswego Supply

West Linn has an existing intertie with Lake Oswego with a design delivery capacity of 3,750 gpm. The intertie is available as a back-up supply to the City's SFWB supply. Assuming the Lake Oswego supply is available and operable in the event of an emergency, the supply is considered adequate to provide an emergency back-up source.

During regional emergencies such as water quality events, major earthquakes, or regional power outages, Lake Oswego could have similar emergencies. In those events, Lake Oswego would have to draw on its limited connections with the Portland Water Bureau and the City of Tigard. However, regional water quality emergencies, which are considered to be low risk events, would not be likely to affect Portland or Tigard water supplies. Regional power outages are expected to last no more than two days, which would allow both the City of West Linn and Lake Oswego to rely on emergency water storage supplies. It is assumed that the greatest risk of regional loss of supply would be caused by a major earthquake event. The recurrence interval for a major earthquake is greater than a 100-years, which is outside of typical design event guidelines. Moderate earthquakes associated with the 100-year recurrence interval would cause limited damage to older facilities, expected in focused areas; it is expected that emergency repairs could be made to key facilities in the region to provide limited water supplies to the City of West Linn.

### Power Outage

Back-up power generation is available at the Bolton Pump Station. The Bolton Pump Station is a critical facility during a power outage since it provides flow to the upper zones. There is sufficient back-up power at the Horton Pump Station to power two pumps. Provisions for back-up power exist at the Willamette Pump Station, but no generator has been purchased for the site. The system could operate during a power outage by relying on a combination of its back-up power and emergency storage. As discussed in the previous section, the Division Street Pump Station has a redundant power supply from an additional substation, and is expected to remain in service during a regional power outage.

Vulnerability Assessment Conclusions

The results of the vulnerability and risk assessment are summarized in Table 6-8.

**Table 6-8  
Summary of Vulnerability Assessment**

<b>HAZARD</b>	<b>VULNERABILITY</b>
<b>MINOR EARTHQUAKE</b>	<b>Local power outage</b>
<b>MODERATE EARTHQUAKE</b>	<b>River crossing, Horton Reservoir, Bland Circle Reservoir</b>
<b>EXTENSIVE EARTHQUAKE</b>	<b>River crossing, Horton Reservoir, Bland Circle Reservoir, general power outage</b>
<b>FLOODS</b>	<b>Little to none</b>
<b>LANDSLIDE</b>	<b>SFWB raw water line, Bolton Reservoir</b>
<b>VOLCANIC ACTIVITY</b>	<b>Little to none</b>
<b>LARGE FIRE</b>	<b>Low, unless in combination with extensive earthquake</b>
<b>LOSS OF DIVISION ST. PS</b>	<b>Low</b>
<b>LOSS OF WILLAMETTE RIVER CROSSING</b>	<b>High – could require 30 days to repair</b>
<b>WATER QUALITY EVENT AT SFWB</b>	<b>Low – but if occurs, likely to impact Lake Oswego alternative source</b>
<b>LOSS OF OREGON CITY 10 MG RES</b>	<b>Low</b>
<b>LOSS OF POWER</b>	<b>Willamette PS, some of Horton PS</b>

The system is at greatest risk of loss of the Willamette River crossing and earthquake damage to selected facilities. The Willamette River crossing could result in a loss of supply, which would require West Linn to rely on its connection to Lake Oswego and its distribution system storage for the duration of the outage.



Depending upon the seasonal demand conditions, the emergency storage that has been proposed in the Master Plan could provide 12 to 36 hours of supply. The existing storage supplies could provide 8 hours to 24 hours of supply, varying by zone.

Several conclusions can be drawn from the vulnerability analysis:

- Repair and seismic upgrade of West Linn's Willamette River transmission pipeline crossing would significantly improve West Linn's system reliability.
- Seismic upgrades of vulnerable facilities to meet current design standards would prepare West Linn against moderate earthquake damage.
- Development of emergency storage supplies and continued operation of back-up power sources would provide West Linn with increased reliability.
- An additional secondary supply would significantly improve West Linn's reliability.

### Role of Emergency Storage

The risk assessment indicates the system is most vulnerable to moderate to heavy earthquake events resulting in major facility outages and loss of supply. In an emergency, an instantaneous transition to alternative sources would not be likely. Emergency storage would "buy" time to allow a disconnection of damaged facilities or lost supplies, and provide a smooth transition to alternative sources. The recommended emergency storage criteria in the Master Plan are supported by this analysis.

### **Factors Influencing Provision of Storage**

Several factors will influence the timing and methodology of providing the needed storage:

- The existing Bolton Reservoir is an old concrete-lined reservoir. A floating cover was installed a few years ago. The reservoir sits at the top of a known landslide that has had recent movement. The expected remaining life of this reservoir is no more than 20 years, when it will be over 100 years old, and could be less due to the slide. Therefore, the City should plan on replacing the Bolton Reservoir with a new reservoir, once the existing reservoir reaches the end of its service life. This would occur sometime after the year 2015.
- As noted above (and discussed in more detail later in this Section), the SFWB is adding storage to its system. This additional new storage could potentially also be made to serve the other gravity pressure zones in West Linn's system (Willamette and Robinwood) if an appropriate site could be found in the City for this potential new reservoir.
- A joint reservoir with the SFWB would be especially useful for replacement of the View Drive Reservoir. The elevation of this existing reservoir is below the hydraulic grade line under normal operating conditions. This makes it difficult to maintain

ES - 69

water quality in the reservoir, as water would sit stagnant in the reservoir. To avoid the problem, the City has throttled the flow to the reservoir, which reduces its usefulness. This reservoir should be replaced at a higher elevation. Combining the Robinwood storage needs with a new SFWB reservoir would provide benefits to the City and satisfy this need.

- Previous City review of reservoir options have determined that the storage volume for the Willamette Zone should be provided at the site of the Bland Circle Reservoir, as a part of Bland Circle Reservoir No. 2.
- The large additional storage requirement that is needed for the Rosemont zone results from a combination of the proposed planning criteria, and the need to serve all storage needs from reservoirs instead of using capacity in the Horton Pump Station as an emergency source. In the past, the Horton Pump Station has been relied upon to provide fire storage because the volume of the storage in the Rosemont Zone was inadequate. In 1997 however, the City reduced the fire flow requirement in the Rosemont Zone to 2,500 gpm for 2 hours because no existing structure, or planned future structure, exceed that fire flow requirement. At this fire flow requirement, the Rosemont Tower is adequate to provide fire storage alone. Even if the Horton Pump Station were to continue to supply fire flow to the Rosemont Zone, this would only reduce the required size of the Rosemont storage by 0.54 MG under the proposed planning criteria. Over 1.5 MG of reservoir capacity would still be needed in the Rosemont Zone by the proposed planning criteria.

Maintaining the 1982 planning criteria for storage (and making the Rosemont Zone consistent with the rest of the City under these criteria) would substantially reduce the size of the required new storage. It would eliminate the need for a new Horton Reservoir, assuming that storage for the Rosemont Zone is provided within that zone. If fire storage was provided from the Horton Zone through the Horton Pump Station, the size of the required reservoir in the Rosemont Zone would be reduced to 0.20 MG at buildout, and a 0.25 MG reservoir would have to be built in the Horton Zone by buildout to supply fire storage to Rosemont.

## **COMPARISON OF PUMP STATIONS TO PLANNING CRITERIA**

A summary of the pumping requirements for each pump station is presented in Table 6 - 9. Table 6 - 10 compares these needs to the existing capacity of each station for the current, the low 2015, and the buildout demands. The nominal firm capacity shown is the rated capacity of the pump station with the largest pump out of service. The actual firm capacity will be different than the nominal because pumps will operate at different points on their operating curve. The current modeled firm capacity shown is the actual firm capacity of the station as predicted in the hydraulic model described below. This table includes the capacity of both the new and existing Bolton Pump Station. It also does not consider any pumping demand on the Horton Pump Station placed by the storage requirements of the Rosemont Zone which are not satisfied by reservoirs within

ES - 70

that zone. The low 2015 demand is used in the table because the sizing considerations will not be materially different if the high 2015 demand numbers were used. Deficiencies have been rounded to the nearest 5 gpm.

As Table 6 - 10 shows, the Willamette Pump Station is adequate until buildout. The Bolton Pump Station was recently expanded. Assuming that the Horton Pump Station does not substitute for the storage needs of the Rosemont Zone, it is adequate until 2015, but then must be expanded by approximately 250 gpm in capacity.

**Table 6 - 10  
Pump Station Capacity Evaluation**

<b>Pump Station</b>	<b>Current Total Installed Capacity (gpm)</b>	<b>Current Nominal Firm Capacity (gpm)</b>	<b>Current Modeled Firm Capacity (gpm)</b>	<b>Existing Deficiency (gpm)</b>	<b>Year 2015 Low Demand Deficiency (gpm)</b>	<b>Buildout Deficiency (gpm)</b>
Willamette	1500	1000	1180	none	none	none
Bolton	5750	4250	3280	none	none	1000
Horton	3350	2350	1857	none	none	250

**COMPARISON OF PIPELINES TO PLANNING CRITERIA**

Approximately 13% of the City’s distribution system consists of pipeline less than 6-inches in diameter. This pipeline does not meet the planning criteria of a minimum of 6-inches for pipelines. It is recommended that all of these pipelines be replaced over time with new pipeline of at least 6-inches diameter. In addition, some of the existing 6-inch diameter pipeline have fire hydrants or may not be part of a looped system. It is estimated that about 5% of the 6-inch diameter pipeline may be in this category and not identified for replacement through the hydraulic model (see below) because fire flow criteria were not investigated on each pipeline in the system due to constraints of time and effort in the modeling. Thus, a total of approximately 83,000 feet of pipeline is recommended for replacement in a Mains Program, with a ten-year program considered as an adequate timeline to accomplish the replacement.

**HYDRAULIC MODEL EVALUATION**

**Model Development**

The existing and future systems were hydraulically modeled in order to evaluate capacities and develop recommended improvements. The hydraulic model chosen for the analysis was H2ONET, which runs within AutoCAD to present input and output of the model, using EPANET to perform the hydraulic calculations. The distribution

system was digitized using the City's electronic basemap, including all pumps, storage tanks, PRVs, and pipelines greater than 6 inches in diameter. Also included in the model were 4-inch diameter and 2-inch diameter pipelines needed to close loops in the model. A total of approximately 104 miles of pipeline are included in the model.

The H2ONET software uses databases to store input and output for each facility. The input databases for nodes (locations where two pieces of pipeline in the model intersect) included elevation, demand, and pressure zone. Pipeline input databases included diameter, length, and roughness, or C-factor (based on material and age of pipeline). Storage tank databases included elevations and storage volumes; pump stations included pump curves; and PRVs included pressure settings and diameter sizes.

The model was calibrated using 1996 demand data and SCADA data for verifying facility operations, including storage tank levels, pressures at pump stations and PRVs and flows throughout the system. Table 6 - 11 shows the locations where the calibration data was collected. Table 6 - 12 shows the comparison of the calibrated model results to the actual field data which was collected. Over 80% of the modeled calibration points were within 3 percent of the measured values and all were within 6 percent. This is well within the standard 5 -10 percent that most models achieve.

The calibration of the model was a "steady-state" calibration. That is, the model was calibrated assuming that flows, reservoir levels, pumping rates, and other system conditions are occurring at a constant rate, or steady-state condition. While this assumption is adequate for planning purposes and determining the overall condition of the system for Capital Improvement Program development, it is not adequate to use the model as an ongoing operational tool. A dynamic calibration called an "extended period simulation" (EPS), should be conducted in future if the City wishes to use the hydraulic model to assist in optimizing operations. In an EPS model simulation, the fluctuations of reservoir levels, pumping rates, and other system variables, which occur over the course of a day, are simulated. The City's SCADA system allows for the collection of the data needed to develop an EPS model.

**Table 6 - 11**  
**Locations Where Calibration Data Was Collected**

**Demand Allocation**

Demand projections were based on population, as presented in Section 3, and were developed for three different planning horizons (with two population projections for one planning horizon): (1) the existing system; (2) low demand projections for the 2015 system; (3) high demand projections for the 2015 system; and (4) buildout. Demands were developed for each individual pressure subzone, based on population projections and landuse within that zone. Demands were allocated to model nodes based on the landuse at each node. In certain areas where new development may occur but where existing infrastructure is absent and no specific information on development pattern was available, the layout of a pattern of pipelines and demand nodes to serve the area had to be assumed as a placeholder. Once specific development plans have been identified, this assumed pattern will need to be reviewed and reevaluated.

**Table 6 - 12  
Comparison of Model Results to Field Calibration Data**

Run	Hydrant #1 Static Pressure % Difference	Hydrant #1 Residual Pressure % Difference	Hydrant #2 Static Pressure % Difference	Hydrant #2 Residual Pressure % Difference
1	0.8	-1.2	0	-2.0
2	-1.8	0	-.9	-1.2
3	1.2	0	-2.2	0
4	0	0	0	1.5
5	0	3.0	-.8	3.0
6	0	0	-.7	1.2
7	1.3	4.9	1.3	3.8
8	0	-5.9	0	2.3
9	1.3	0	0	0
10	0	-6.1	0	1.7
11	0	0	-1.3	3.4
12	0	-2.2	0	4.7
13	-1.2	-4.9	-1.1	-4.9

### **System Deficiencies Analysis**

Each of the planning horizons were evaluated using the planning criteria presented in Section 4. Pump stations and storage tanks have defined design capacities, as presented in Section 5. Pipelines, however, function as part of a larger network and must be evaluated through modeling for various demand scenarios. Two demand scenarios were investigated:

- (1) peak hour demands, and
- (2) maximum day demands plus fire flows.

For the second scenario, one fire flow at a time was applied to each of the seventeen pressure subzones using a residential fire flow of 1,000 gpm. The system was also evaluated for non-residential fires modeled in each of the five zones using the following flows:

- Horton: Industrial/Commercial fire, 3,000 gpm,
- Rosemont: 3,000 gpm,
- Willamette: Industrial/Commercial fire, 3,000 gpm,
- Bolton: Industrial/Commercial fire, 3,000 gpm,
- Robinwood: Residential, 2,000 gpm, and 3,000 gpm commercial in selected areas
- Bland : Residential, 2,000 gpm and 3,000 gpm commercial in selected areas.

Where industrial or commercial fire flows are established, the fire flow modeling occurred at the location of the specific industrial or commercial facility which would generate the high fire flow.

The following planning criteria were used to identify deficiencies in pipelines:

#### Peak Hour Demand Scenarios

- Transmission pipelines (10-inch diameter and larger) with velocities greater than 5 fps on peak day demands;
- Distribution pipelines with velocities greater than 10 fps on peak hour demands; and
- Pressures less than 45 psi or greater than 120 psi.

#### Maximum Day Demand Plus Fire Flow Scenarios

- Pressures less than 20 psi or greater than 120 psi.

The system-wide peak day demand used in the analysis was 6.5 mgd as defined in Section 2. The system wide peak hour demand, which corresponds to a flow of twice the peak day demand, was 13.0 mgd. All existing pumps, storage facilities, and operational settings were modeled to evaluate the existing system. Supply from SFWB was modeled as a constant 6.5 mgd input.

### **Capital Improvement Development**

The analysis of the system and recommended improvements to correct deficiencies were developed in a step-by-step process. First, the existing system was evaluated for deficiencies under both the peak hour demand and the peak day demand plus fire flow scenarios. The improvements needed to remedy these existing deficiencies were then incorporated into the model. Improvements may include new reservoirs, expanded pump stations, redefining zone boundaries, valve setting adjustments, and parallel pipelines. The improved system became the basis for the next analysis of future planning horizons. This approach prevents redundant modeling of deficiencies of the existing system.

The low 2015 demand projections were then applied to the system, as improved for existing deficiencies. This is the second planning horizon model system. Again, both the peak hour demand and the peak day demand plus fire flow demand scenarios were evaluated. Where deficiencies existed for the 2015 horizon, improvements were identified by two methods. First, an attempt was made to expand an improvement that was already identified as needed to correct an existing system deficiency. Where this was infeasible, either hydraulically or economically, new improvements were identified to relieve low 2015 projection deficiencies. The system as improved to meet the low 2015 system became the basis for the repeated analysis of the high demand 2015 projection. The system as improved for the high 2015 demand projection then subsequently became the basis for the buildout system analysis.

## Identified System Deficiencies

Model analysis showed that the existing system has deficiencies at peak hour primarily in the Bolton and Rosemont Zones, with other deficiencies in the Bland and Willamette Zones. Capital improvements to correct these deficiencies were identified. Analysis of the system for the existing peak day demand plus fire flows scenario identified deficiencies in the Willamette, Bland, Bolton, Rosemont and Robinwood Zones. Many 6-inch lines throughout the system also registered as having velocities above the planning criteria during a fire on a peak day. However, these pipelines were not identified for improvement because the pressure remained above the 20 psi criteria and no harm would result from the high velocities due to the short duration of the event.

Analysis of the future demands showed deficiencies in all zones. In several cases, enlargement of an improvement that was required for the existing system, also relieved the future deficiency. The pipeline capital improvements that were identified, the existing or future deficiency that was relieved by the improvement, and the costs for each pipeline capital improvement are presented in Table 6 - 13. The basis for the pipeline unit costs shown in Table 6 - 13 is presented in Section 7.

The modeling identified the need for an estimated \$14.45 million in pipeline improvements between now and buildout. The largest share of the more immediately needed improvements, almost \$1.5 million, is for improvements along Willamette Falls Drive. The largest single need, \$5 million, is for a second transmission pipeline from the Division St. Pump Station, across the Willamette River that will be needed after the year 2015 to meet buildout growth. Another \$2,000,000 is for additional improvements on the Willamette Falls Drive transmission main needed to reach buildout.

With two exceptions, improvements were assumed to replace the existing pipeline. Mains along Hillcrest Dr. in the Rosemont Zone and Willamette Falls Dr. in the Willamette Zone were assumed to parallel relatively new existing pipelines in good condition that are assumed to remain in the ground. In all other cases any existing pipeline was replaced with a new pipeline.

In addition to capital improvements, two other types of improvements were made to the system to relieve deficiencies. The first such improvement is re-zoning. Low pressures found near pressure zone boundaries were eliminated by connecting customers to a higher zone. Re-zoning corrected deficiencies on Debok Rd. (subzone 1), Imperial Dr. (subzone 3), Haskins Rd. (subzone 2), and Palomino Wy (subzone 6), and eliminated the need for capital improvement projects. The second improvement involved the adjustment of PRV settings to raise pressures. The PRV settings that were used in the model are presented in Table 6 - 14. Prior to rezoning, it is important to investigate the actual pressures at these locations to assure that pressures will not exceed plumbing code maximums without installation of individual pressure regulators.

### TABLE 6-14

ES - 76



## RECOMMENDED SYSTEM VALVE ADJUSTMENTS

Valve	Location, Zone	Recommended Setting (psi)
1-1	Willamette Falls Dr. / Willamette	76
1-2	Killarney / Willamette	40
4-1	Hood St. / Bolton	69
4-2	Broadway St / Bolton	45
4-3	Buck St & Failing St. / Bolton	41
4-4	Dillow Dr / Bolton	43
5-1	Clark St.	62
5-2	Oregon City Blvd	41
7-1	Bridgeview Dr / Horton	50
8-1	Horton Rd / Horton	75
10-2a	View Dr. / Rosemont	15
11-1	View Dr. / Rosemont	45
11-2	Upper Midhill Dr. / Rosemont	51
12-1	Marylhurst Cr. / Rosemont	50
13-1	Valley View Dr. / Rosemont	64
13-2	Hillcrest Dr. / Rosemont	60
13-3	Marylhurst Dr / Rosemont	58
13-4	Stonehaven Dr. / Rosemont	73
13-5	Troon Dr. / Rosemont	Closed 67
14-1	Carriage Wy / Bolton	47
16-1	Buck St. & Davenport / Bolton	50
16-2	Barclay Dr. / Bolton	65
16-3	Lowry Dr. / Bolton	70
16-4	Mark Lane / Bolton	70
100-1	Marylhurst Ct / Rosemont	60
PRV	Derby St	50
PRV- .	Salamo Dr. / Rosemont (Cascade Summit)	45
PRV- Apollo Rd	Apollo Rd	75
Valve	Division St. PS	42
Valve	Mapleton PRV	65
Valve	Mapleton TCV	

Low pressures were also identified near storage reservoirs where elevations of the distribution system service are so close to the storage tank that pressures cannot meet the planning criteria. For these locations, no capital improvements were identified as being helpful in alleviating these conditions. If customers are not experiencing problems, then no action is warranted. If in the future some customers do experience problems, a case-by-case review of the options should be made. Rezoning, booster pumps and other options may be available if the problem warrants such action.

### **UNACCOUNTED FOR WATER AND PILOT LEAK DETECTION SURVEY**

As part of this Master Plan, an unaccounted for water and pilot leak detection survey was conducted. The pilot leak detection was conducted the week of March 31, 1997.

The unaccounted for water survey was based upon the period of February, 1996 through February, 1997. This survey was then updated based on 1997 and 1998 data. The pilot leak detection was conducted by Heath Consultants Incorporated, as a subconsultant to Montgomery Watson. The pilot leak detection project evaluated a subset of the City's distribution system piping for leaks. Heath Consultants also assisted in the unaccounted for water survey (Heath Consultants, 1997). The unaccounted for water survey seeks to measure both supply and use, to arrive at an estimate of the water that may be lost. A discussion of these steps is given below.

## **Water Supply**

The City of West Linn purchases its water from the South Fork Water Board (SFWB). Over the period of March, 1996 through February, 1997, the City purchased 1,373,420 hundred cubic feet (ccf) of water, or an average of 114,451.7 ccf per month. (Units of water measure in this subsection will be ccf because that is the unit of measure which is used in residential flow metering and billing by the City.) Table 6 - 15 shows the monthly water purchase over this period from the SFWB. Adjustments must potentially be made to the water supply figures to account for source meter errors, changes in reservoir and tank storage, and other contributions or losses.

The meter that measures the source water from the SFWB is a magnetic flow meter that was installed only a couple of years ago. This type of meter, when properly installed, is considered to be highly accurate. The installation of the meter was reviewed and determined to be correct. Thus, no correction for source meter inaccuracy was made to the supply.

In some cases, changes in reservoir or tank levels can effect the measurement of the amount of water that is supplied. However, the City maintains its tanks and reservoirs at close to full levels, and therefore the volume of any potential reservoir changes within the City's supply system over the one-year period considered in the survey is very small. It is assumed to be about 400 ccf (equivalent to a 2 foot change in reservoir elevation at all storage reservoirs in the system).

**Table 6 - 15**  
**Monthly Water Purchase from SFWB, March 1996 - February, 1997**

No other contributions or losses in supply were identified during this period. Table 6 - 16 summarizes the adjusted total water supply.

**Table 6 - 16**

<b>Adjusted Total Water Supply</b>
------------------------------------

DESCRIPTION	SUBTOTAL (ccf)	TOTAL (ccf)
<b>Total Metered Supply</b>		<b>1,373,420</b>
<b>Adjustment to Total Supply</b>		
Source Meter Error	0	
Change in Reservoir Level	400	
Other Contributions or Losses	0	
Total Adjustments		<b>400</b>
<b>Total Adjusted Supply</b>		<b>1,373,020</b>

**Measured Metered Water Use**

Over the same period of March 1996 through February, 1997, the metered water use in the City of West Linn system was 1,105, 357 ccf, or an average of 92,113.1 ccf per month. Table 6 - 17 shows the metered water sales per month for the period.

As with water supply, there are potential adjustments due to meter inaccuracies in customer meters and adjustments due to the difference in time period between when the water meter was read and billed, and the time the water usage occurred, or meter reading lag-time. An estimated 379 ccf were billed during this period but used previously and must be subtracted from the metered water use.

**Table 6 - 17**  
**Metered Water Sales Over the Period March, 1996 through February, 1997**

MONTH	VOLUME (ccf)
March	71,083
April	54,083
May	69,984
June	68,562
July	87,904
August	167,005
September	154,829
October	137,190
November	88,636
December	69,888
January	70,507
February	65,686
<b>TOTAL</b>	<b>1,105,357</b>

Meter Inaccuracies

There are no records, meter test results or other information on the accuracy of the water meters in the City of West Linn's system. With the exception of approximately 20 meters, all the meters in the City's system are 2-inch or smaller. Typically, if residential meters are inaccurate, they will under-register from between 5% and 15%. Larger meters may under-register by considerably more. For the purposes of this unaccounted for water survey, it was assumed that system-wide, meters are under-registering on average by 3%. This figure was derived by assuming that ten percent of the meters are under-registering by 5%, ten percent of the meters are under-registering by 10% and ten percent of the meters are under-registering by 15% while the remaining meters all are accurate. Thus, over the survey period, this under-registering could represent a loss of 33,160 ccf.

The City currently replaces residential water meters when they fail. It currently costs the City between \$50 and \$75 to replace a residential meter, including labor and the cost of the materials. Testing residential meters typically cost from \$25 - \$50 per meter. Thus, there is no cost incentive to test a residential meter instead of replacing it. However, the question is, when should it be replaced - at failure, or prior to that time. If a meter under-registers by 10%, the typical monthly registration is 10 ccf, and the cost of water is \$1.00 per ccf, then the lost revenue of the meter becomes \$1.00 a month. Payback on replacement of the meter under these assumptions for West Linn is then 50 to 75 months, or 4 to 6 years. If the typical residential meter in the West Linn system is under-registering for this period of time prior to failure, then it would be cost effective to replace it prior to failure. This is why some systems replace residential meters on a scheduled of every 15 - 20 years. If the meter does not under-register to this extent,

then it may be more cost effective to continue to replace meters at failure. Table 6 - 18 summarizes the adjusted meter water use for the City.

**Table 6 - 18**  
**Adjusted Metered Water Use, March 1996, through February, 1997**

<b>Unadjusted Metered Water Sales</b>		<b>1,105,357</b>
<b>Adjustments to Metered Water Use</b>		
Meter Lag Time	379	
Meter Errors	33,160	
Total Adjustments to Metered Sales		<b>32,781</b>
<b>Corrected Total Metered Use</b>		<b>1,138,138</b>

### Authorized Unmetered Water Uses

There are a number of authorized water uses that are not metered in a water system. These uses and estimated volumes of water use from them are shown in Table 6 - 19.

**Table 6 - 19**  
**Estimated Authorized Unmetered Water Uses, March 1996, February, 1997**

Water is drawn from the City's distribution system from fire hydrants for fire suppression, testing fire equipment, firefighting training, and hazardous materials reduction. Based on the City's records, an estimated 310 ccf of water was used for these purposes over the period.

Water is used from the distribution system to flush water mains from hydrants and blowoffs in response to customer complaints and water quality concerns. Water may also be used from these hydrants and mains for flushing storm sewers, sanitary sewers,

and street cleaning. Based on the City's records, a total of 55 ccf are estimated for water main flushing, 103 ccf for storm drain flushing, 35 ccf for street cleaning and 138 ccf for sewer cleaning over the period. Some systems also maintain unmetered free-flowing water sample taps for water quality monitoring purposes. While the City does maintain several dedicated water quality sampling taps, these are not free-flowing taps.

In some areas, water systems may provide water to schools, parking strip media landscaping, decorative fountains, and public swimming pools without being metered. No such uses have been identified in the City of West Linn's system.

Another unmetered use of water from the system is for construction. The City currently does not have a program to meter construction use. Metering can be accomplished by issuing a meter along with a permit to use hydrants for construction water. Based on the approximately 200 units of housing constructed over the period, it is estimated that 2400 ccf of water was used for construction purposes.

### **Water Losses**

Heath Consultants conducted sonic leak detection testing on approximately 16.2 miles of the distribution system. This represents approximately 15% of the 104 miles of pipeline in the system. The areas that were surveyed were chosen because they were the older areas of the City and were the most suspected to have leaks. The sonic tests identified a total of 13 potential leaks. Each of the identified sites was then dug up and inspected for leakage. Of the 13 sites, eight were found to have leaks when they were excavated. The total flow from the leaks was found to be 23 gpm. If the rate of leakage found in the pilot test (23 gpm over 16.2 miles of pipeline) were to be extrapolated throughout the City, total expected leakage in the pipelines would be 153 gpm, or 107,331 ccf per year. This leakage would represent about 7.8% of the total water supply from the SFWB for that period. A leakage rate of around 8% in pipelines is the mid-range of the typical 5-15% rate for most systems.

Other water losses can occur through evaporation of water from open storage reservoirs, illegal connections to the water system, malfunctioning distribution system controls, purposeful overflow of reservoirs for water quality or operational purposes, theft of water, and seepage and leaks from storage reservoirs. Of these potential sources, only leakage for reservoir seepage (at the Bolton Reservoir) is expected to occur. Assuming a leakage rate of 5 gpm, the estimated leakage is 3,513 ccf over the twelve month period. These are shown in Table 6 - 20.

**Table 6 - 20**  
**Water Losses, March 1996 Through February, 1997**

**Summary of Unaccounted-For Water Survey**

Based on a total adjusted water supply over the survey period of 1,373,020 ccf and a corrected metered water use of 1,138,138 ccf, the total unmetered water use is 234,882 ccf, or about 17 % of the water supply. The water losses that are estimated based on current data account for 110, 884 ccf or about 8% of the water supply. Based on current data, the authorized water uses which are unmetered account for 3,041 ccf, or about 0.2% of the supply. The remainder of the unmetered water, a bit less than 9%, is unaccounted-for. This is summarized in Table 6 - 21.

**Table 6 - 21**  
**Summary of Unaccounted For Water Survey, March, 1996 Through February, 1997**

There are several possibilities to explain the unaccounted-for water:

- Other portions of the system may be leaking at greater rates than the portions that were surveyed in the pilot leak test. If system-wide leakage were at 12% instead of the 8% found in the pilot test, then another 3-4% of the unmetered water would be accounted-for.
- The existing meters may be significantly underregistering. If the meters were all registering 10% low instead of the 3% assumed in this analysis, an additional 5% of the supply would be accounted-for.
- Authorized, but unmetered uses may be greater than have been estimated in this survey. Little data is available for these uses.

Data from the full year of 1997 and 1998 were recently also reviewed to determine whether the water loss was changing over time. Table 6 – 22 summarizes the data from these years and compares it to the data during the water loss study. This shows that the water loss has been constant over the last three years.

**Table 6-22  
Summary of Unaccounted-for Water**

Year	Total Volume of Water Purchased from SFWB (MG)	Total Volume of Water Billed to City Customers (MG)	Unmetered Water Use (%)	Water Losses (%) As Identified In Study	Unaccounted for Water Use (%)
Study –1996	1,027	851	17	8	9
1997	1,019	827	19	8	11
1998	1,063	876	18	8	10

### Recommendations

Based on this survey, the following recommendations have been made to develop more information on unaccounted-for water and ultimately reduce system water losses.

- A routine leak detection program should be implemented. The complete distribution system should be surveyed once every five years at minimum. Because the City already owns the sonic detection equipment necessary to conduct the survey, the City can conduct the survey with its own personnel, or it may contract with a leak detection survey firm.



- A leak repair log should be maintained. The estimated quantity of water that is being lost by each leak which is found and repaired, whether from the routine leak detection program or as a part of other activities, should be recorded.
- Unmetered water use reports should be maintained as part of the monthly operating logs. Water uses such as pump lubrication, main flushing, fire hydrant inspections, tank cleaning and draining, etc. should be recorded so as to maintain accurate unmetered water use statistics.
- Records on the amount of water used for fire fighting, hydrant flushing, and fire training should be maintained to record unmetered water use.
- All large meters (3-inch or greater) that are presently not outfitted with test ports, should be so fitted, and then tested on an annual basis.
- A pilot test program of small meters should be conducted. Fifty to 100 small meters representing the various models and ages (with an emphasis on older meters) in the system should be removed and tested to determine what the typical average rate of underregistering is in the system, and at what point it will become economical to replace them. For the moment, it is assumed that these meters should be replaced on a 20 year cycle.
- A program of metering construction water use, either through an honors system permit or through issuance of hydrant meters and construction water permits, should be considered. This would provide more detailed information, and may add revenue from more accurate accounting of water use in this area.

## **REVIEW OF OTHER INFORMATION AND ISSUES**

### **Emergency Supply/ Source Reliability**

The intertie with the water treatment plant operated by the City of Lake Oswego is designed to provide 3,750 gpm of emergency supply. This is equivalent to 5.4 mgd. The planning criteria in Section 4 of this Master Plan indicates that the emergency supply should be able to meet average day demand requirements. Section 3 identified that the year 2015 average day demand is projected to be 4.0 mgd, and the buildout average day demand is projected to be 5.43 mgd. Thus, as long as the intertie with the City of Lake Oswego remains able to supply the 3,750 gpm design capacity, the City of West Linn can be considered to have an adequate emergency supply.

The City should take several steps, however, to assure that this intertie with Lake Oswego remains fully operable. First, the City should review its existing agreement with the City of Lake Oswego to assure that all necessary contractual provisions for the intertie are in place. Second, the physical connection should be reevaluated to assure that the intertie will be available and operable whenever it is needed. In particular, an

inline valve on the Lake Oswego line and a meter in the West Linn line may need to be installed. This **Lake Oswego Intertie Upgrade Project** should be incorporated into the Capital Maintenance Program for West Linn.

However, there are circumstances where the Lake Oswego plant may not be able to provide the required emergency supply to West Linn. The Lake Oswego plant uses the Clackamas River as its source, just as the SFWB plant does. If the cause of the supply outage to West Linn is due to a contamination event or flood or other problem associated with the Clackamas River source, then it is possible that the Lake Oswego plant will be out of service at the same time as the SFWB plant. If the supply outage is localized to the SFWB plant, is caused by loss of the transmission pipeline across the Willamette on the Interstate 205 bridge, or by a landslide in the vicinity of Atkinson Park where the transmission pipeline is known to be vulnerable to such an occurrence, then the Lake Oswego plant is likely to be available to provide the emergency supply. If the problem is associated with the SFWB plant, however, the Lake Oswego plant will be called upon to supply not only West Linn, but also Oregon City. In that circumstance, less water would be available to West Linn.

An outage at the SFWB plant due to contamination of the river or flooding is likely to last only for a couple of days. The Water Master Plan which the SFWB recently completed (Montgomery Watson, 1997) calls for SFWB to maintain storage for at least one day average demand to protect against such outages. All of the SFWB's current storage is located in Oregon City. If some portion of the additional storage which the SFWB will build were to be located in West Linn instead of locating all new SFWB storage in Oregon City, the emergency supply capabilities and reliability of the West Linn system would be substantially improved. Five million gallons of storage would provide for one day average demand at buildout for West Linn and would greatly strengthen the emergency supply capabilities of the West Linn. Such storage would need to be built at an elevation of 490 feet to match the existing hydraulic grade line of the SFWB system, or pumped to maintain this head if located at a lower elevation. The City of West Linn should conduct a siting study to determine if an acceptable site for a reservoir exists. If one does exist, the City should bring it to the attention of the SFWB and seek to build this reservoir in conjunction with the SFWB.

Another option for improving emergency supply is development of an aquifer storage and recovery system (ASR). In an ASR system, water that would be available from the SFWB system would be placed into wells within the City of West Linn during times of excess supply. This water could then be withdrawn during emergencies or to assist in meeting peak summer demands if the SFWB did not have available supply. The City of Salem, Oregon is currently developing an ASR system. Their costs for development are less than \$500,000 per mgd of supply, which are at the low end of typical costs for ASR development. To meet a year 2015 average day demand of 4 mgd for the City of West Linn, the costs for an ASR system would be at least \$2,000,000. Given these significant costs, ASR is not as attractive as maintaining the existing intertie with the City of Lake Oswego or siting some of the SFWB's storage capacity in West Linn.

However, if these options do not prove viable, then ASR should be investigated in more detail.

A second supply line from the SFWB across the Willamette River to the City is not needed until beyond the year 2015 for the purpose of transmitting peak day flows from the SFWB to the City of West Linn. However, construction of this second line would serve to improve the reliability of the source. The crossing of the Willamette River on the I-205 bridge is perhaps the most vulnerable piece of the transmission system as documented in the 1996 Report (MSA, 1996) discussed earlier in this Section. There are many considerations in selecting a route for a second transmission pipeline. In addition to the vulnerability of the crossing, issues include the location of a potential of a SFWB storage reservoir in West Linn, the availability of transmission pipeline at a different crossing location, and the nature of rock and other material through which a new crossing would have to pass. The costs which have been assumed in this Master Plan reflect a route which essentially parallels the existing 24-inch diameter supply line, although the new pipeline would be designed to better withstand seismic events. However, the best route for a new supply pipeline needs more detailed examination and should be considered when the location of additional storage for the SFWB is clearer. A route that does not parallel the existing pipeline would be more preferable. A second line would not, however, reduce the desirability to build additional storage in West Linn nor would additional storage reduce the long-term desirability to build the second supply line.

### **Service Replacement**

An ongoing program of water service renewal should be provided for in the Capital Maintenance Program. It is assumed that water services will be replaced on a 75 year cycle. With approximately 7,000 services in the system, this would result in replacement of approximately 90 services a year.

### **Water Quality**

The water quality of the both the Clackamas River supply and the West Linn distribution system is excellent. The monitoring program in the West Linn system meets State requirements and is designed to anticipate and correct problems. The City, in conjunction with the SFWB, should obtain water quality data on Haloacetic Acid (HAA) levels in its system. This is a class of disinfection byproduct compounds that will be regulated in the next couple of years, with the initial regulation set at 60 ug/l. Based on the levels of Total Trihalomethanes (TTHM's) which the City's monitoring program measures, no problems are anticipated in complying with this upcoming regulation. However, confirmation that HAA levels will be below regulatory limits should be obtained. No other upcoming regulations are anticipated to cause compliance problems for the City of West Linn. However, the City should anticipate and prepare for other upcoming regulations, such as the Consumer Confidence Report, which will be required as a consequence of the 1996 reauthorization of the Safe Drinking Water Act.

### **Operator Certification**

The City's water system is classified as a Level 3 Distribution System by the State Health Division. A Level 3 system must be operated by an operator with a Water Distribution - Level 3 certification. The City must plan for and develop operators with the Level 3 certification.

### **Rate Structure**

The current rate structure includes 14 ccf of water use within the flat bimonthly rate. This is an amount that many residential customers will use during a two month period. As a result, customers do not have any incentive to minimize water use. It is recommended that the next time the City modifies its water rates, that it move to a cost-of-service methodology which incorporates a service charge for customer and meter related costs, and a commodity charge for the use of all amounts of water. The City may wish to consider conservation-inducing, inclining block rate structures for the commodity charge. Many communities in the metropolitan region have done this, particularly during the summer months in order to reduce summer peak day demands. Under these rate structures, those who use relatively high amounts of water pay a larger share of the total costs of providing water to all. The City may also wish to review its charges and procedures for recovering costs of unmetered, authorized water uses, such as construction water.

### **Conservation Programs**

Because the City is a wholesale customer of the SFWB, any reduction in water use will result in a direct reduction of purchased water costs. Thus, an effective conservation program is an important element in maintaining low water rates for City customers. While the City currently provides conservation related information to its customers and the impacts are felt of naturally occurring conservation from plumbing code modifications which mandate low flow showers, faucets and toilets, the City's conservation program is not fully developed.

A major reason for this lack of full development is the City's appropriate goal of being coordinated with the broader Portland regional conservation effort. Because many conservation programs are more effective if conducted on a wider service area basis, the water providers in the region have established the Columbia-Willamette Regional Conservation Coalition to coordinate conservation efforts. While the Portland Regional Water Supply Plan completed in 1996 identified some overall conservation goals for the region, it did not establish specific program components for various entities to meet those goals. As a result, the Conservation Coalition is in the process of a two-year effort to better determine the specific conservation targets that are achievable in the various parts of the region, the specific conservation program elements which will achieve those targets, the cost-effectiveness of conservation elements, and the monitoring programs required to assure that the targets are in fact being met. The City of West Linn should participate in this Coalition effort. When the information from the Coalition work is available, the City should use it to expand its own conservation

programs. In the interim, the City should provide public information about wise water use and begin to prepare for adoption of potential conservation program elements, such as landscape ordinances and industrial, commercial and residential water audits, in addition to the leak detection and rate structure evaluations discussed elsewhere in this section.

### **Staffing Level**

A detailed evaluation of the staffing levels and needs and organizational structure for the water system is not included in the Scope of Work of this Master Plan. However, several general comments can be provided.

The organizational structure which the City maintains of a water crew under an operational branch, and engineering support provided by an engineering branch of a Public Works Department is typical of many cities the size of West Linn. It is a means of efficiently using limited personnel resources to satisfy a number of municipal operating needs.

Current staffing levels appear to be able to adequately maintain and operate the existing facilities and system. However, it appears that the staff have very little time to conduct efforts which go beyond the routine maintenance and operation to more long-term goals of improving the system. Recommendations such as increased leak detection work, better record keeping of unmetered water uses, and evaluation of the impacts of upcoming water regulations, which are contained in this Master Plan, are unlikely to be able to be implemented with the current staffing levels. The City should review its staffing levels and increase staffing as needed in order to implement the recommendations of this Master Plan.

### **Urban Reserve Area**

A detailed evaluation of the impacts of the Metro designated Urban Reserve Area adjacent to the City is beyond the scope of this Master Plan. However an assessment of the impacts of the URA on the rest of the water system was conducted. The peak day demand that was estimated in Section 3 for this area of 0.425 mgd was applied at one point on the 16-inch diameter pipeline on Rosemont Rd.

The hydraulic model was then used to evaluate the impacts of this additional demand on the system as improved for the year 2015. Approximately 2700 feet of pipe along Bonnet St. and Summit to Parker Rd must be upsized to 18-inch diameter to supply this demand. Several hundred additional feet of smaller diameter pipeline must also be upsized to meet this demand. Costs of this pipeline work would be approximately \$500,000. In addition to the pipeline improvements storage for that area would be required. Assuming a fire flow of 2,500 gpm for 2 hours, the storage needs would become approximately 0.6 MG, with an estimated cost of \$420,000. At minimum, an additional 300 gpm of firm pumping capacity would be needed at the both Horton and Bolton Pump Stations. Costs for these improvements might be another \$200,000.

Thus, total costs to serve the URA (not including the costs of distribution piping within the URA) would be in the range of \$1 - 1.5 million.

## **Section 7**

# **Basis of Cost Estimates**

Planning level construction and operation and maintenance (O&M) costs are estimated in this Water Master Plan for the projects and system needs identified in Section 6. These planning level cost estimates have been prepared from the information and data available at the time of this report and should be considered accurate only at the planning level. The final costs of any projects, when implemented, will depend on the actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors at the time the project is actually built. As a result, the final actual project costs will vary from the estimates herein. These estimates are not definitive predictions of the costs of any specific project.

Costs of the projects are estimated assuming a traditional public works procurement process of design, bidding, award and construction by a licensed contractor using commonly accepted means and methods. Alternative methods of project procurement may result in lower project costs. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News-Record (ENR) Construction Cost Index (CCI) is a commonly used index for this purpose. For future reference, the ENR CCI of 6648 for the Seattle area construction market (the nearest market ENR monitors) was used for cost estimates in this study. The estimated cost of the facilities should be expected to change along with the accuracy of the estimate as a project proceeds into preliminary and final design. The average of the contractors bids should fall within the range of plus or minus 30 percent of the estimates herein after adjustment for changes in the ENR index and project scope.

Total capital costs for each project are comprised of several components. These components are the directly estimated construction cost, an allowance for contingencies, and an allowance for engineering, construction management, administrative and legal costs. The allowance for contingencies covers items such as variations in the project configuration that are developed during preliminary design and final design, unforeseen site conditions encountered during construction, and reasonable project changes during construction. The contingency allowance does not include major project scope additions or additional costs resulting from permit mitigation requirements such as wetlands enhancement.

The general basis of the cost estimates for new construction for each type of facility is given below. Any modifications to this general basis, where appropriate, are provided in Section 9, Summary of the Capital Improvement and Capital Maintenance Programs.

### **PIPELINES**

The assumed costs per foot of installed pipe are shown in Table 7 -1.

**Table 7 -1**  
**Assumed Basis of Pipeline Costs**  
**(\$/ft of Installed Pipe)**

Diameter (inches)	TOTAL \$/ft	Material \$/ft	Installation \$/ft	Subtotal -Const. Cost \$/ft	Contingency (20%) \$/ft	Engineering, Const. Management & Administrative (15%) \$/ft
<b>6</b>	<b>\$65.15</b>	34.50	13.80	<b>48.30</b>	9.60	7.25
<b>8</b>	<b>\$75.50</b>	39.90	16.00	<b>55.90</b>	11.20	8.40
<b>10</b>	<b>\$90.70</b>	48.00	19.20	<b>67.20</b>	13.40	10.10
<b>12</b>	<b>\$109.65</b>	58.00	23.20	<b>81.20</b>	16.25	12.20
<b>14</b>	<b>\$124.65</b>	65.90	26.40	<b>92.30</b>	18.50	13.85
<b>16</b>	<b>\$146.35</b>	77.40	31.00	<b>108.40</b>	21.70	16.25
<b>18</b>	<b>\$171.00</b>	90.50	36.20	<b>126.70</b>	25.30	19.00
<b>20</b>	<b>\$201.40</b>	106.60	42.60	<b>149.20</b>	29.80	22.40
<b>24</b>	<b>\$275.55</b>	145.75	58.30	<b>204.05</b>	40.90	30.60
<b>30</b>	<b>\$360.00</b>	190.50	76.20	<b>266.70</b>	53.30	40.00

Estimates for pipelines are based on installation in typical urban street environments. Among the basic assumptions upon which the cost estimate is based, unless otherwise noted, are:

- Rights-of-way are in streets with asphalt paving to 4-inch depth. Pavement replacement is assumed to be required for the full project length.
- There are no significant utility relocations required for pipe installation.
- Trenching is in soil, with no rock encountered. Trench width is equal to the nominal pipe diameter plus 2 feet and trench depth assumes cover to top of pipe equal to 3 ½ feet.
- No trench dewatering is required.
- Unless specifically noted, joints are unrestrained.
- Pipe material is ductile iron, Class 52, cement lined and asphalt coated, in the size range of 6-inch to 30-inch diameter.
- Hydrant spacing is 400 feet for mains 18-inch and smaller.
- Two valves per 250 feet for 6-inch to 12-inch pipe, per 350 feet for 14-inch to 20-inch, per 500 feet for 24-inch and 30-inch. Valves are gate valves for 6-inch to 10-inch and butterfly valves for 12-inch to 30-inch piping.
- Projects are in the range of 100 feet to 5,000 feet in length.
- There are no costs for property or easement acquisition.



Use of restrained joints could add 10% to the construction costs. Installation in rock instead of soil could add 10-20% to project costs.

It is recommended that when pipelines are designed, consideration should be given to the use of restrained joints for transmission lines on a case-by-case basis. Restrained joints should be used when transmission pipelines cross unstable land, railroad tracks, freeways, or other locations which could either result in unusual ground movements or could result in significant damage to property or life should a leak occur.

## **STORAGE TANKS AND RESERVOIRS**

The costs for various size ranges of tanks and reservoirs are shown in Table 7-2. These costs are for at-grade steel tank tanks and reservoirs.

**Table 7-2**  
**Assumed Basis of Steel At-Grade Reservoir Costs**  
**(\$/gallon)**

Costs for storage tanks and reservoirs assume construction without any special site constraints or other requirements unless specifically noted. Among the basic assumptions upon which the cost estimate is based, unless otherwise noted, are:

- Reservoirs are constructed of steel.
- Reservoirs are constructed on-grade.
- No rock is encountered for reservoir foundation excavation.
- Landscaping around the reservoir is grass.
- The reservoir exterior is coated with one color of standard tank paint.
- Seismic reinforcement is to Zone 3.
- Piping to bring water to and from the reservoir is located at the site.
- There are no costs for land acquisition or site demolition.

- There are no site or permit constraints which limit the use of the most economical height to diameter ratio for the desired reservoir volume.
- There are no special site environmental or community mitigation costs associated with the reservoir construction.

Seismic requirements for facilities in the Pacific Northwest have changed substantially over the last several years due to increased understanding of seismic risk in the region. It is likely that these requirements will continue to become more stringent. New facilities which are considered “lifeline” are required to have a site specific seismic analysis. Such an analysis could lead to more stringent requirements than the Zone 3 reinforcement assumed in these cost estimates.

Special screening or landscape requirements that are specific to a site could add up to 30% to the costs of a reservoir. Another site consideration is the location of the site relative to existing piping to bring water to and from the reservoir. Sites that are far from existing adequately sized piping would incur additional costs to bring pipes to and from the site.

If it is desired that reservoirs be buried, then steel tanks could not be used. Concrete reservoirs would then be required. Table 7-3 presents the cost basis for concrete tanks. The other assumptions are the same as for the steel reservoirs.

**Table 7-3  
Assumed Basis of Buried Concrete Reservoir Costs  
(\$/gallon)**

Size (million gal)	Total Cost (\$/gal)	Construction (\$/gal)	Contingency (\$/gal)	Engineering, Const. Management Adminstrative (\$/gal)
1.0	\$0.82	\$0.61	\$0.12	\$0.09
1.5	\$0.80	\$0.59	\$0.12	\$0.09
2.0	\$0.77	\$0.57	\$0.11	\$0.09
3.0	\$0.73	\$0.54	\$0.11	\$0.08
3.5	\$0.68	\$0.50	\$0.10	\$0.08

## **PUMP STATIONS**

The costs for various size ranges of installed pumping capacity are shown in Table 7-4.

**Table 7-4**  
**Assumed Basis of Pump Station Costs**  
**(\$/HP)**

Costs for pump stations assume construction without any special site constraints or other requirements unless otherwise noted. Among the basic assumptions upon which the cost estimate is based, unless otherwise noted, are:

- No rock is encountered during excavation.
- Landscaping around the site is grass.
- Seismic reinforcement is to Zone 3.
- There are no costs for land acquisition or site demolition.
- There are no special site environmental or community mitigation costs associated with the pump station construction.
- Buildings are of concrete masonry construction.
- Standby generator costs not included unless specifically noted.

## **MAINTENANCE PROJECTS**

Costs for maintenance projects are based on a judgment of the nature of the maintenance project compared to the nature and scope of other related projects that Montgomery Watson has performed in the Pacific Northwest. Interior paint coatings are estimated at \$6.00 / sf. Exterior coatings are estimated at \$4.50 / sf for ground level tanks and \$7.00 / sf for elevated tanks. Costs for PRV vault sealing and sump pumps are estimated at \$8,000 per vault. Costs for stabilization of the Bolton slide is based on a preliminary letter of investigation from Landslide Technologies in October, 1997 (Landslide Technologies, 1997). Initial seismic evaluation of the reservoirs is estimate at \$40,000. Seismic repairs are estimate at \$140,000 in total for all existing reservoirs

that may need upgrade. Cathodic protection is estimated at \$15,000 for initial evaluation, and then a total of \$40,000 for all existing reservoirs that may need upgrade.

It is assumed that water meters will be replaced on a 20-year cycle. Given approximately 7,000 meters in the system, this would result in replacing 350 meters a year. At current costs of replacement of \$75 per meter, this program would be approximately \$26,000 per year. It is also assumed that water services will be replaced on a 75 year cycle. This would result in replacement of over 93 services a year. Assuming a cost for replacement of \$400, this program would be approximately \$38,000 a year.

The Mains Replacement program is assumed to replace approximately 8,300 feet of small diameter pipeline a year with 6-inch diameter pipe. Using the \$65.15 pipe replacement cost from Table 7-1, this program is estimated to cost \$540,000 a year.

## **Section 8**

# **Summary of Public Involvement**

This Water Master Plan was completed with the assistance of a public involvement program. This public involvement program included a number of items including:

- Four meetings with the City of West Linn's Utility Advisory Board (UAB)
- A stakeholder survey consisting of telephone interviews with ten individuals representing a cross-section of views within the City of West Linn.
- Preparation of an informational brochure on the Master Plan and the water system which was mailed to each household in the City of West Linn. This brochure included notification of two open public meetings.
- Two facilitated public workshops. One was held at the West Linn City Hall on April 16, 1998 and was broadcast on West Linn cable television. The second meeting was held at the Public Library on April 28, 1998.
- A work session and public hearing before the West Linn Planning Commission. The public hearing was broadcast on West Linn cable television.

The stakeholder survey was designed to provide feedback on a range of water system issues. The interviews were held in the summer and fall of 1997. The detailed questions which were asked in the stakeholder survey and the resulting responses are provided in Appendix D.

The two public workshops each followed the same format. Several informational exhibits and brochures about the water system were available for viewing prior to the workshop. Mayor Jill Thorn provided an introduction and overview of the workshop. Joe Glicker, the Project Manager for the Master Plan, then conducted a 45 minute summary presentation about the findings of the Master Plan. Elaine Cogan then facilitated public comments and discussion of what had been presented. The "next steps" towards adoption of the Master Plan were then summarized and the meeting was adjourned. Each meeting lasted approximately two hours. The public meeting that was held on April 16<sup>th</sup>, was a joint meeting of the West Linn Planning Commission and the City Council. A combined total of approximately a dozen individuals (other than Planning Commission and City Council members) attended the two public workshops. One member of the Utility Advisory Board and one member of the public attended both workshops. A summary of the comments that were provided at the two public workshops is provided in Appendix E.

Generally, the respondents in the stakeholder survey and the public participants in the public workshops were satisfied with the West Linn water system. There was general understanding and acceptance of the need to keep the water system in good condition. As one citizen said, "we all understand that a system can't go on forever without repair." While West Linn citizens may support a program of active maintenance and sustenance, there may be concern about the cost of the total package of recommended improvements in the draft Master Plan.

There appears to be a belief that the current water rates are fair. Participants indicated they might support a rate increase if there was a proven need, such as to keep up with increased costs from the South Fork Water Board, or upgrade, repair, and maintenance of the existing system. There is some support for exploring alternative rate structures, such as all water use being charged a commodity charge related to usage instead of the current flat fee for a portion of the water usage. One participant at the public workshop and two respondents to the stakeholder survey suggested the use of property taxes to some extent for water charges.

# **Section 9**

## **Summary of Capital Improvement and Capital Maintenance Programs**

### **CAPITAL IMPROVEMENT PROGRAM (CIP)**

Based on the evaluation of the existing system presented in Section 6, this Section describes the recommended Capital Improvement Program (CIP). Projects within the CIP are listed as occurring in four timeframes - 1999 through 2003; 2004 through 2008; 2009 through 2015; and beyond 2015. Projects are broken down into three categories: pipelines, reservoirs, and pump stations. Detailed descriptions of the projects are given in Appendix A. A total of about \$13.2 million in improvements is recommended between now and the year 2015. Another \$11.1 million would be spent after the year 2015 to meet the City's needs to build-out. Also included in the CIP is the scheduled update of the Master Plan in five years.

This Master Plan listing of CIP projects is intended to be a recommended plan and long-term guide for the development of the City's water system. It is not intended to be a specific list of required projects. While projects are listed in this CIP as being scheduled for construction in a given year, this is intended only to provide a general guideline of priorities, relationships between projects, ties to levels of growth, and understanding of maintenance priorities. Each year the City should review the Master Plan and adopt a specific Capital Improvement and Capital Maintenance Program that incorporates the general guidelines of the Master Plan into the specific activities for that year. The Master Plan should also be reviewed and updated every five years to account for changing circumstances and new information.

### **Pipelines**

Almost 6 miles of pipeline projects were identified to meet peak hour demands, and peak day plus fire flow demands for existing, 2015, and buildout conditions. These project were prioritized into three groups:

- The first priority improvements relieve peak hour demand deficiencies and relieve fire flow deficiencies in the existing system.
- The second priority group relieves deficiencies that will occur as a result of future growth to the year 2015.
- The third priority group relieves deficiencies that will occur as a result of growth beyond the year 2015 to buildout.

Projects in the third priority group are scheduled to be constructed after the year 2015. They are included in the CIP as information of future system needs. Some of the

growth funded distribution projects in this third priority group may be constructed earlier if the pace and location of development proceeds differently than assumed. Table 9 - 1 groups the recommended projects by these priorities. A total of about \$4.9 million in pipeline improvements are recommended between now and the year 2015. The largest share of this, almost \$1.2 million, is for improvements along Willamette Falls Drive. Looking beyond the year 2015, an additional estimated \$9.2 million in pipeline improvements are needed to reach the projected build-out demand of the City. Over half of this is for a second transmission pipeline to the SFWB.

## Reservoirs

The general basis for the cost estimate for each reservoir is given in Section 7. However, given the difficult history of siting reservoirs in the City of West Linn, and the potential for combining certain reservoirs, a specific, case-by-case analysis of each reservoir was conducted. Included in that analysis was a preliminary siting survey for each reservoir. This information is discussed below.

Table 9 - 2 summarizes the proposed reservoir construction sizing, cost and timing. Table 9 - 2 assumes that reservoirs will be constructed on the basis of the proposed storage criteria. Total cost for reservoir construction is estimated at over \$7,480,000, of which \$6,380,000 would be spent by the year 2015.

**Table 9 - 2  
Proposed Reservoir Construction**

RESERVOIR	SIZE(Mg)	COST	1999-2003	2004-2008	2009-2015	After 2015
Land Purchase	na	<b>\$690,000</b>	\$690,000			
Bland No.2/Will.	2.00	<b>\$1,900,000</b>	\$1,900,000			
Bolton/SFWB	2.50	<b>\$1,100,000</b>				\$1,100,000
View Drive/Replace	1.25	<b>\$720,000</b>		\$720,000		
Horton/Rosemont	3.40	<b>\$3,070,000</b>	\$3,070,000			
<b>TOTAL</b>	<b>9.15</b>	<b>\$7,480,000</b>	<b>\$5,660,000</b>	<b>\$720,000</b>	<b>\$0</b>	<b>\$1,100,000</b>

## Site Review

For each reservoir, a site must be identified based on the elevation of the pressure zone, connections to the system, neighborhood development and zoning, and project cost. A preliminary screening of potential reservoir sites was conducted as part of the Master Plan.

A defined methodology was used for the preliminary screening. First, a search was conducted for conventional (at-grade steel tank) reservoir sites at the appropriate elevation within the defined pressure zone boundary, or adjacent to the defined boundary, limited to a distance of 1,000 ft. For screening purposes, the appropriate elevation was assumed to be the ground elevation of existing reservoirs in the zone.



Then, the identified sites were confirmed to have sufficient area to support a new reservoir (at least one and one-half acre). Sites were then narrowed to include only those that did not have significant structures or development already on them. Zoning was then reviewed to determine whether or not it was favorable. For example, if a site is found in the middle of a residential planning unit, it may not be as favorable as a site located within the Urban Growth Boundary (UGB), outside of the City Boundary. The sites that were found were then ranked based on proximity to existing and planned future transmission pipelines, ability to construct (based on aerial survey), and proximity to existing development.

Following preliminary screening of conventional reservoir sites, the areas were screened further to determine whether buried or partially buried tank sites are available. The same steps were used to identify buried or partially buried tank sites.

The preliminary screening was a desktop analysis, using Metro aerial photos and Metro's regional database of tax lots and City zoning information. A brief site visit was conducted to determine if there were any major variances that were obvious compared to the desktop analysis.

From the preliminary screening methodology, several sites were identified for each reservoir project. For Bland Circle and Horton Reservoir sites, additional buried and partially buried reservoir sites were investigated. The findings are summarized below and are given in more detail in a Technical Memorandum (Montgomery Watson, 1999b) provided to the City for future investigation. The reservoir configurations and cost information presented in this Section are based on this siting review.

### Bolton Reservoir

The storage at the Bolton site is adequate to the year 2015. After that time, the Bolton Reservoir will have reached its useful life and should be replaced with a new reservoir sized for build-out conditions. It is assumed that the reservoir will be constructed at the existing reservoir site. It is possible that this reservoir can be consolidated with a new SFWB reservoir located in the City of West Linn as discussed below.

### Robinwood/View Drive Replacement/SFWB Joint Use Reservoir

The storage for the Robinwood Zone is deficient by about 0.4 MG based on the existing reservoir size at View Drive of 0.5 MG. This deficiency will grow to 0.5 MG by the year 2015 and 0.75 MG at buildout. Construction of another reservoir is proposed to correct the existing deficiency and meet future needs. It is recommended that this new reservoir be located at a higher elevation than the existing reservoir and that the volume of the existing reservoir be replaced in this new reservoir. Thus, this new reservoir would be 1.25 MG in size.

To meet the needs of the SFWB a new water storage reservoir is needed in that system. This new reservoir would be in addition to the existing SFWB Mountain View

Reservoir located in Oregon City. If such a new reservoir were to be constructed, it would increase reliability of the supply to the City of West Linn. The existing SFWB Mountain View Reservoir has a ground elevation of 490 ft. Since the proposed joint-use reservoir and Mountain View Reservoir operate in the same zone, the target ground elevation for the joint-use reservoir should be 490 ft.

Ideally, the proposed joint-use reservoir should be located near the major transmission lines in the West Linn system to provide the best service to West Linn and SFWB/Oregon City. At an elevation of 490 ft., the reservoir would be located just above the Bolton zone, and would need to tie into the Bolton transmission lines to provide the most effective service. As a result, potential sites were evaluated within close proximity of Bolton Reservoir, to tie into the largest transmission lines and provide the best supply to the West Linn system.

Several sites for such a reservoir do exist for such a reservoir in a park across the street from the Bolton Reservoir site. These sites are readily screened because of the numerous trees surrounding them. However, construction would require tree removal at the site.

For this Master Plan, it is assumed that the View Drive replacement reservoir would be constructed at this site as an at-grade steel reservoir with screening. If an actual reservoir were to be constructed, the potential for including future Bolton storage as well as SFWB storage should be explored. Costs in the Master Plan do not consider any potential economies of scale of a joint-use reservoir. Because of the time it is anticipated to investigate the potential for a joint-use reservoir and to establish agreements for such a reservoir, and due to the relatively small current deficit, the new View Drive Reservoir is shown in the years between 2004 and 2008 in the Master Plan.

### Rosemont/Horton Zones

Storage for the Rosemont Zones is deficient by 1.5 MG for existing conditions. The deficiency grows to about 2.2 MG at build-out. It is recommended that due to the large current deficiencies, this storage should be constructed within the 1998-2002 time period.

The existing Rosemont Reservoir is a 110 ft.-high elevated tank. The reservoir has a bottom elevation of 820 ft., and an overflow elevation of 850 ft. The ground elevation of the tank sits at 740 ft. The ideal ground elevation for a second Rosemont reservoir would be 740 ft. or higher. However, the Rosemont Reservoir sits at the highest elevation within the city limits and the City's Urban Growth Boundary (UGB). No additional sites could be identified within the city limits with the same elevation and there is not enough space at the existing Rosemont site to accommodate an additional reservoir. Outside the UGB, only one site was identified at an elevation of 740 ft. or higher. However, the site is occupied by a residence that sits precisely at the highest elevation. There are no feasible sites for a buried or partially buried Rosemont Reservoir within the Rosemont Zone or UGB.

In order to accommodate new storage for the Rosemont zone, a new taller elevated tank, or standpipe would have to be constructed at a lower elevation. Cost increases significantly with the height of the tower, however, so the selected site should sit at the highest possible elevation. The analysis conducted for this report assumed a practical upper tank height limit of 160 ft. This is based on an upper limit of cost-effective tank designs. A tank height of 160 ft. would require a minimum ground elevation of 690 ft.

There were no sites found within the city limits or UGB above elevation 690 ft. Outside the UGB, five sites were identified above elevation 690 ft. While these are technically feasible, the costs for construction would be more than continuing to rely upon storage capacity in Horton Reservoirs that is pumped via the Horton Pump Station. Because of the past difficulties in finding a site for a reservoir in the Rosemont Zone, it is extremely unlikely that a very tall tower could obtain required land use permits, even if it was more economical. As a result, it has been decided to provide storage for the Rosemont Zone via expansion of the Horton Reservoir and Horton Pump Station.

With the lower fire flows utilized in this Master Plan, the Horton Zone currently does not have a deficiency based on an existing storage volume of 1.5 MG. By the year 2015, however, the zone will have a deficiency of 0.6 MG, which will grow to 1.2 MG at buildout. Combined with the 2.2 MG requirement for the Rosemont Zone, this results in the need for a 3.4 MG size for the Horton Reservoir No. 2.

The existing Horton Reservoir has a ground elevation of 690 ft. Analysis of potential sites for a conventional second Horton reservoir site was limited to an elevation of 690 ft. to 700 ft. The new reservoir must have an overflow elevation equivalent to the existing reservoir overflow elevation, which is 730.5 ft. Therefore, the area was screened for sites for a buried or partially buried reservoir with an elevation falling between 690 ft. and 730.5 ft. There are several locations that look feasible for developing either a conventional or a buried or partially buried Horton II Reservoir. In particular, one site that was recently purchased by the City to develop a senior center, may also be able to support a partially buried Horton II Reservoir, either by itself or by the addition of property adjacent to the site to the parcel.

For cost estimating purposes, a new Horton reservoir is assumed to be a concrete, buried reservoir. Included in the cost estimate is a 20% additional allowance for site screening and landscaping and an allowance for bringing 2,500 feet of 18-inch diameter piping to the site of the reservoir.

### **Willamette/Bland Reservoir**

Storage for the Willamette Zone is deficient by 0.75 MG for existing conditions. This deficiency grows to about 1.5 MG at build-out. Storage for Bland Circle currently is deficient by about 0.4 MG based on the existing reservoir size of 0.5 MG. This deficiency will not grow in size until the year 2015. The City has previously decided that storage for the Willamette Zone will be provided from the Bland Circle Reservoir.

Because the Bland Circle No. 2 Reservoir will serve both the Willamette and Bland zones, it is recommended that it be built in the 1990-2003 timeframe. A size of 2.0 MG will meet the needs to build-out of both zones.

The existing Bland Circle Reservoir sits at an elevation of 539 ft. Screening for a conventional second Bland Circle reservoir site was limited to an elevation of 540 ft. to 550 ft. The new reservoir must have an overflow elevation equivalent to the existing reservoir overflow elevation, which is 587 ft. Therefore, sites for buried reservoirs were limited to between 540 and 587 ft elevation. There are several locations that look promising for developing either a conventional, or a buried or partially buried Bland Circle Reservoir. Several of these sites are near the existing Bland Circle reservoir and near existing transmission pipelines.

For cost estimating purposes, a new Bland Circle reservoir is assumed to be a concrete, buried reservoir. Included in the cost estimate is a 20% additional allowance for site screening and landscaping and an allowance for bringing 2,500 feet of 18-inch diameter piping to the site of the reservoir.

### **Land Purchase**

In addition to the reservoirs themselves, it is assumed that land will need to be purchased for some of the reservoirs in order to build them. It is assumed that land will cost \$100,000 an acre with an additional 15 percent of the land cost required for acquisition costs. It is assumed that each reservoir site will require up to 2.0 acres, for a total of 6 acres of land for the three reservoirs (it is assumed that the Bolton Reservoir will be replaced on the existing City-owned site). This results in a total land allocation cost of \$690,000. This allowance is included in Table 9 - 2.

## **Pump Stations**

Prioritization of installation of new pump stations was reviewed on a case-by-case basis. The general basis for the cost estimate for each pump station is given in Section 7. Table 9 - 3 summarizes the proposed pump station construction sizing, cost and timing. Just over \$2.0 million in improvements is recommended to the year 2015. These improvements will satisfy needs until build-out.

The new Bolton Pump Station was recently completed. Beyond the year 2015, installation of two additional pumps is anticipated at this pump station. The cost for these new pumps and their installation is shown in Table 9-3.

While additional capacity is not currently needed at the existing Horton Pump Station to meet peak demands, an upgrade of Horton Zone pumping will be needed when the new Horton Reservoir is constructed, regardless of the capacity of the existing Horton Pump Station. The new Horton Reservoir will not be located at the existing reservoir site, and

the options for actually expanding at the existing pump station site are limited. Therefore, the Horton Pump Station Upgrade is shown to occur when the Horton Reservoir is constructed. The sizing of this pump station to meet the needs of the Rosemont Zone and the Horton Zone were reviewed in a report titled *Horton Pump Station Improvements Concept Design* (Montgomery Watson, 1999a). This new pump station will be sized to provide fire flow pumping to the Rosemont Zone in addition to the peak day flow need that is not met by the existing Horton Pump Station. This station will be sized for an initial capacity of about 2,800 gpm, with ultimate expansion to 6,000 gpm. The cost estimate for this pump station was developed in the February 1999 report at \$2,035,000, including an emergency generator and an allowance of 1,250 feet of 14-inch diameter piping to the site.

The cost for a new emergency generator for the Willamette Pump Station is also shown in Table 9 - 3. This generator should be purchased within the next five years.

**Table 9 - 3  
Proposed Pump Station Upgrades**

PUMP STATION	SIZE (GPM)	COST	1998-2002	2003-2007	2008-2015	After 2015
Willamette-Gen	0	\$60,000	\$60,000			
Bolton	3,000	\$200,000				\$200,000
Horton	2833/6000	\$2,035,000	\$2,035,000			
<b>TOTAL</b>		<b>\$2,295,000</b>	<b>\$2,095,000</b>	<b>\$0</b>	<b>\$0</b>	<b>\$200,000</b>

### Cost Allocations

The allocation of the costs of the CIP to existing and future customers is based on the methodology used in development of the City's system development charges (SDC's). The allocation of project costs for reservoirs and pumps are summarized in Table 9 – 4. Reservoir and pump station projects are allocated on the basis of the ratio of the capacity of the existing system deficiency to the capacity of the future deficiency. The Bolton Reservoir is a replacement of an existing reservoir, with no deficiency either now or in the future. This is therefore allocated solely to existing customers.

**Table 9 - 4  
Allocation of Reservoir and Pump Station Projects**

Project	Cost	% Existing	Existing Cost	% Future	Future Cost
<b>Reservoir Land</b>	\$690,000	0	0	100	\$690,000
<b>Bland #2 / Willamette</b>	\$1,900,000	58	\$1,102,000	42	\$798,000
<b>Bolton</b>	\$1,100,000	100	\$1,100,000	0	0
<b>View Dr / Replacement</b>	\$720,000	53	\$381,000	47	\$339,000
<b>Horton/Rosemont</b>	\$3,070,000	R- 68	1,351,000	H-100	\$1,719,000

	H- 0		R-32		
<b>Subtotal</b>					
<b>Reservoirs</b>	<b>\$7,480,000</b>	<b>52</b>	<b>\$3,934,000</b>	<b>48</b>	<b>\$3,546,000</b>
<b>Willamette Gen</b>	\$60,000	55	\$33,000	45	\$27,000
<b>Bolton</b>	\$200,000	0	0	100	\$200,000
<b>Horton</b>	\$2,035,000	62	\$1,261,000	38	\$774,000
<b>Subtotal Pump</b>					
<b>Stations</b>	<b>\$2,295,000</b>	<b>56</b>	<b>\$1,294,000</b>	<b>44</b>	<b>\$1,001,000</b>
<b>TOTAL</b>	<b>\$9,775,000</b>	<b>53.5</b>	<b>\$5,228,000</b>	<b>46.5</b>	<b>\$4,547,000</b>

The allocation of costs for pipelines is more complicated. It is assumed that any pipeline that is not solely a transmission pipeline, serves properties directly from it. These properties are obtaining their distribution service from the pipeline and are therefore a “local” beneficiary of the pipeline. This local portion of the pipeline is considered the first 8-inches diameter capacity because this is the recommended pipeline size for distribution pipeline. This local portion is not SDC eligible. If a new pipeline is being installed to a new area, this “local portion” could be funded by an Advanced Financing Agreement (AFA) with the City. If a new pipeline is replacing an existing pipeline, this local portion is funded via water rates. If a new pipeline does not replace an existing pipeline, but instead parallels it (presumably because the existing pipeline has substantial remaining useful life) then the new pipeline is allocated solely to future funding. Similarly, if a new pipeline is solely a transmission pipeline and does not service any local area, and is installed to serve growth, it is allocated solely to future, SDC funding. If a pipeline is needed to correct an existing deficiency, and this same size pipeline is adequate to buildout, then the cost of the pipeline is an existing system cost. If a pipeline is needed to correct an existing deficiency, but must be increased in size to meet future demands, then the proportion of the future pipeline capacity that is represented by the size of pipe needed to satisfy the existing deficiency, is allocated to the existing system, and the rest is allocated to future costs. The cost allocation using these guidelines for pipelines are shown in Table 9 – 5.

Of the total capital needs of nearly \$24.3 million represented by the projects in the Master Plan, 67.5%, or \$16.4 million are allocated to future system, or growth. The remaining 32.5%, or \$7.9 million, is allocated to the existing system. Of the \$13.2 million in capital projects that are recommended prior to the year 2015, about 47%, or \$6.1 million, is allocated to existing customers and 53%, or \$7.1 million is allocated to future growth. Of the projects that are SDC eligible, the Horton Reservoir No. 2, the Parker Rd. Transmission Main and the Bland Circle Loop are Future Urban Area (FUA) SDC eligible by the City’s criteria.

## **CAPITAL MAINTENANCE PROGRAM**

In addition to the Capital Improvement Program, a Capital Maintenance Program is recommended for major maintenance and replacement needs of existing facilities,

based on the evaluation presented in Section 6. More detailed descriptions of the projects are given in Section 6 and in Appendix B.

**Table 9 - 6  
Recommended Capital Maintenance Program**

<b>PROJECT</b>	<b>COST (\$)</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
Horton Reservoir Repair	\$50,000	\$50,000				
Bolton Slide Stabilization	\$200,000	\$200,000				
Reservoir Coatings	\$630,000	\$30,000	\$200,000	\$200,000	\$100,000	\$100,000
Reservoir Seismic Repair	\$180,000	\$40,000	\$50,000	\$30,000	\$30,000	\$30,000
PRV Vault Repair	\$80,000	\$16,000	\$16,000	\$16,000	\$16,000	\$16,000
Reservoir Cathodic Protect.	\$55,000	\$15,000	\$10,000	\$10,000	\$10,000	\$10,000
Service Replacement	\$190,000	\$38,000	\$38,000	\$38,000	\$38,000	\$38,000
Meter Replacement	\$130,000	\$26,000	\$26,000	\$26,000	\$26,000	\$26,000
Bolton Res Improvements	\$20,000	\$20,000				
Horton PS Improvements	\$40,000			\$40,000		
Lk. Oswego Intertie Upgrade	\$75,000		\$75,000			
Main Replacements	\$2,700,000	\$540,000	\$540,000	\$540,000	\$540,000	\$540,000
I-205 Main Catwalk&Fall Pro	\$400,000		\$400,000			
<b>TOTAL</b>	<b>\$4,750,000</b>	<b>\$975,000</b>	<b>\$1,355,000</b>	<b>\$900,000</b>	<b>\$760,000</b>	<b>\$760,000</b>

The projects have been prioritized based on an assessment of the importance of the maintenance and repair needs. All projects are recommended to occur within the next five years. Table 9 - 6 summarizes these needs. A total of approximately \$4.7 million in capital maintenance is recommended over the next five years.

# Section 10

## Conclusions and Recommendations

### CONCLUSIONS

The South Fork Water Board will have adequate water to serve the needs of the City of West Linn to its buildout population, from its current Clackamas River source, as long as the transmission line from the SFWB remains in service. As long as the existing intertie with the City of Lake Oswego remains able to supply the 3,750 gpm design capacity, the City of West Linn can be considered to have an adequate emergency backup source. Thus, the City has the potential for a reliable long-term water source of water.

The water quality of the both the Clackamas River supply and the West Linn distribution system is excellent. The system meets all existing regulations and is anticipated to continue to do so into the future as long as the City accomplishes the required Capital Maintenance projects as needed.

Significant investments in distribution system improvements are needed. These improvements are needed to correct existing deficiencies, to meet the needs of population growth, and to provide more reliable service.

### RECOMMENDATIONS

**To meet the objectives stated above, a Capital Improvement Program that is shown in Table 10 -1 should be funded. The cost of the recommended Capital Improvement program to the year 2015 is estimated to be about \$13.2 million. Another \$11.1 million would be spent after the year 2015 to meet the City's needs to buildout. Of the total capital needs of nearly \$24.3 million represented by the projects in the Master Plan, 67.5%, or \$16.4 million are allocated to future system, or growth. The remaining 32.5%, or \$7.9 million, is allocated to the existing system. Of the \$13.2 million in capital projects that are recommended prior to the year 2015, about 47%, or \$6.1 million, is allocated to existing customers and 53%, or \$7.1 million is allocated to future growth. Assuming approximately 7,000 services in the City currently, this represents a total of about \$872 per household, or \$54.50 a year averaged over the 16-year period assumed available to the year 2015.**

**Among the improvements attained through these projects are:**

- Existing flow and pressure deficiencies at peak hour in the Bolton, Rosemont, Bland, Robinwood and Willamette Zones will be corrected.



- Existing pressure deficiencies during fire flows events in the Robinwood Zone will be corrected.
- The system improvements to accommodate the projected growth in water demand to the year 2015 will be provided.
- An emergency generator for the Willamette Pump Station would be provided.
- The Master Plan would be updated in five years.
- Significantly improved emergency storage would be provided throughout the City.
- The Bland Circle No. 2, the Horton 2 Reservoir, and the Horton No. 2 Pump Station would be constructed to serve the Willamette, Bland, Horton and Rosemont Zones.
- A replacement for the View Drive reservoir would be constructed to serve the Robinwood Zone.

**As part of this Capital Improvement Programs the City should:**

- Affirm a fire flow requirement throughout the City of 3,000 gpm for 3 hours .
- Adopt new storage criteria of fire flow plus 25% of maximum day demand for equalization plus one average day demand for emergency storage as a long-term goal.
- Bring sites that are available within the City of West Linn and that could serve the needs of both the SFWB and the City to the attention of the SFWB, and seek to build a joint-use reservoir with the SFWB.
- Replace the View Drive Reservoir at a higher elevation. This may be the same location/reservoir as the joint SFWB reservoir.
- Use restrained joints when designing transmission pipelines which cross unstable land, railroad tracks, freeways, or other locations which could either result in unusual ground movements or could result in significant damage to property or life should a leak occur.
- Make minor adjustments in certain pressure zone boundaries and pressure regulator settings to relieve pressure problems near zone boundaries.
- With two exceptions, the City should replace existing pipelines instead of adding parallel pipes when making pipeline improvements.

In addition to the Capital Improvement Program, over the next five years approximately \$4.75 million is recommended for a Capital Maintenance Program. This recommended program is shown in Table 10 - 2. This amount would be funded by existing customers. Assuming approximately 7,000 services in the City currently, this represents a total of about \$678 per household, or \$136 a year (\$11 a month) averaged over the 5 year period.

**This Capital Maintenance Program should:**

- Stabilize the landslide at the Bolton Pump Station and stabilize potential areas for landslide along the 24-inch diameter supply line from the SFWB.
- Provide for the replacement of small, undersized water mains throughout the City.

**Table 10- 2**

**Recommended Capital Maintenance Program**

PROJECT	COST (\$)	1998	1999	2000	2001	2002
Horton Reservoir Repair	\$50,000	\$50,000				
Bolton Slide Stabilization	\$200,000	\$200,000				
Reservoir Coatings	\$630,000	\$30,000	\$200,000	\$200,000	\$100,000	\$100,000
Reservoir Seismic Repair	\$180,000	\$40,000	\$50,000	\$30,000	\$30,000	\$30,000
PRV Vault Repair	\$80,000	\$16,000	\$16,000	\$16,000	\$16,000	\$16,000
Reservoir Cathodic Protect.	\$55,000	\$15,000	\$10,000	\$10,000	\$10,000	\$10,000
Service Replacement	\$190,000	\$38,000	\$38,000	\$38,000	\$38,000	\$38,000
Meter Replacement	\$130,000	\$26,000	\$26,000	\$26,000	\$26,000	\$26,000
Bolton Res Improvements	\$20,000	\$20,000				
Horton PS Improvements	\$40,000			\$40,000		
Lk. Oswego Intertie Upgrade	\$75,000		\$75,000			
Main Replacements	\$2,700,000	\$540,000	\$540,000	\$540,000	\$540,000	\$540,000
I-205 Main Catwalk&Fall Pro	\$400,000		\$400,000			
<b>TOTAL</b>	<b>\$4,750,000</b>	<b>\$975,000</b>	<b>\$1,355,000</b>	<b>\$900,000</b>	<b>\$760,000</b>	<b>\$760,000</b>

Note: Construction costs based on a Seattle area ENR of 7124

- Make seismic, coatings, and cathodic protection repairs and improvements at the existing reservoirs.
- Solve flooding problems at existing PRV vaults.
- Provide for ongoing replacement of existing water meters on a 15 - 20 year cycle (between 430 and 325 meters a year) and services on a 75 year cycle.
- Make other minor repairs to assure the longevity of existing facilities.

- Make maintenance improvements to the I-205 Transmission Main to assure its continued operation.
- Improve the operation of the intertie with the City of Lake Oswego.

**To develop better information over time on unaccounted-for water, and to reduce the amount of such losses, the following recommendations are made:**

- A routine leak detection program should be implemented. The complete system should be surveyed once every five years at minimum. Because the City already owns the sonic detection equipment necessary to conduct the survey, the City can conduct the survey with its own personnel, or it may contract with a leak detection survey firm.
- A leak repair log should be maintained. The estimated quantity of water that is being lost by each leak which is found and repaired, whether from the routine leak detection program or as a part of other activities, should be recorded.
- Unmetered water use reports should be maintained as part of the monthly operating logs. Water uses such as pump lubrication, main flushing, fire hydrant inspections, tank cleaning and draining, etc. should be recorded so as to maintain accurate unmetered water use statistics.
- Records on the amount of water used for fire fighting, hydrant flushing, and fire training should be maintained to record unmetered water use.
- All large meters (3-inch or greater) that are presently not outfitted with test ports, should be so fitted, and then tested on an annual basis.
- A pilot test program of small meters should be conducted. Fifty to 100 small meters representing the various models and ages (with an emphasis on older meters) in the system should be removed and tested to determine what the typical average rate of underregistering is in the system and at what point it will become economical to replace them. Many systems have found that a schedule of replace of between 15 and 20 years, regardless of their condition, is economical.
- A program of metering construction water use, either through an honors system permit or through issuance of hydrant meters and construction water permits, should be considered. This would provide more detailed information on this unmetered water use and may add revenue from more accurate accounting of water use.

### **When the City modifies its water rates, the City should:**

- Consider a cost-of-service rate structure which charges a commodity charge for all water used.
- Consider an inclining block rate structure for summer water use to the commodity component of its rate structure to encourage conservation.

### **Other recommendations include:**

- The City should review its contractual agreement with the City of Lake Oswego with a view to strengthening that agreement to assure that the emergency intertie between the two systems will be available and operable whenever it is needed.
- The City, in conjunction with the SFWB, should obtain water quality data on Haloacetic Acid (HAA) levels in its system, to confirm that it has low levels of this compound that will soon be regulated.
- The City should prepare for other upcoming new federal drinking water regulations, including the Consumer Confidence Report which will be required starting in 1999.
- The City should participate in the regional Conservation Coalition effort that is identifying appropriate and achievable levels of conservation within the area. When the information from the Coalition work is available, the City should use it to expand its own conservation programs. In the interim, the City should provide public information about wise water use and begin to prepare for adoption of potential conservation program elements, such as landscape ordinances and industrial, commercial and residential water audits, in addition to the leak detection and rate structure evaluations discussed elsewhere in this section.
- The City must plan for and develop operators with the Level 3 certification.
- The City should expand the steady-state hydraulic model that has been developed in this Master Plan to a dynamic model, called an "extended period simulation" model, which will allow it to optimize the operation of the water system.
- The City should review its staffing levels and increase staffing as needed in order to implement the recommendations of this Master Plan. It appears that the staff have very little time to conduct efforts which go beyond the routine maintenance and operation to more long-term goals of improving the system. Recommendations such as increased leak detection work, conservation program implementation, better record keeping of unmetered water uses, and evaluation of the impacts of upcoming water regulations, which are contained in this Master Plan, are unlikely to be able to be implemented with the current staffing levels.

- The City should review its Design Code and determine whether changes are appropriate to it once this Water System Master Plan has been adopted.
- The City should update its System Development Charges once this Master Plan has been adopted.
- Each year, the City should adopt a Capital Improvement Program and a Capital Maintenance Program that incorporates the general guidance of the Master Plan into specific activities.
- This Master Plan should be reviewed and revised at least every five years in order to account for continually changing circumstances and conditions.

# Appendix D

## Results of Stakeholder Survey

A stakeholder survey consisting of telephone interviews with ten individuals representing a cross-section of views within the City of West Linn was conducted. The stakeholder survey was designed to provide feedback on a range of water system issues. The interviews were held in the summer and fall of 1997. The individuals who were interviewed were:

- A Plant Nursery Owner
- A Restaurant Manager
- A Certified Public Accountant
- A Collection Agency Owner
- A Small Business Owner
- A Developer
- A Retired Manager of the Chamber of Commerce
- A Property Manager
- A Dentist
- A Homeowner

The detailed questions which were asked in the stakeholder survey and the resulting responses are provided below. Not all respondents provided answers to all questions.

### 1. How long have you been in West Linn?

**Lived?** Average, 17 years, from a low of 6 months to a high of 34 years.

**Worked?** Average, 13 years; range 6 months to 34 years. (note: not all respondents work in West Linn.)

### 2. On a scale of one to five -- one, very bad and five, very good -- how would you rate the quality of West Linn's water? (e.g. taste, odor, temperature, clarity) Explain.

Seven of the ten respondents rated the quality of water as very good (5), with only one saying the water is very bad (1).

*Comments:*

- In summer, the taste is not very good
- No problem

- Lives on one of oldest water lines in the city. Has been “yelling” for 13 years for repairs
- Some sediment in the summer

**3. On a scale of one to five -- one, very bad and five, very good -- how would you rate the quality of West Linn's water system? (e.g. quick response to problems, water pressure, billing system, physical plant) Explain.**

Five respondents rated the water system quality very good (5) or good (4); three rated it average (3); and one rated it poor (2).

*Comments:*

- No problems since Sunburst was put in
- Needed repair at 11:30 pm; good, quick response
- No problems
- I don't like the fact that the sewage cost goes up with water usage (you get stung watering your yard which doesn't involve sewage)
- Fundamental engineering/infrastructure problems have to be resolved
- Too much pressure; need to have pressure valve installed

**4. West Linn and Oregon City get their water from the same source: the Clackamas River. Both cities own and operate the South Fork Water Board, which runs the water treatment plant which actually supplies the water. West Linn residential customers pay a minimum of \$19 every two months. Oregon City residents pay about twice as much. Do you have any opinions about why this is?**

- West Linn voters turned down any increase
- No idea; would expect Oregon City to be less
- Oregon City probably convinced voters it needs the money
- Citizens in Oregon City have “better common sense” than people in West Linn
- “Squeaky wheels” in town oppose everything
- Not sure/West Linn water rates are too high
- Political opposition in West Linn
- West Linn did not raise rates every year to keep up with inflation
- We voted to roll back rates

**5. All West Linn residents pay a minimum of \$19 every two months to use as much as 10,500 gallons of water. Yet, about 35% of the people use less than that. What do you think of this flat rate system?**

- It's fair (3)
- The minimum fee should be higher (1)
- People should pay for what they use, with no minimum (5)

**6. Generally, do you think West Linn's water rates are just right? too low? too high? Explain.**

Respondents were divided. Three said the water rates are just right; two said they were too low; and one said they were too high. The rest do not have an opinion.

*Comments:*

- Rates are what are needed to maintain the system
- 25% of the system known to be leaking; replacements needed
- Ratepayers should pay the cost to maintain system

**7. West Linn water rates have not changed since 1987. Since then, the voters turned down two requests for increases. Under what conditions, if any, would you support a water rate increase in West Linn? (check as many as applicable)**

- \_\_\_(4)\_\_\_ Meet demands of growth.
- \_\_\_(6)\_\_\_ Keep up with increased costs at South Fork.
- \_\_\_(4)\_\_\_ Improve the water quality.
- \_\_\_(6)\_\_\_ Upgrade equipment such as water mains and lines.
- \_\_\_(6)\_\_\_ Maintain and repair the system as needed.
- \_\_\_(5)\_\_\_ Be assured of an adequate supply in an emergency.
- \_\_\_(1)\_\_\_ Recommended by the Utility Advisory Board.
- \_\_\_(2)\_\_\_ Other

If someone says we will not have any water coming to our house if we don't pay more  
If the system fails

**8. System development charges (SDCs) are paid by all new construction in the city to help cover the cost of the consequences of growth, including additions to the water system. Our SDC fees are among the highest in the region. What is your opinion of these charges?**

- Just right? (6)
- Too low? (1)
- Too high? (0)
- No opinion (3)



*Comments:*

- Developers recover their costs; they want the job done right
- Developers should pay more for the cost of improvements
- Citizens, as well as developers, have to be willing to pay for the costs of growth

**9. By law, these system development charges cannot pay for the cost of operating the water system, which has been steadily increasing. To pay for the higher cost of operating, maintaining, and repairing the system, do you favor (check as many as apply)**

- \_\_\_(7)\_\_\_ Higher water rates?
- \_\_\_(2)\_\_\_ City subsidize increased needs through the property tax?
- \_\_\_(0)\_\_\_ Keep water rates the same.
- \_\_\_(6)\_\_\_ Bond issues for capital improvements.
- \_\_\_(1)\_\_\_ Other

*Comments:*

- If we knew specifically what we were paying for and you did what you said with the increase
- Higher SDCs; people should not have to pay for new area growth

**10. Complete this sentence: West Linn's high quality water is:**

- \_\_\_(1)\_\_\_ very important; one of the reasons I live here.
- \_\_\_(0)\_\_\_ not particularly important.
- \_\_\_(0)\_\_\_ would cause me to move, or think about moving, if it deteriorated.
- \_\_\_(7)\_\_\_ like any other utility - something I take for granted.

**11. Anything else you would like to add?**

- Owns well; does not use city water
- Not sure why people turned down water rate increases; maybe they're newcomers to the city
- If we want good water, we have to pay for it
- Cost a lot of money now
- People are against growth; that's why they oppose higher water rates
- Higher rates might be supported if there is a crisis (restriction on watering lawns)
- People have to see what they would get (for a rate increase)
- Tell us what our rates represent now. (improvements, sewer, general cost, etc.)
- Water and sewer are never free

- West Linn is not flat; water does not flow uphill naturally
- Too many West Linn citizens have a general negative feeling about government
- People need to understand that things wear out and need to be repaired
- Schools need more money; why doesn't the water system?
- Give people information about water in their bills
- Publish true water problems with photos in *West Linn Tidings*. Explain exactly what needs to be fixed and exactly how much it will cost. Ask for the money for each project as needed.

# Appendix E

## Summary of Comments at Public Meetings

Two facilitated public workshops were held during the course of preparation of this Water Master Plan. One was held at the West Linn City Hall on April 16, 1998 and was broadcast on West Linn cable television. The second meeting was held at the Public Library on April 28, 1998.

The two public workshops each followed the same format. Several informational exhibits and brochures about the water system were available for viewing prior to the workshop. Mayor Jill Thorn provided an introduction and overview of the workshop. Joe Glicker, the Project Manager for the Master Plan, then conducted a 45 minute summary presentation about the findings of the Master Plan. Elaine Cogan then facilitated public comments and discussion of what had been presented. The “next steps” towards adoption of the Master Plan were then summarized and the meeting was adjourned. Each meeting lasted approximately two hours. A combined total of approximately a dozen individuals (other than Planning Commission and City Council members) attended the two public workshops. One member of the Utility Advisory Board and one member of the public attended both workshops. The public meeting which was held on April 16<sup>th</sup>, was a joint meeting of the West Linn Planning Commission and the City Council.

Issues which were raised at these meetings are as follows:

### **APRIL 16, 1998**

#### **City Council, Planning Commission**

- Does the City own the hydraulic model?
- How have you verified it?
- What do storage facilities look like?
- What about:
  - cost reductions?
  - power usage?
  - coordination with others?
  - operations?
  - significant opportunities in “qualitative terms?”
- How can we make sure growth pays its own way?
- Can we adopt standards between the 1982 version (of the Water Master Plan) and the consultant’s 1998 criteria?
- Didn’t mention how to solve flooding.
- How much is “steel in the ground” driven by the fire code?

## Public

- People will accept in-ground storage (more than above ground.)
- What is likelihood of simultaneous emergency circumstances affecting the City water supply?
- Is it possible to do a cost/benefit analysis?
- The proposed criteria are common ones.
- Are code requirements currently in place to constrain Rosemont fire flow?
- Could we stay with lower storage requirements due to other locally available municipal resources? (e.g. Milwaukie, Oregon City, etc.)
- We should expand shared storage between West Linn and South Fork.
- What is the cost effectiveness of the meter replacement program?
- What is the value of periodic testing vs. a fixed replacement cycle?
- Distinguish between the 25 and 15-year replacement recommendations.
- What types of improvements are desired in a water intertie with other cities?
- Do the recommend improvements reduce the need for the intertie?
- Comment favoring a usage charge.
- Desire expressed that additional money raised through property taxes vis a vis water rate increase for tax (state/federal) deduction.
- Desire for installation of meters on major transmission mains to track “area” usage.
- Recommendation that fire flow be figured from peak hour demand to minimize risk.
- The firm pumping combination of pumps that will exist after the initial expansion of the Bolton Pump Station will presumably consist of all of the pumps in the existing Bolton Station working in parallel with one of the two new nominally rated 1500 gpm pumps. Since you don’t have the manufacturer’s performance curves for the existing Bolton Station pumps and as I understand it you are not using any of the measured performance data from the October 1993 tests for the existing pumps, how can your hydraulic model legitimately and accurately predict that such a firm pumping combination will have a firm pumping capacity of as much as 3200 gpm, as stated on page 3 of your February 27 testimony to the Boundary Commission?
- If after the Bolton Pump Station is initially expanded and the firm pumping combination of pumps, as enumerated above, is actually tested and found to have a firm pumping capacity of considerably less than 3200 gpm, that will mean you will have told the Boundary Commission and the City that the Bolton Pump Station was capable of handling considerably more growth than it will be capable of. What would be the consequences of that and what would happen then?
- In you Table 6-11 on page 6-16 of your Draft Water Master Plan showing recommended system valve adjustments, it shows a recommended setting of 45 psi for the PRV valve located at elevation 620 near Salamo Road that presently supplies all of Tanner Basin’s Horton zone’s water. Even after the initial expansion of the Bolton Pump Station and installation of a partial extension of the Parker Road pipe line (which I have dubbed the “Substitute Plan”) it is acknowledged that fire flow at the top of the Basin’s Horton zone will need support from the Rosemont zone through this PRV. That means this “Substitute Plan” cannot stand entirely independently on its own to serve the Basin’s Horton zone. Also, at times other than

those covering fire incidents at the top of the Basin's Horton zone, won't a setting of 45 psi for that PRV also result in admitting water to help feed the Horton zone at least during times when no pumps or very few pumps are running at the Bolton Station?

- Your Table 6-7 on page 6-11 if your draft Water Master Plan shows a current modeled firm capacity for the Horton Station of 1557 gpm. This is further down from your previously cited number of 1780 gpm. To me neither one of these number made any realistic sense and have gone in a direction that would mean that the Horton Station is not even nearly as capable as indicated by the measured 1900 gpm firm pumping capacity under the conditions of the October 1993 tests of the station.
- As I've shown in previous submittals to you, even by using my much greater "effective firm pumping capacities" for the Horton Station when assuming a constant rate of draw down from a beginning level (stipulated in the existing Water Master Plan as an assumed beginning level under fire fighting conditions of  $\frac{3}{4}$  full) to empty, the Rosemont Tower would become empty in a time considerably less than 120 minutes stipulated as a needed capability in fighting a school or commercial fire in the Rosemont zone at a fire flow rate of 2500 gpm, if such a fire occurred on a day of maximum daily demand having a level of maximum demand predicted by you for 1999.
- It's beyond me how you can come up with only 1557 gpm for the firm pumping capacity of the Horton Pump Station and claim it can handle all growth in the Rosemont zone out past the year 2015. Please explain how you came up with this number and how you can contend it is adequate past the year 2015.

**APRIL 28, 1998:**

### **Public**

- How would cost be spread to all households?
- Doesn't seem that high.
- Paying for what we use might be a workable solution.
- If you do, it would "change city into a brown city."
- We should have been raising water rates incrementally over time.
- Support upkeep of system for residents but not for new development.
- Prefer that charges for water needs be paid through property taxes.
- With a rate-based system you'd be surprised how much you'd pay for a small amount of water.
- What about replacement of old mains? Do we actually have 50-year-old pipes?
- (Re: paying for water improvements from property taxes.) Some people do not itemize and couldn't take deductions.
- We should measure water that is used during construction by developers and not paid for.
- We should encourage conservation, but not through rates.
- Is the projection of growth per year accurate? Shouldn't it be higher?

ES - 121

- Growth since 1988 has brought in more revenue even though rates have not changed since then.
- We should be given two sets of recommendations--the new plan and what we would have to pay for under 1982 standards with no more capital improvements until 2015.
- What are the needs for Horton and Rosemont zones (only) to year 2015?
- We should have reliable metering for the whole system.
- It's unfair to assign 350 gallons throughout the city. There are considerable differences among zones—older, e.g. more developed areas use less water.
- The city should also do an “extended period” simulation model.
- Analyze the fire flow on a peak hour basis rather than peak days.
- What is the difference between 1982 and recommended criteria?
- The emergency storage today (24 hours) is barely adequate. The major difference between 1982 and current criteria is the amount of storage we would have.
- This is a plan. We have to decide on the levels of risk we can afford and want to be comfortable with.
- The plan should be updated every year.