City of West Linn

WATER SYSTEM MASTER PLAN

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

City of West Linn, Oregon

November 2008

WATER SYSTEM MASTER PLAN

FOR

CITY OF WEST LINN, OREGON

November 2008

Prepared by:

MURRAY, SMITH & ASSOCIATES, INC.
Engineers/Planners
121 SW Salmon, Suite 900
Portland, Oregon 97204

07-0848.409

Resolution No. 08-44
West Linn, Oregon

A RESOLUTION OF THE WEST LINN CITY COUNCIL ADOPTING A NEW WATER SYSTEM MASTER PLAN FOR THE CITY OF WEST LINN.

WHEREAS, proposed Water System Master Plan addresses the changed circumstances, regulatory requirements and includes updated technical data since the Plan was last updated in 2004; and,

WHEREAS, the proposed Water System Master Plan provides an assessment of the City's water distribution system; and,

WHEREAS, the proposed Water System Master Plan identifies current system deficiencies; and,

WHEREAS, the proposed Water System Master Plan identifies future water supply requirements, and recommends future system needs; and,

WHEREAS, the proposed Water System Master Plan is classified as a Supporting Document to the West Linn Comprehensive Plan; and,

WHEREAS, based on the recommendations and under the guidance of an outside professional consultant, a new Water System master Plan is proposed and is included as Exhibit "A"; and,

WHEREAS, the Utility Advisory Board has reviewed the proposed Water System Master Plan and recommended it approval; and,

WHEREAS, on October 15, 2008, the West Linn Planning Commission considered and reviewed the proposed Water System Master Plan and unanimously recommended its approval;

NOW, THEREFORE, BE IT RESOLVED BY THE WEST LINN CITY COUNCIL THAT:

Section 1: The 2008 City of West Linn Water System Master Plan is hereby adopted as the new plan governing water system policy, planning, and operation.

Section 2: This Resolution shall be effective immediately upon adoption.

This Resolution adopted by the West Linn City Council this 10th day of November, 2008.

Norman B. King
Norman King, Mayor

ATTEST:

Tina Lynch
Tina Lynch, City Recorder

ACKNOWLEDGMENTS

Appreciation is expressed to all who contributed to the completion of this Master Plan.

City of West Linn, City Council

City of West Linn, Planning Commission

City of West Linn, Utility Advisory Board

City of West Linn Staff

Involved Citizens of West Linn

Murray, Smith & Associates, Inc.

LIST OF ABBREVIATIONS

AAGR – Average Annual Growth Rate
AC – Asbestos Cement
ADD – Average Day Demand
ASR – Aquifer Storage and Recovery
ATS – Automatic Transfer Switch
AWWA – American Water Works Association
CAD – Computer Aided Drafting
CCI – Construction Cost Index
CFS – Cubic Feet per Second
CIP – Capital Improvement Projects
CMU – Concrete Masonry Unit
CMP – Capital Maintenance Plan
CRBG – Columbia River Basalt Group
DHS – Department of Human Services
DOH – Department of Health
DSL – Oregon Division of State Lands
DSPS – Division Street Pump Station
DWPLF – Drinking Water Protection Loan Fund
ENR – Engineering News Record
EPA – Environmental Protection Agency
FPS – Feet Per Second
FY – Fiscal Year
GIS – Geographical Information System
GPCD – Gallons Per Capita Per Day
GPD – Gallons Per Day
GPM – Gallons Per Minute
HGL – Hydraulic Grade Line
HP – Horsepower
I-205 – Interstate 205
IGA – Intergovernmental Agreement
ISO – Insurance Services Office
LDR – Low Density Residential
MCC – Motor Control Center
MDD – Maximum Day Demand
MDR – Medium Density Residential
MFR – Multi-Family Residential
MG – Million Gallons
MGD – Million Gallons per Day
MHDR – Medium-High Density Residential
MSA – Murray, Smith & Associates, Inc.
MSL – Mean Sea Level
NFPA – National Fire Protection Association
OAR – Oregon Administrative Rules
OECDD – Oregon Economic and Community Development Department
O&M – Operation and Maintenance
ORS – Oregon Revised Statutes
OWRD – Oregon Water Resources Department
PPH – Persons Per Household
PRC – Population Research Center
PRV – Pressure Reducing Valve
PSI – Per Square Inch
PVC – Polyvinyl Chloride
RWPS – Raw Water Pump Station
SCADA – Supervisory Control and Data Acquisition
SDC – System Development Charge
SDWRLF – Safe Drinking Water Revolving Loan Fund
SFR – Single Family Residential
SFWB – South Fork Water Board
TVFR – Tualatin Valley Fire & Rescue
UAB – Utility Advisory Board
UGB – Urban Growth Boundary
USACE – United States Army Corps of Engineers
VFD – Variable Frequency Drive
WMPU – Water Master Plan Update
WSMP – Water System Master Plan
WTP – Water Treatment Plant

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MSA

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Authorization

On March 13, 2007, the consulting engineering firm of Murray, Smith & Associates, Inc. (MSA) was authorized by the City of West Linn (City) to prepare this Water System Master Plan (WSMP).

Purpose and Compliance

The purpose of this WSMP is to provide an assessment of the City's water distribution system, to identify current system deficiencies, determine future water supply requirements and recommend improvements that correct existing system deficiencies and provide for future system needs. This WSMP complies with water system master planning requirements established under Oregon Administrative Rules (OAR) for Public Water Systems, Chapter 333, Division 61. Included in the planning and analysis work presented in this plan is the impact of complying with recent fire flow requirement changes for residential construction.

Planning Period and Study Area

The planning period for this WSMP is approximately 20 years, through the year 2030. Certain planning and facility sizing efforts will use estimated water demands at saturation development. Saturation development, or build out, occurs when all land within the Urban Growth Boundary (UGB) which City staff has determined to be economically and physically developable, has been fully developed according to current land use and zoning designations. The planning period for transmission and distribution facilities is to saturation development of the City's water system planning area which is concurrent with the UGB.

The study area for this master plan includes the City's existing water service area and all areas within the City's existing UGB. The City provides potable water to approximately 24,615 people through 8,600 residential, commercial and industrial service connections. The City's water service area includes all areas within the current City limits as well as a limited number of customers outside the UGB that receive extra-territorial water service from the City. For the purpose of this analysis, this small number of services is included as if they were actually within the UGB. Plate 1 of Appendix A illustrates the City's water service area limits, pressure zone boundaries and major water system facilities.

South Fork Water Board Supply and Emergency Supply Connection Facilities

Currently, the City's primary water supply is from the South Fork Water Board (SFWB) water treatment plant (WTP) located in Oregon City. The City also has an emergency supply connection to the City of Lake Oswego's WTP located at the north end of the City. The City's water distribution system consists of six (6) service zones supplied by six (6) storage facilities and five (5) pumping stations. Each of the service zones is supplied by gravity from a storage facility.

Pressure Zones

The City's existing distribution system is divided into the following six (6) major service levels, or pressure zones:

- Bolton Pressure Zone
- Horton Pressure Zone
- Rosemont Pressure Zone
- Robinwood Pressure Zone
- Willamette Pressure Zone
- Bland Pressure Zone

Storage Reservoirs

The City's water system has a total storage capacity of 5.5 mg distributed across six (6) storage reservoirs. Table ES-1 presents a summary of the City's existing storage reservoirs, including capacities, overflow elevations and pressure zone served.

Table ES-1
Reservoir Summary

Reservoir Name	General Location	Usable Capacity (mg)	Overflow Elevation (ft)	Pressure Zone Served
Bolton	Skyline Drive	2.0	440	Bolton
Horton	Horton Road & Santa Anita Drive	1.5	731	Horton
Rosemont	Suncrest Drive	0.4	860	Rosemont
Bland Circle	Bland Circle	0.5	585	Bland
Willamette	Salamo Road	0.6	351	Willamette
View Drive	View Drive	0.5	328	Robinwood

Pumping Facilities

The City's water distribution system includes four (4) booster pump stations. A fifth pump station is located at the City's emergency supply connection with Lake Oswego. Table ES-2 summarizes the pump configuration, total capacity and firm capacity of each station. The pump station capacities presented in Table ES-2 represent the nominal capacities of the pumps.

Table ES-2
Existing Pump Station Summary

Pump Station	Pump Configuration (gpm)	Total Installed Capacity (gpm)	Nominal Firm Capacity (gpm)
Bolton	3 @ 1,500	4,500	3,000
Horton	2 @ 1,300; 2 @ 900	4,400	3,100
Willamette	3 @ 500	1,500	1,000
View Drive	3 @ 600	1,800	1,200
Lake Oswego Emergency Intertie	2 @ 2,200	4,400	2,200

Distribution System Piping

The City's water service area distribution system is composed of various pipe types in sizes up to 24 inches in diameter. The total length of piping in the service area is approximately 117 miles. The pipe types include cast iron, ductile iron, polyvinyl chloride (PVC), steel, asbestos cement, copper and galvanized iron. Table ES-3 presents a summary of pipe lengths by diameter. Table ES-4 presents a summary of pipe length and percentage of system by material.

Table ES-3
Existing Pipe Inventory

Diameter (in.)	Linear Feet in System	Miles in System	Percent of Total Pipeline Length
Less than 6	69,036	13.1	11
6	271,437	51.4	44
8	142,059	26.9	23
10	41,364	7.8	7
12	22,243	4.2	4
14	15,557	2.9	2
16	10,544	2.0	2
18	18,790	3.6	3
20	9,161	1.7	1
24	20,070	3.8	3
Total	**620,261**	**117.4**	**100**

Table ES-4
Pipe Material Summary

Pipe Material	Length (feet)	Percent of Total Length
Ductile Iron	379,862	61.2
Cast Iron	127,063	20.5
Asbestos Cement	63,932	10.3
Polyvinyl Chloride	14,630	2.4
Galvanized Steel	9,752	1.6
Steel	10,363	1.7
Copper	3,633	0.6
Polybutylene	815	0.1
Unknown	10,211	1.6
	620,261	**100**

Water Demand Projections

Estimates of future water demands were developed from the existing water use data and City land use data and population projection estimates. Water demand estimates are summarized in Table ES-5.

Table ES-5
Estimated Water Demand Summary

Year	Water Demand (mgd)		
	Average Day Demand	Maximum Day Demand	Peak Hour Demand
2008	3.5	8.1	21.3
2010	3.6	8.3	21.8
2015	3.7	8.6	22.6
2020	3.9	8.9	23.4
2025	4.0	9.3	24.5
2030	4.2	9.7	25.5
Saturation Development	4.3	10.0	26.3

Water System Operation and Maintenance

The City's water system is operated and maintained by the Public Works Department which performs all system operation and maintenance for the distribution system from the City's 24-inch diameter supply main in Oregon City, downstream of the Division Street Pump

Station and the SFWB WTP. An evaluation of the City's water system operation and maintenance (O&M) practices was completed with the following items recommended for inclusion in the City's water system Capital Maintenance Plan (CMP) and Capital Improvements Plan (CIP):

1. *Reservoir Seismic Assessment and Improvements* – Assess the current seismic risk at four (4) reservoir sites and determine if the current level of seismic restraint is adequate. Develop recommended improvements to meet current seismic code requirements. It is recommended that these assessments will be completed for the Willamette, View Drive, Bland and Horton Reservoirs.

2. *Bolton Reservoir Replacement and Old Bolton Pump Station Abandonment* – Based on the current and previous evaluations of the Bolton site, it is recommended that the Bolton Reservoir be abandoned and replaced, and that the old Bolton Pump Station be demolished and removed. The required capacity of the proposed Bolton Reservoir replacement will be further discussed in Section 6. Given the age and condition of the reservoir, it is anticipated that this improvement is included as a near-term (less than five (5) years) improvement in the CIP.

3. *Ongoing Reservoir Lining and Coating Maintenance* – Three (3) of the City's reservoirs (Bland, Rosemont and View Drive) will require re-coating within the next 10 to 20 years. A schedule for completing these re-coatings is included in the CMP. Most coatings have a service life of approximately 20 to 30 years so it is anticipated that all of the reservoirs, with the possible exception of the Willamette and Horton Reservoirs which were re-painted in the past five (5) years, will need coating maintenance within the 20-year planning horizon of this WSMP.

4. *Willamette Pump Station MCC Assessment* – An assessment of the condition, performance and operation of the existing MCC's in the Willamette Pump Station should be completed to determine if corrective repairs or replacement will be required to address issues identified by City staff.

5. *Demolition of Abandoned View Drive Site Facilities* – The abandoned reservoir and pump station on the View Drive site should be demolished and removed to improve site aesthetics and reduce the risk associated with failure of aging structures.

6. *SCADA System Upgrades* – The SCADA system should be upgraded to replace existing aging infrastructure, including the Master Telemetry Unit and components at remote pump station sites.

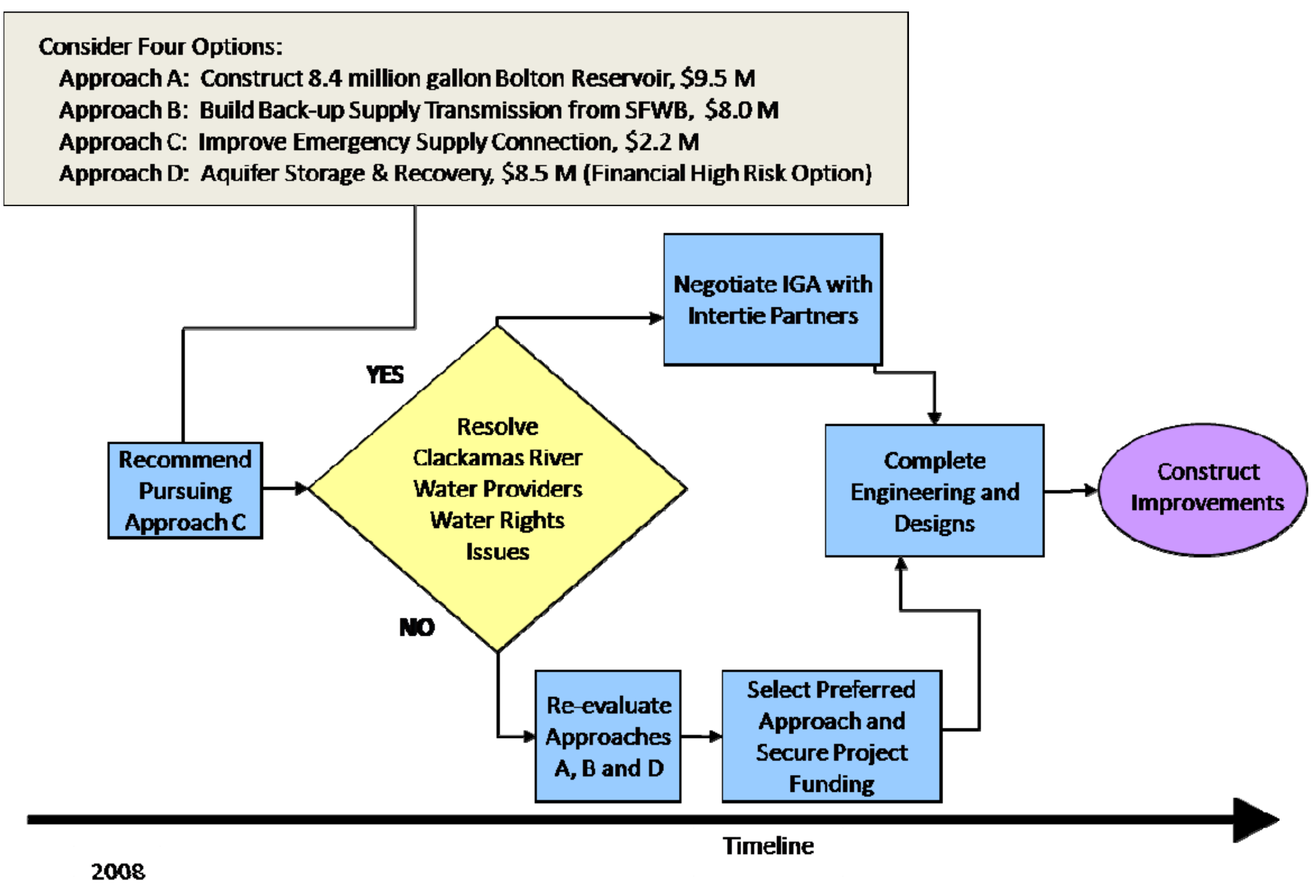
Water Supply Evaluation

A comprehensive and system wide supply system evaluation of City supply facilities was completed that included consideration of a number of approaches, methodologies and solution option development. The supply analysis was completed based on capacity needs, reliability, redundancy and included consideration of piping, pumping, aquifer storage and finished water storage options. The analysis considered the following four (4) solution approaches:

- Solution Approach A: Construction of a new 8.4 million gallon Bolton Reservoir
- Solution Approach B: Build back-up supply transmission from SFWB
- Solution Approach C: Improve the emergency supply capacity and reliability of the Lake Oswego Emergency Supply Connection
- Solution Approach D: Aquifer Storage and Recovery (ASR)

The four (4) solution approaches presented above provide varying degrees of certainty, risks and costs. Based on input from and discussions with City staff and policy makers it is recommended that Solution Approach C be pursued. Once fully developed and implemented this approach most economically meets the City's supply and reliability needs. The successful implementation of this approach requires the resolution of ongoing water rights discussions with a number of Clackamas River water users. Figure ES - 1 presents a decision tree diagram summarizing the recommended supply system strategy for the City.

Figure ES-1
Supply Approach Decision Tree



Distribution System Storage Evaluation

A distribution system storage evaluation was completed that established City-wide water storage requirements as well as storage requirements for the City's six (6) pressure zones. Storage deficits were found in a number of the City's service zones under saturation development conditions. These deficits are summarized as follows:

- 0.4 mg in the Robinwood pressure zone
- 0.8 mg in the Willamette pressure zone
- 0.7 mg in the Horton pressure zone
- 0.3 mg in the Bland pressure zone
- 0.8 mg in the Rosemont pressure zone

Two (2) approaches were considered to address the current and future supply and storage deficits presented above. Both approaches include system improvements that, if implemented, would result in adequate supply and storage through saturation development. Specifically, each approach addresses the following pressure zone supply and storage deficits at saturation development. Both approaches also consider the anticipated need to replace the Bolton Reservoir due to concerns over the age of the reservoir, usable capacity and maintenance of the floating cover.

Approach A – Storage Only

Approach A considers the construction of additional storage facilities to address the long-term supply and storage deficits discussed above. Where feasible, storage improvements are configured to address deficits in more than one (1) pressure zone.

Approach B – Storage and Emergency Supply Improvement

Approach B considers the construction of additional storage facilities as well as the development of expanded, reliable emergency supply facilities to address the long-term supply and storage deficits discussed above. Where feasible, improvements are configured to address deficits in more than one (1) pressure zone.

These two (2) alternative approaches were presented to, and reviewed by City staff, the UAB and the City Council. The City Council directed that the development of recommended system improvements be based on Approach B. The resulting recommended improvements and associated project costs are incorporated in the recommended CIP and CMP.

Distribution System Analysis

A hydraulic network analysis computer program was used to evaluate the performance of the existing distribution system and to aid in the development of proposed system improvements.

System performance and adequacy was evaluated to identify areas of deficiency and develop recommended system improvements for the CIP.

Recommended Improvements

The distribution system analyses formed the basis for the recommended water distribution system improvements. Recommended improvements include maintenance projects to improve the reliability or performance of existing facilities and proposed new or replacement facilities to address existing inadequacies or inadequacies found when future demand conditions were imposed on the system. System improvements include recommendations for improvements to reservoirs, pump stations, distribution system water lines and other facilities. The recommended improvements in this section are presented by project type and include projects related to the City's CMP and CIP. Project cost estimates are presented for all recommended improvements and annual budgets are presented which support on-going programs. All recommended improvements are located within the City's existing UGB and are intended to serve existing development and planned growth that occurs inside the UGB.

Capital Maintenance Program

A number of improvements were identified for inclusion in the City's water system CMP. The CMP is recommended for major maintenance and replacement needs of existing facilities. Table ES-6 lists the projects included in the CMP and itemizes the estimated project costs associated with these maintenance projects for the 20-year study period of the WSMP. All estimates are in 2008 dollars.

Table ES-6
Recommended CMP Project Cost and Budget Summary

CMP Project	Estimated Project Cost
Asbestos Cement Pipe Replacement	$6,900,000
Galvanized/Steel Pipe Replacement	750,000
Pressure Reducing Valve Vault Improvements	100,000
Reservoir Seismic Assessment and Improvements	390,000
Reservoir Coating Maintenance and Replacement	360,000
Willamette Pump Station Motor Control Center Assessment and Upgrades	120,000
Demolish Abandoned View Drive Site Facilities	75,000
SCADA System Upgrades	150,000
Total	**$8,845,000**

Capital Improvement Program

Based on the analysis of the water system's storage, pumping, transmission, and distribution facilities presented in previous sections, a list of recommended system improvements for each category has been developed for inclusion in the CIP. CIP projects prioritized in the following order:

1. Correct existing deficiencies (health and safety risks)
2. Provide for existing maintenance needs
3. Providing for growth

A discussion of CIP elements is presented below.

Reservoirs

It is recommended that two (2) new reservoirs be constructed in the water service area within the planning horizon. Table ES-7 presents a summary listing of these recommendations and includes project cost estimates for each reservoir as well as timing for a recommended project start.

Table ES-7
Recommended Reservoir Improvement Summary

Project Start (Fiscal Year)	Project Description	Estimated Project Cost
2010	Bolton Reservoir Replacement – 4.0 MG	$8,000,000
2014	Bland Reservoir No. 2 – 0.3 MG	$525,000
	Total	**$8,525,000**

Pump Stations

It is recommended that two (2) pump stations be modified or upgraded. Booster pump station recommendations are based on analysis presented in prior sections. Table ES-8 presents a summary of recommended pump station improvements including project priority and an estimated project start and cost for each recommendation.

Distribution System Improvements

The distribution system analysis found that water line improvements are needed to provide improved hydraulic transmission capacity, increased fire flow capacities and provide for system expansion. The recommended distribution system improvements are grouped in the categories based on the City's current SDC allocation methodology. A tabulated summary of recommended distribution system water line improvements for each pressure zone is presented in Table 8-5 in Section 8. Each improvement is identified by category and includes existing diameter and pipe material, proposed replacement or new diameter, linear feet of main and SDC allocation.

Table ES-8
Recommended Pump Station Improvement Summary

Project Start (Fiscal Year)	Project Description	Estimated Project Cost
2011	Emergency Intertie Pump Station Expansion	$ 75,000
2016	Bland Intertie Supply to Rosemont	$ 1,250,000
	Total	**$1,325,000**

CMP and CIP Summary

A summary of the recommended improvements is tabulated and presented in Section 8 as Table 8-6 that provides prioritized project sequencing by illustrating annual project needs for each facility or improvement category in the next eight (8) years. Those improvements recommended for construction beyond fiscal year (FY) 2017 and within the 20-year planning horizon are identified as medium term projects and those beyond the 20-year planning horizon are identified as long-term improvements. It is recommended that the City's CMP be funded at approximately $550,000 per year for the first five (5) years and then approximately $410,000 per year for the next 15 years. It is recommended that the City's total 20-year CIP and CMP funding need be established at approximately $1,570,000 annually for storage, pumping and distribution system piping improvements over the 20-year planning horizon.

Plate 1 in Appendix A illustrates the City's water system and identifies proposed CIP and CMP projects discussed herein. Individual project data sheets, contained in Appendix E, include further detail about each CIP project.

Funding Sources and Water System CIP and CMP Funding

The City may fund the water capital maintenance and improvement programs from a variety of sources. In general, these sources can be summarized as: 1) governmental grant and loan programs; 2) publicly issued debt; and 3) cash resources and revenues.

It is recommended that the City complete a detailed water rate and SDC analysis with the completion of this WSMP to determine specific funding needs and potential funding sources associated with the adopted CIP and CMP. It is anticipated that changes in rates and SDC's will be required to keep pace with inflation and fund the proposed improvements through build-out of the system. It is recommended that these studies also provide guidance to the City on the best use of the funding options described above.

Study Recommendations

It is recommended that the City of West Linn take the following actions:

1. Formally adopt this study as the City of West Linn's Water System Master Plan.

2. Adopt the prioritized recommended system improvements described in Section 8 and specifically listed in Tables 8-5 and 8-6 as the CMP and the CIP for the City's water service area.

3. Immediately proceed with supply system reliability improvements referred to as Approach C, which improves the emergency supply capacity and reliability of the Lake Oswego Emergency Supply Connection.

4. Proceed with the detailed water rate and SDC analysis recommended above and follow the recommendations generated through these processes.

5. Review and update this plan within seven (7) to 10 years or sooner, to accommodate changes or new conditions.

Summary

The water system master planning work completed as part of this study provided an inventory of the City's existing water supply and distribution system, developed and presented criteria for the system analysis and developed recommendations from these findings to correct existing deficiencies and to provide for system expansion needs. A summary of all recommended improvements is presented in Table 8-6. The table provides prioritized project sequencing by illustrating FY project needs for each facility or improvement category. It is recommended that the City's CIP and CMP be funded at approximately $1,570,000 annually over the 20-year planning horizon for recommended storage, pumping and distribution system piping improvements.

SECTION 1

SECTION 1
INTRODUCTION

Authorization

On February 27, 2007, the consulting engineering firm of Murray, Smith & Associates, Inc. (MSA) was authorized by the City of West Linn (City) to prepare this Water System Master Plan (WSMP).

Purpose

The purpose of this WSMP is to provide an assessment of the City's water distribution system, to identify current system deficiencies, determine future water supply requirements and recommend improvements that correct existing system deficiencies and provide for future system needs.

The Water System Plan from 1982 and Plan update from 1987 performed by MSA and the 1999 Water Master Plan performed by Montgomery Watson were reviewed in the preparation of this system evaluation, as well as the most recent plan update completed by City staff in 2004. In addition, the 2004 South Fork Water Board (SFWB) Master Plan and Water Management and Conservation Plan were also reviewed. City staff provided water system documentation, including geographical information system (GIS) data and the existing water system hydraulic model. A site visit to the major water system facilities described herein was completed on April 23, 2007 with the City's Water Operations Supervisor.

Compliance

This plan complies with water system master planning requirements established under Oregon Administrative Rules (OAR) for Public Water Systems, Chapter 333, Division 61.

Scope of Work

The scope of work for this study includes the following tasks:

- ***Summarize Existing Conditions*** – Prepare an inventory of existing water system facilities including supply sources, transmission and distribution piping, storage reservoirs and pumping station. Document existing pressure zone configuration.
- ***Evaluate and Establish Water Storage Requirements*** – Determine baseline storage capacity needs, update fire flow requirements, develop system reliability criteria and derive water demand projections from population forecasts and current usage data.

- ***Determine Future Water Needs*** **–** Define water service planning area and planning horizon, develop population forecasts and identify per capita water demand characteristics based on historical production data.
- ***Evaluate Existing Facilities and Operations*** **–** Assess existing operation and maintenance programs, identify operating efficiency opportunities and system deficiencies and recommend system reliability improvements.
- ***Perform Hydraulic Modeling and Identify Capital Improvement Projects*** – A hydraulic model will be developed and used to perform a detailed analysis of the City's transmission and distribution system piping, storage capacity and pressure zone limits under a variety of demand and fire flow conditions. Provide recommendations for Capital Improvement Projects (CIP).
- ***Perform Supply Evaluation*** – Document the City's existing water supply from the South Fork Water Board (SFWB) and associated water rights. Evaluate existing supply capacity and reliability. Assess the potential for aquifer storage and recovery (ASR) near the Kenthorpe Well.
- ***Develop a Capital Improvements Plan and Capital Maintenance Plan*** **–** Develop and present the CIP and Capital Maintenance Plan (CMP), which include estimated project costs for recommended water system infrastructure and maintenance improvements. Recommend project scheduling and sequencing.
- ***Prepare Cost Allocations and Financing Options*** **–** Included as part of the CIP and CMP work will be characterization of each project with respect to allocating benefit between existing and future customers. Identify opportunities for outside funding sources based on the nature of the projects.
- ***Prepare Water System Master Plan Document*** **–** Prepare a water system master plan that documents and describes the planning and analysis work including mapping, recommended improvements and a CIP/CMP.

SECTION 2

SECTION 2
EXISTING WATER SYSTEM

General

The purpose of this section is to document the facilities inventory and describe the City of West Linn's (City) existing water system. Included are brief discussions of supply facilities, storage reservoirs, pumping facilities and distribution system piping.

Background and Study Area

The City's existing water service area includes all areas within the current City limits. The City provides potable water to approximately 24,615 people through 8,600 residential, commercial and industrial service connections. The study area of this planning effort is the entire area within the City's urban growth boundary (UGB) as illustrated in Figure 2-1.

Currently, the City's primary water supply is from the South Fork Water Board (SFWB) water treatment plant (WTP) located in Oregon City. The City also has an emergency supply connection to the City of Lake Oswego's WTP located at the north end of the City. The City's water distribution system consists of six (6) service zones supplied by six (6) storage facilities and five (5) pumping stations. Each of the service zones is supplied by gravity from a storage facility.

Plate 1 of Appendix A illustrates the City's water service area limits, pressure zone boundaries and major water system facilities.

Supply Facilities

South Fork Water Board Supply

The SFWB was established under Oregon Revised Statutes (ORS) 190 by agreement between the cities of West Linn and Oregon City for the purposes of supplying water to the two (2) cities. The SFWB owns and operates water supply facilities consisting of a river intake on the Clackamas River, which includes a raw water pumping station, a water treatment plant located in the Park Place area of Oregon City, finished water pumping station, and raw and finished water transmission pipelines.

Water Rights Summary

The SFWB holds four (4) water rights in the Clackamas River basin. 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, and all pre-date the 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

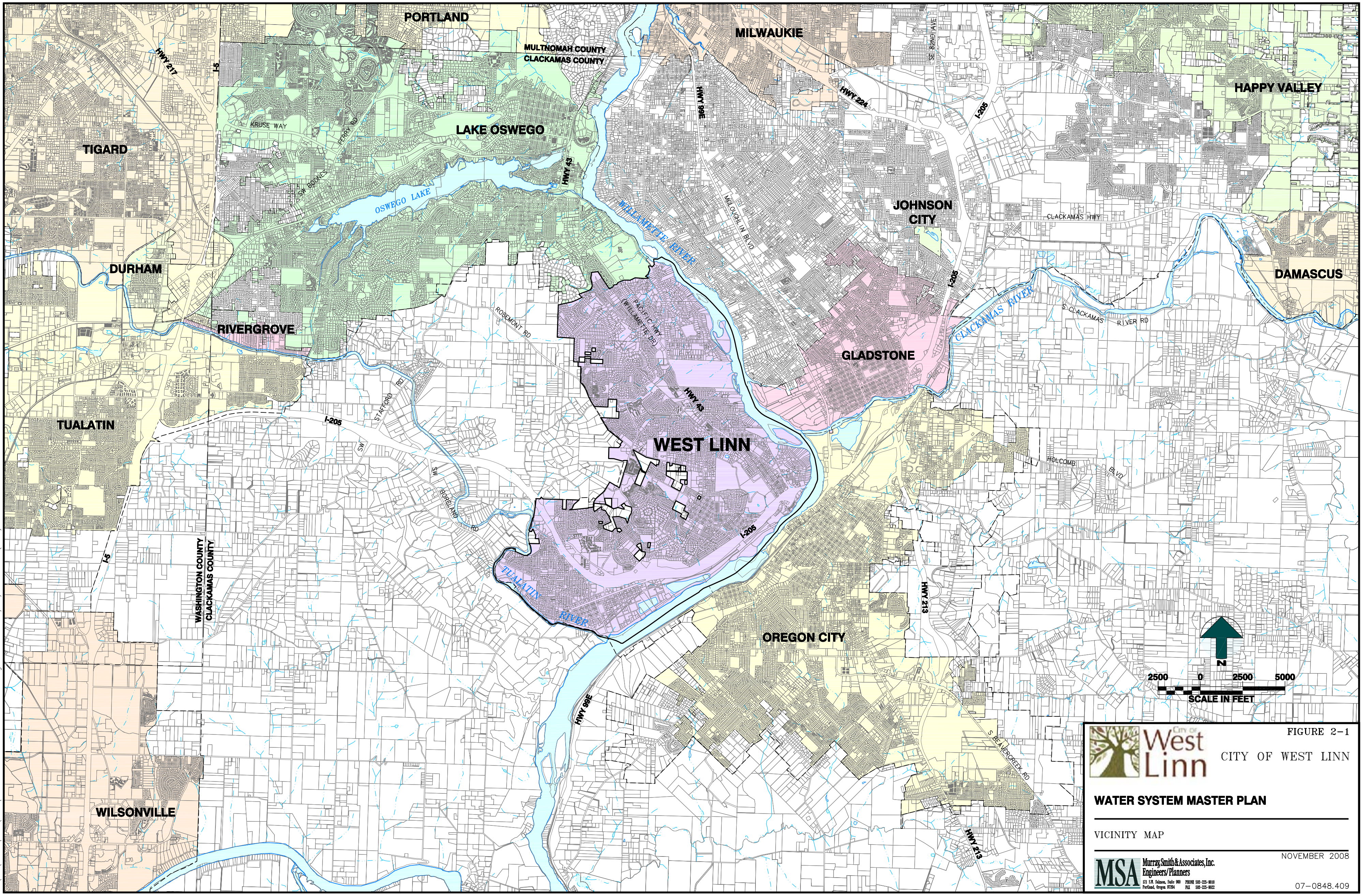


FIGURE 2-1

City of West Linn

CITY OF WEST LINN

WATER SYSTEM MASTER PLAN

VICINITY MAP

NOVEMBER 2008

MSA Murray, Smith & Associates, Inc. Engineers/Planners
121 S.W. Salmon, Suite 900, Portland, Oregon 97204 PHONE 503-225-9010 FAX 503-225-9022

07-0848.409

G:\07\0848\409\CAD\07-0848-409-OR-FIGURE 1.dwg 9-18-08 11/13/08 17:04 (SKW) million gallons per day (mgd). During the summertime when low natural stream flows occur, the permitted withdrawal rates cannot be achieved as there are insufficient streamflows to support the authorized withdrawal amounts. Previous studies have estimated that the actual maximum withdrawal rate for all four (4) rights during periods of low streamflow is 80.0 cfs (51.71 mgd). As of 2004, the SFWB has the right to withdraw at the new intake up to 66.0 cfs or 42.6 mgd. The four (4) water rights held by the SFWB are summarized in Table 2-1.

Table 2-1
Water Rights Summary

Permit No.	Priority Date	Permitted Production Rate		
		Cubic feet per Second (cfs)	Gallons per Minute (gpm)	Million Gallons per Day (mgd)
S2257	7/17/1914	6	2,693	3.88
S3778	1/16/1918	20	8,977	12.93
S9982	8/11/1926	30	13,465	19.39
S22581	8/3/1953	60	26,930	38.78
Total		**116**	**52,064**	**74.98**

River Intakes

The SFWB has two (2) raw water intakes located on the Clackamas River. The new intake, constructed in 1996, is located at Clackamas River Mile 1.7. This new intake is designed and constructed to pass a maximum flow of approximately 82 cfs (53 mgd) and is equipped with fish screens to meet current federal and state regulations.

The old intake, which is inoperable, is located approximately 500 feet upstream of the new intake and is no longer maintained or in service. As a condition of approval of the construction of the new intake, the City of Oregon City, Oregon Division of State Lands (DSL) and the United States Army Corps of Engineers (USACE) require the SFWB to remove the old river intake and raw water pump station. The 2004 South Fork Water Board Water System Master Plan includes a capital project to complete the removal.

Raw Water Pump Station

The raw water pump station is located in the same structure as the river intake. The pump station contains five (5) vertical turbine pumps. The current firm capacity, or capacity with the largest pump out of service, is approximately 30 mgd. The planned ultimate capacity of the raw water pump station is approximately 53 mgd.

Raw Water Transmission Main

An existing 42-inch diameter steel raw water transmission main extends approximately 600 feet from the raw water pump station and connects to a 27-inch diameter concrete cylinder pipe main, originally constructed in 1954, that extends to the WTP. The capacity of the existing raw water transmission main is approximately 22 mgd.

Water Treatment Plant

The SFWB WTP is located in the Park Place area of Oregon City on Hunter Avenue south of the river intake and raw water pump station. The WTP, constructed in 1958 and upgraded in 1975, 1986 and more recently, has a rated production capacity of approximately 22 mgd.

Finished Water Supply to West Linn

A 30-inch diameter concrete cylinder pipe transmission main transmits water by gravity from the SFWB WTP clearwell to the Division Street Pump Station. The Division Street Pump Station, located near the intersection of Division Street and Penn Lane in Oregon City, pumps water to the City of Oregon City Mountainview Reservoir. The pump station has a firm pumping capacity of approximately 17.6 mgd. Supply to the City is from a connection to the 24-inch diameter pump station discharge main near the station. The connection includes a pressure control station and 16-inch diameter master meter. The City's 24-inch diameter transmission main extends west and crosses the Willamette River on the Interstate 205 (I-205) bridge where it connects to the City's distribution system.

City of Lake Oswego Emergency Supply Connection

In 1984, the City entered into an intergovernmental agreement with the City of Lake Oswego and the SFWB 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 the City was constructed. Activation of the intertie may be accomplished only by the mutual consent of Lake Oswego and SFWB.

In 2001, the intertie was improved with the construction of an intertie pump station with a current nominal capacity of approximately 6 mgd. The below-grade pump station is located near the intersection of Old River Road and Willamette Drive. The pump station contains two (2) 2,200 gpm frame mounted end suction centrifugal pumps with space for a future third pump. The pump station can be used to pump emergency supply from the Lake Oswego distribution system into the Bolton and Robinwood pressure zones through altitude and pressure reducing valves located at the station. The pump station provided water to the City from November 2001 to April 2002 during the upgrade of the City's I-205 transmission main from the SFWB and has subsequently provided supply for short durations.

Pressure Zones

General

The City's existing distribution system is divided into six (6) major service levels, or pressure zones. Pressure zones are usually defined by ground topography and designated by overflow elevations of water storage facilities or outlet settings of pressure reducing facilities serving the zone. A description of each of the City's major pressure zones is presented below and includes a description of the service area, storage facilities and pumping facilities serving the zone.

Bolton Pressure Zone

The Bolton pressure zone serves lower elevation areas of the City on either side of Willamette Drive (Highway 43) south from Cedaroak Drive to the mouth of Tanner Creek, and encompasses approximately 1,250 acres. The Bolton pressure zone and subzones serve customers below an approximate ground elevation of 340 feet above mean sea level (msl). This pressure zone is directly connected to the SFWB transmission main and operates at an approximate hydraulic grade line (HGL) of 490 feet based on the overflow elevation of Oregon City's Mountainview Reservoir which is served by the same transmission main from the Division Street Pump Station. The City's Bolton Reservoir also provides gravity service to this zone although the overflow elevation of the reservoir, at 440 feet, is typically below the hydraulic grade of the SFWB supply.

Horton Pressure Zone

The Horton pressure zone serves higher elevation areas of the City on the uphill side of I-205 and Willamette Drive, and encompasses approximately 1,000 acres. The Horton pressure zone and subzones serve customers at ground elevations between 340 and 620 feet above msl. This pressure zone is served from the Horton Reservoir and operates at a hydraulic grade of approximately 731 feet.

Rosemont Pressure Zone

The Rosemont pressure zone serves the highest elevation areas in the City west of the Horton pressure zone, encompassing approximately 950 acres. The Rosemont pressure zone and subzones serve customers at ground elevations between 220 feet and 750 feet above msl. This pressure zone is served by the Rosemont Reservoir and operates at a hydraulic grade of approximately 860 feet.

Robinwood Pressure Zone

The Robinwood pressure zone is located at the northerly end of the City, encompassing approximately 560 acres. The Robinwood pressure zone serves customers at ground elevations below 220 feet above msl. This pressure zone is served by the View Drive Reservoir and operates at a hydraulic grade of approximately 328 feet.

Willamette Pressure Zone

The Willamette pressure zone is located at the southerly end of the City between I-205 and the Tualatin River, encompassing approximately 1,140 acres. The Willamette pressure zone serves customers at ground elevations between 100 feet and 280 feet above msl. This pressure zone is served by the Willamette Reservoir and operates at a hydraulic grade of approximately 351 feet.

Bland Pressure Zone

The Bland pressure zone is located on the northerly side of I-205 between the Horton and Willamette pressure zones, and encompasses approximately 350 acres. The Bland pressure zone and its subzone serve customers at ground elevations between 280 feet and 475 feet above msl. This pressure zone is served by the Bland Reservoir and operates at a hydraulic grade of approximately 585 feet. In 2003, the Bland pressure zone was connected to the Horton pressure zone with a manually operated intertie to provide supplemental supply to the Bland pressure zone during peak demand periods. The intertie can supply approximately 100,000 gallons per day (gpd) to the Bland pressure zone.

Storage Reservoirs

General

The City's water system has a total storage capacity of 5.5 mg distributed across six (6) storage reservoirs. Table 2-2 presents a summary of the City's existing storage reservoirs, including capacities, overflow elevations, and pressure zone served. Also presented below is a brief discussion of the features of each reservoir.

Bolton Reservoir

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. An interior liner was installed in 1989. 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 diameter steel inlet/outlet pipe. As discussed above, the Bolton Reservoir provides 2.0 mg of gravity storage for the Bolton pressure zone, but the reservoir water surface is normally below the hydraulic grade line of the transmission line from the SFWB. The reservoir also provides suction supply to the Bolton Pump Station.

Table 2-2
Reservoir Summary

Reservoir Name	General Location	Usable Capacity (mg)	Overflow Elevation (ft)	Pressure Zone Served
Bolton	Skyline Drive	2.0	440	Bolton
Horton	Horton Road & Santa Anita Drive	1.5	731	Horton
Rosemont	Suncrest Drive	0.4	860	Rosemont
Bland Circle	Bland Circle	0.5	585	Bland
Willamette	Salamo Road	0.6	351	Willamette
View Drive	View Drive	0.5	328	Robinwood

Horton Reservoir

The Horton Reservoir is located at the intersection of Horton Road and Santa Anita Drive. It is a 1.5 mg ground level welded steel reservoir. The reservoir is filled by the Bolton Pump Station and supplies suction supply to the Horton Pump Station in addition to providing gravity supply to the Horton pressure zone. The inlet pipe is 14-inch diameter and extends from the distribution system to the reservoir. A 14-inch diameter outlet/suction pipe extends from the wall of the reservoir to the adjacent Horton Pump Station.

Rosemont Reservoir

The Rosemont Reservoir is a 0.4 mg elevated welded steel, spheroid tower located on Suncrest Drive. The reservoir is filled from the Horton and View Drive Pump Stations. It supplies water to the Rosemont pressure zone service area. Piping for the elevated reservoir includes a single 18-inch diameter ductile iron pipe from Suncrest Drive, a steel inlet/outlet, and an overflow pipe inside the reservoir.

Bland Reservoir

The Bland Reservoir is a 0.5 mg ground level welded steel reservoir located on Bland Circle and serves the Bland pressure zone. It is supplied by the Willamette Pump Station. A 10-inch diameter common inlet/outlet pipe serves the reservoir.

Willamette Reservoir

The Willamette Reservoir is a 0.6 mg ground level welded steel reservoir located on Salamo Road. Flow to the reservoir is through a transmission main along Willamette Falls Drive from the Bolton pressure zone. The reservoir provides gravity supply to the Willamette pressure zone and suction supply to the Willamette Pump Station. A 16-inch diameter pipe extending out of the south side of the reservoir serves as the main suction for the pump station. A 14-inch by 10-inch diameter cross has also been cut into the 10-inch diameter inlet/outlet pipe to provide suction for the pump station if the reservoir is taken out of service. A new control/altitude valve and meter vault were recently constructed on Willamette Falls Drive to control flow from the Bolton pressure zone into the Willamette pressure zone and Willamette Reservoir.

View Drive Reservoir

The View Drive Reservoir is a 0.5 mg ground level welded steel reservoir located on View Drive in the Robinwood neighborhood. The View Drive Reservoir provides gravity supply to the Robinwood pressure zone and suction supply to the View Drive Pump Station. A 10-inch diameter common inlet/outlet pipe extends to a valve vault near the reservoir where it tees into two (2) 10-inch lines, one (1) with an altitude valve that closes supply to the reservoir when it is full and the other with a check valve which allows flow from the reservoir when the system pressure drops. Flow to the reservoir is controlled by an adjacent pressure reducing valve (PRV) and altitude valve located near the Lake Oswego Intertie Pump Station.

Pumping Facilities

General

The City's water distribution system includes four booster pump stations. A fifth pump station is located at the City's emergency supply connection with Lake Oswego. Table 2-3 summarizes the pump configuration, total capacity and firm capacity of each station. The pump station capacities presented in Table 2-3 represent the nominal capacities of the pumps. Also presented below is a brief description of the existing features of each pump station.

Table 2-3
Existing Pump Station Summary

Pump Station	Pump Configuration (gpm)	Total Installed Capacity (gpm)	Nominal Firm Capacity (gpm)
Bolton	3 @ 1,500	4,500	3,000
Horton	2 @ 1,300; 2 @ 900	4,400	3,100
Willamette	3 @ 500	1,500	1,000
View Drive	3 @ 600	1,800	1,200
Lake Oswego Emergency Intertie	2 @ 2,200	4,400	2,200

Bolton Pump Station

The Bolton Pump Station is located adjacent to the Bolton Reservoir and was constructed in 1999 replacing the old Bolton Pump Station which was constructed in the early 1970s. The facility contains three (3) 1,500 gpm can-type vertical turbine pumps with space for a fourth future pump. The station pumps water from the Bolton Reservoir to the Horton Reservoir through a 14-inch diameter transmission main. The pumps are controlled by the Supervisory Control and Data Acquisition (SCADA) system with control setpoints based on the water level in the Horton Reservoir. The pump station also includes an emergency, standby diesel generator in case of a power failure.

Horton Pump Station

The Horton Pump Station is a concrete and wood frame structure located adjacent to the Horton Reservoir. The Horton Pump Station contains four (4) frame mounted end suction centrifugal pumps. The station pumps water from the Horton Reservoir to the Rosemont Reservoir through Rosemont pressure zone distribution piping. The pumps are controlled by the SCADA system with control setpoints based on the water level in the Rosemont Reservoir. The pump station also includes an emergency, standby diesel generator in case of a power failure.

Willamette Pump Station

The Willamette Pump Station is a concrete structure constructed in 1994 and located adjacent to the Willamette Reservoir. The station contains three (3) 500 gpm can-type vertical turbine pumps. The station pumps water from the Willamette Reservoir to the Bland Reservoir. The pumps are controlled by the SCADA system with control setpoints based on the water level in the Bland Reservoir. The Willamette Reservoir provides suction supply to the pump station through a 16-inch diameter pipe. The pump station also includes an emergency, standby diesel generator in case of a power failure.

View Drive Pump Station

The View Drive Pump Station is a concrete structure located at the View Drive Reservoir site. The station contains three (3) 600 gpm can-type vertical turbine pumps. The station pumps water from the View Drive Reservoir to the Rosemont Reservoir and supplies two (2) subzones through PRVs connected to the pump station discharge. The pumps are controlled by the SCADA system with setpoints based on the water level in the Rosemont Reservoir. The pump station also includes a manual transfer switch and plug for a portable emergency generator.

Distribution System Piping

The City's water service area distribution system is composed of various pipe types in sizes up to 24-inches in diameter. The total length of piping in the service area is approximately

117 miles. The pipe types include cast iron, ductile iron, polyvinyl chloride (PVC), steel, asbestos cement, copper and galvanized iron. The oldest piping in the system likely dates back to 1915 when the SFWB was first established. Table 2-4 presents a summary of pipe lengths by diameter.

Table 2-4
Existing Pipe Inventory

Diameter (in.)	Linear Feet in System	Miles in System	Percent of Total Pipeline Length
Less than 6	69,036	13.1	11
6	271,437	51.4	44
8	142,059	26.9	23
10	41,364	7.8	7
12	22,243	4.2	4
14	15,557	2.9	2
16	10,544	2.0	2
18	18,790	3.6	3
20	9,161	1.7	1
24	20,070	3.8	3
Total	**620,261**	**117.4**	**100**

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

There are approximately 8,600 water meters throughout the water system. Over 96 percent of these meters are residential, 5/8 x 3/4-inch meters. Most of the remaining meters are 1-inch, 1½-inch, and 2-inch meters that serve multifamily housing, commercial, and public facilities. There are less than 20 meters system-wide that are 3 inches or greater in size.

Based on data from the City's GIS pipeline data base more than 80 percent of the pipe in the City is Ductile or Cast Iron. Approximately 10.3 percent is AC and the remaining 10 percent is polyvinyl chloride (PVC), galvanized steel, steel, copper, polybutylene and unknown material. Table 2-5 presents a summary of pipe material, length and percentage within the distribution system.

Table 2-5
Pipe Material Summary

Pipe Material	Length (feet)	Percent of Total Length
Ductile Iron	379,862	61.2
Cast Iron	127,063	20.5
Asbestos Cement	63,932	10.3
Polyvinyl Chloride	14,630	2.4
Galvanized Steel	9,752	1.6
Steel	10,363	1.7
Copper	3,633	0.6
Polybutylene	815	0.1
Unknown	10,211	1.6
	620,261	**100**

Summary

Section 2 presents a summary of the City's existing water system, including the transmission and supply system, storage and pumping facilities, pressure zones and distribution system piping.

The City provides potable water to approximately 24,615 people through over 8,600 residential, commercial and industrial service connections. The City's primary water supply is from the SFWB WTP located in Oregon City. The SFWB was created by the cities of West Linn and Oregon City for the purposes of supplying water to the two (2) cities. The City also has an emergency supply connection to the City of Lake Oswego's WTP located at the north end of the City.

The City's water distribution system consists of six (6) service or pressure zones supplied by six (6) storage facilities and five (5) pumping stations. These pressure zones are: Bland, Bolton, Horton, Robinwood, Rosemont, Willamette and View Drive. Each of the service zones is supplied by gravity from a storage facility.

SECTION 3

SECTION 3
POPULATION PROJECTIONS AND WATER REQUIREMENTS

General

This section presents population projections and estimated water demands for the City of West Linn (City) service area. Included in this section are a description of the water service area limits and a summary of current land use and zoning designations within the service area. Population and water demand forecasts are developed from regional and City planning data, current land use designations and historical water demand records.

Service Area

The City's water service area includes all areas within the current City limits as well as a limited number of customers outside the urban growth boundary (UGB) that receive extra-territorial water service from the City. For the purpose of this analysis, this small number of services is included as if they were actually within the UGB. Figure 2-1 illustrates the location of the City's service area relative to adjacent water provider service areas.

Planning Period

The planning period for this master plan is approximately 20 years, through the year 2030. Certain planning and facility sizing efforts will use estimated water demands at saturation development. Saturation development, or build out, occurs when all land within the UGB which City staff has determined to be economically and physically developable, has been fully developed according to current land use and zoning designations. The planning period for transmission and distribution facilities is to saturation development of the City's water system planning area which is concurrent with the UGB. This assumption allows a determination of the ultimate size of facilities. Typically, if substantial improvements are required beyond the planning period to accommodate water demands at saturation development, staging is often recommended for certain facilities where incremental expansion is feasible and practical. Unless otherwise noted, recommended improvements identified in this plan are sized for saturation development within the water system planning area.

Land Use

Land use and zoning classifications for the City's water system planning area are established under the City's Comprehensive Plan. Table 3-1 summarizes zoning classifications and areas for each classification within the City's water system planning area, the current UGB.

Table 3-1
Land Use Summary

Zone	Zoning Description	Area within City of West Linn UGB (acres)
LDR	Low Density Residential	3,621.2
MDR	Medium Density Residential	358.5
MHDR	Medium-High Density Residential	195.2
MU	Mixed Use Transition	17.8
NC	Neighborhood Commercial	1.7
GC	General Commercial	126.6
OBC	Office-Business Center	53.5
CI	Campus Industrial	7.7
GI	General Industrial	178.7
FU-10	Future Urban	5.4
	No Zoning (River and Freeway ROW)	543.6
FU-10	Area Outside City Limits (within UGB)	140.7
	Total	**5,250.6**

Historical Population

The Portland State University Population Research Center (PRC) provides current and historical population estimates for the State of Oregon. The PRC data presents estimates of the population within the City limits on July 1st each year. These estimates are based on U.S. Census Bureau counts developed and published every 10 years. Annual estimates are refined by the PRC through analysis of supplemental demographical data.

The City currently provides potable water to approximately 24,615 people. The number of persons per household (PPH) is approximately 2.77 for single family residential (SFR) which, for the purposes of this analysis, is equivalent to a low density residential (LDR) zoning designation. The number of PPH is approximately 1.54 for multi-family residential (MFR) which, for the purposes of this analysis, includes both medium density residential (MDR) and medium-high density residential (MHDR) zoning designations. This results in approximately 10,009 existing dwelling units within the City. The larger number of dwelling units relative to the number of service connections (there are approximately 8,600 service connections) reflects single metered connections to multi-family dwelling units within the City's water service area. Table 3-2 summarizes historical population and water usage within the City's water service area.

Table 3-2
Historical Population and Water Demand Summary

Year	Water Service Area Population[1]	Historical Water Demand				
		Average Day Demand (ADD)		Maximum Day Demand (MDD)		MDD:ADD
		mgd	gpcd	mgd	gpcd	
2002	23,430	3.5	149	6.8	290	1.9
2003	23,820	3.3	139	7.7	323	2.3
2004	23,970	3.3	138	7.3	305	2.2
2005	24,075	3.0	125	6.6	274	2.2
2006	24,615	3.1	126	7.0	284	2.3

Note: 1. Historical and current population estimates are certified estimates from July 1st of each year as developed by the Portland State University Population Research Center.

Historical Water Demands

The term "water demand" refers to all of the water requirements of the system including domestic, commercial, municipal, institutional and industrial as well as non-revenue water consumption. 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).

Historical water demand estimates were extracted from water production data provided by the City. Table 3-2 summarizes these estimates for the years 2002 through 2006. The water demand data presented in Table 3-2 is an estimate of the system-wide water usage (residential, commercial, industrial and institutional) and has been applied to the water service area population to determine a per capita water usage for the entire system.

Based on the most recent historical water usage patterns and historical population, the water service area's average daily demand is approximately 3.1 mgd with an average daily per capita consumption ranging from 125 to 149 gpcd since 2002. Recent maximum daily water demand usage has ranged from 1.9 times to 2.3 times the average daily demand. This is equivalent to a maximum per capita usage between 274 and 323 gpcd.

Population Forecasts

Table 3-3 presents a population forecast summary in five-year increments through 2030. Anticipated population growth rates within the UGB were derived from actual growth rates between 2002 and 2006. An Average Annual Growth Rate (AAGR) of 0.8 percent is assumed for population estimates through 2030. The City's projected population within the water service planning area (UGB) at saturation development was determined based on a detailed review of data developed by the City's Planning Department. A copy of the City planning document "Residential Development Unit Tracking Map and Summary", (Residential Unit Tracking Analysis) March 5, 2007, is included in Appendix B. A discussion of the methodology used to develop the ultimate population projection for the service area is discussed below.

Table 3-3
Population Forecast Summary

Year	Population
2008	25,000
2010	25,400
2015	26,450
2020	27,500
2025	28,600
2030	29,800
Saturation Development	30,931

As shown in Table 3-3, it is estimated that the existing water service planning area will approach saturation development, or build-out conditions shortly after 2030. For the purposes of this analysis, it is assumed that the City water service area will reach saturation development at the end of the 20-year planning horizon.

Population projections for each pressure zone at saturation development were generated by analyzing the number of existing and potential residential dwelling units in each pressure zone as presented in the Residential Unit Tracking Analysis. The total number of potential dwelling units in each pressure zone was then divided into two (2) categories: Low Density and High Density according to the percentage of low and high density existing dwelling units. Low Density dwelling units are those located within an area with an LDR comprehensive plan land use designation. Low Density dwelling units are assumed to have a population of 2.77 people per unit. High Density dwelling units are those located within an area with an MDR or MHDR comprehensive plan land use designation. High Density dwelling units are assumed to have a population of 1.54 people per unit. Population projections at saturation development are summarized by pressure zone in Table 3-4.

Due to varying distributions of low and high density housing units, the individual pressure zone population projections summarized in Table 3-4 may differ from overall population projections for the City. Within this master plan, system-wide facility recommendations will be based on a build-out population of 30,931 people as detailed in the City's Residential Unit Tracking Analysis and shown in Table 3-3.

For water system planning purposes, it is prudent to use the saturation development population forecasting methodology. This methodology provides for the most economical development of water system infrastructure improvements by assuming full occupancy at saturation development conditions and thereby determining the ultimate size of facilities. This allows development to progress without incurring additional costs for facility duplication.

Table 3-4
Population Projection at Saturation Development

Pressure Zone	Existing Population[1]	Total Potential Dwelling Units			Population at Saturation Development
		Low Density	High Density	Accessory[2]	
Bland	1,906	682	173	43	2,198
Bolton	4,270	1,395	664	72	4,959
Horton	6,192	2,625	291	124	7,843
Robinwood	1,915	850	51	42	2,476
Rosemont	5,435	1,991	984	100	7,130
Willamette	4,898	1,640	932	86	6,064
				Total	**30,670**

Notes:
1. Existing population derived from Residential Unit Tracking Analysis current dwelling unit break-down. Existing population also includes all dwelling units outside the City but within the UGB; assume that these units are low density (PPH= 2.77).
2. Additional 5 percent of LDR; PPH = 1.0

Water Demand Projections

Estimates of future water demands were developed from the City's present per capita water production data and population forecasts presented herein. For the purposes of this plan, estimated average daily water usage is assumed to be approximately 140 gpcd. Current maximum daily per capita usage is estimated at approximately 287 gpcd. Given the fluctuation in per capita water demand under MDD conditions, a maximum daily per capita usage of 325 gpcd will be used for water demand forecasts.

Estimated average and maximum day water demands are developed by multiplying the approximate per capita water usage by the anticipated population for that year. To provide an estimate of peak hourly usage, a factor of 2.63 was applied to the estimated maximum day demands in Table 3-5. This factor is based on actual historical water usage data obtained from the City for certain pressure zones and typical peak hour usage data for the region. The methodology used to develop estimated peak hour demand projections is discussed further below. Population projections and anticipated water demand, in five-year increments through 2030 and for saturation development, are summarized in Table 3-5.

Table 3-5
Population Forecasts and
Estimated Water Demand Summary

Year	Water Demand (mgd)		
	Average Day Demand	Maximum Day Demand	Peak Hour Demand
2008	3.5	8.1	21.3
2010	3.6	8.3	21.8
2015	3.7	8.6	22.6
2020	3.9	8.9	23.4
2025	4.0	9.3	24.5
2030	4.2	9.7	25.5
Saturation Development	4.3	10.0	26.3

Table 3-6
Saturation Development Water Demand Summary
By Pressure Zone

Pressure Zone	Water Demand (mgd)		
	Average Day Demand	Maximum Day Demand	Peak Hour Demand
Bland	0.3	0.7	1.4
Bolton	0.7	1.6	2.4
Horton	1.1	2.6	5.6
Robinwood	0.3	0.8	1.2
Rosemont	1.0	2.3	12.6
Willamette	0.9	2.0	3.1
Total	**4.3**	**10.0**	**26.3**

To provide an indication of the anticipated ultimate water demand within each pressure zone, water demand projections identified in Table 3-5 have been further developed for individual pressure zones and summarized in Table 3-6. To provide an estimate of peak hourly usage at saturation development for the Bolton and Robinwood pressure zones, a factor of 1.5 was applied to the estimated maximum day demand based on data from other communities with similar land use and water demand patterns because recent water demand data was not available specifically for these zones. For the Bland, Horton, Rosemont and Willamette pressure zones, the estimated peak hourly usage at saturation development was determined by multiplying the maximum day demand of that zone by the ratio of the recent peak hourly demand to maximum day demand, developed through analysis of recent water use data obtained from the City.

Summary

This section presents an analysis of anticipated future water demand based upon existing and projected populations within the current water service area and the City's water planning area which is concurrent with the UGB. Current zoning designations identified in the City of West Linn's Comprehensive Plan and population growth rates synthesized from the City's Residential Unit Tracking Analysis and data from the PRC anticipate an ultimate population within the UGB of approximately 30,931 people.

The City's current maximum daily water demand is approximately 7.0 mgd. Based on the population projections and historical water production data, an ultimate maximum day water demand of approximately 10.0 mgd is anticipated within the City's current UGB. The water requirements presented in this section and the planning criteria presented in Sections 4, 5 and 6 will be used to evaluate system performance and develop a comprehensive capital improvement and maintenance programs presented in Section 8.

SECTION 4

SECTION 4
EXISTING SYSTEM EVALUATION

General

The City of West Linn's (City) water system is operated and maintained by the Public Works Department. Public Works performs all system operation and maintenance for the distribution system from the City's 24-inch diameter supply main in Oregon City, downstream of the Division Street Pump Station and the South Fork Water Board (SFWB) Water Treatment Plant (WTP). This section focuses on the City's major distribution system facilities, including pump stations and reservoirs and includes a general assessment of the performance of the distribution system piping.

Water system operation and maintenance (O&M) work conducted by the Public Works Department includes line repairs and maintenance; hydrant service and maintenance; meter reading, maintenance and replacement; distribution system flushing; valve maintenance and exercising, as well as some line replacements and upgrades. The Public Works Department also performs O&M for reservoirs, booster pump stations and the Lake Oswego emergency intertie, performs distribution system water quality sampling, and oversees the City's cross-connection control and backflow prevention programs. The Public Works Department also provides emergency response for all components of the water system.

Current O&M Program Evaluation

The Public Works Department is currently working to prepare a "Water Systems Operations and Maintenance Guide" to document system facilities and current O&M programs. As is typical of water systems the size of the City, much of this information is not currently documented in an accessible manner but is instead held by individual staff members. It is anticipated that completion of the O&M Guide for the water system will ensure that operations and maintenance procedures are thoroughly documented and understood by all staff and will allow for ongoing efficient operation of the system as the City experiences future work-force transitions. A copy of the preliminary outline for the "Water Systems Operations and Maintenance Guide" is included in Appendix C.

The City also maintains checklists for each type of critical water system facility and for the telemetry system. These checklists act as a guide for routine inspections and preventative maintenance at reservoirs and booster pump stations.

Currently, reactive water system O&M tasks such as leak repairs and mechanical/electrical equipment repair and replacement are documented and logged. This is an important first step in collecting the necessary data to develop a more thorough accounting of work orders, labor expenditures and to track areas where major system deficiencies exist. A software database should be considered for logging and tracking this information for further development of more systematic O&M programs. The City has developed a comprehensive geographic information system (GIS) distribution system inventory. Once a database of O&M activity is developed, linking this database to the GIS inventory would provide the City with a valuable tool for analyzing, planning and prioritizing O&M decisions.

O&M Program Development and Documentation

A summary of proposed steps in development of a comprehensive O&M program are listed below and can serve as the basis for development of a more comprehensive system that can guide staffing, labor allocation and budgeting decisions as well as provide valuable input into the City's water system Capital Maintenance Plan (CMP). A check mark is located next to the tasks which the City has already completed.

Tasks		Completed
1.	Establish an inventory of system components including: piping, valves, hydrants, pumps, reservoirs and other facilities.	☑
2.	Determine the time required to perform the various maintenance and repair tasks required based on staff input and industry standards.	☐
3.	Identify equipment needed by staff to complete work and estimate the cost per hour for each piece of equipment. A replacement schedule for the equipment should also be developed for budgeting purposes.	☐
4.	Develop a target maintenance schedule for each system component/program.	☐
5.	Determine the total amount of time/budget required to complete O&M tasks/programs based on this information.	☐
6.	Assess overall Public Works Department staffing and budgeting needs to meet water system O&M goals. Prioritize programs and goals within current and future budget constraints.	☐

Recommended O&M Program Element Summary

Based on typical industry standards and a review of local, regional and national practices for similar sized water systems, a summary of specific preventative/proactive O&M program elements has been developed for consideration by the City. Some of these programs have already been implemented by the City in some form and this is identified in the list below, recognizing that the City invests significant staff time and financial resources to ongoing O&M of the water system.

O&M Program		Current Status and Recommendations	Completed
1.	Pipe Maintenance and Replacement	• City is currently replacing aging and undersized piping on an emergency basis due to funding. • Develop a systematic program, a CMP, coordinated with the CIP to identify and prioritize main replacements as funds allow.	☑ ☐
2.	Water Meter Maintenance and Replacement	• Establish a schedule for testing large meters based on water loss and consider the cost/benefit ratio of such a program. • Document meter location, type, size and age in support of developing a schedule and budget for a meter replacement. • Develop a fire line detector monitoring program.	☐ ☑ ☐
3.	Hydrant Maintenance Program	• The City currently exercises all hydrants on a five (5) year cycle.	☑
4.	Valve Maintenance and Exercising Program	• Develop a schedule for isolation valve exercising. Exercise every valve at least once every five (5) years. Maintenance to be completed as needed based on valve exercising.	☐
5.	Leak Detection Program	• City currently addresses leak detection and repair needs reactively as evidence of leaks is manifested. • Prepare annual water audits to track water loss and determine the cost/benefit ratio of pursuing a systematic leak detection and repair program.	☑ ☐
6.	Reservoir Maintenance Program	• Continue current program of routinely cleaning and inspecting tanks (divers); should be completed every five (5) years, and maintaining coating and cathodic protection systems as needed. Typical cycle for coating maintenance is 20 to 30 years, depending on exposure.	☑
7.	Booster Pump Maintenance Program	• Continue current pump preventative maintenance program. • Record voltage/amperage data as well as pump speed, output and run time data. Compile into monthly reports for identifying performance changes that could indicate a need for maintenance or replacement.	☑ ☐

The Public Works Department staff is charged with maintaining and replacing system components to allow for continuous and reliable operation of the water system. Staff members are dedicated and capable with the appropriate skills and knowledge required to perform all necessary O&M tasks. Based on the analysis of the current operations, it appears that the Public Works Department has made efficient use of limited resources to adequately maintain the system in a manner that ensures satisfactory delivery of water to all customers.

Evaluation of Existing Facilities

General

The City's water distribution system includes six (6) primary pressure zones and an additional 14 subzones, four (4) booster pump stations, six (6) distribution storage reservoirs, 32 pressure reducing valve stations and over 117 miles of distribution system piping. Figure 4-1 presents a hydraulic profile of the water system illustrating all of the major system components. An analysis of the condition of the City's existing SFWB supply transmission main from the Division Street Pump Station across the Willamette River on the I-205 Bridge will be included in Section 5 which documents the evaluation of the City's supply system.

An evaluation of the condition of each of the major components of the distribution system is presented below.

Distribution System

As summarized in Section 2 the City's existing distribution system contains approximately 12.1 miles of asbestos cement (AC) water mains, comprising approximately 10.3 percent of the City's distribution system piping. Most of this piping was installed in the 1950s and 1960s. AC pipe can generally be expected to have a design, or service life, of approximately 50 years. A number of communities have under taken replacement programs targeting AC pipe which was installed in the 1950s and 1960s. Approximately two-thirds, or 330 miles of the City of Regina, Saskatchewan, Canada's water distribution is older AC piping. Regina completed a study of the Failure Conditions of Asbestos Cement Water Mains in 2003 which evaluated water main break history of the City's AC pipe. The analysis found that from 1994 to 2003 the incidents of AC water line breaks increased exponentially, which correlated with pipe age as a majority of the City's AC pipe, which was installed 40 to 50 years ago. The American Water Works Association Research Foundation is currently funding a comprehensive research project to evaluate the long-term performance of AC water pipe. The objective of this four (4) year project, expected for completion in 2011, is to provide water utilities with a comprehensive guidance document for the management of AC pipe in water distribution systems.

The City's water department has documented increased break repair incidents of AC pipe. The majority of the existing AC pipe is in the Robinwood, Horton and Rosemont service zones. Based on the current understanding of AC pipe service life and performance, as well as the age of the existing pipe in the City's distribution system, the City can anticipate

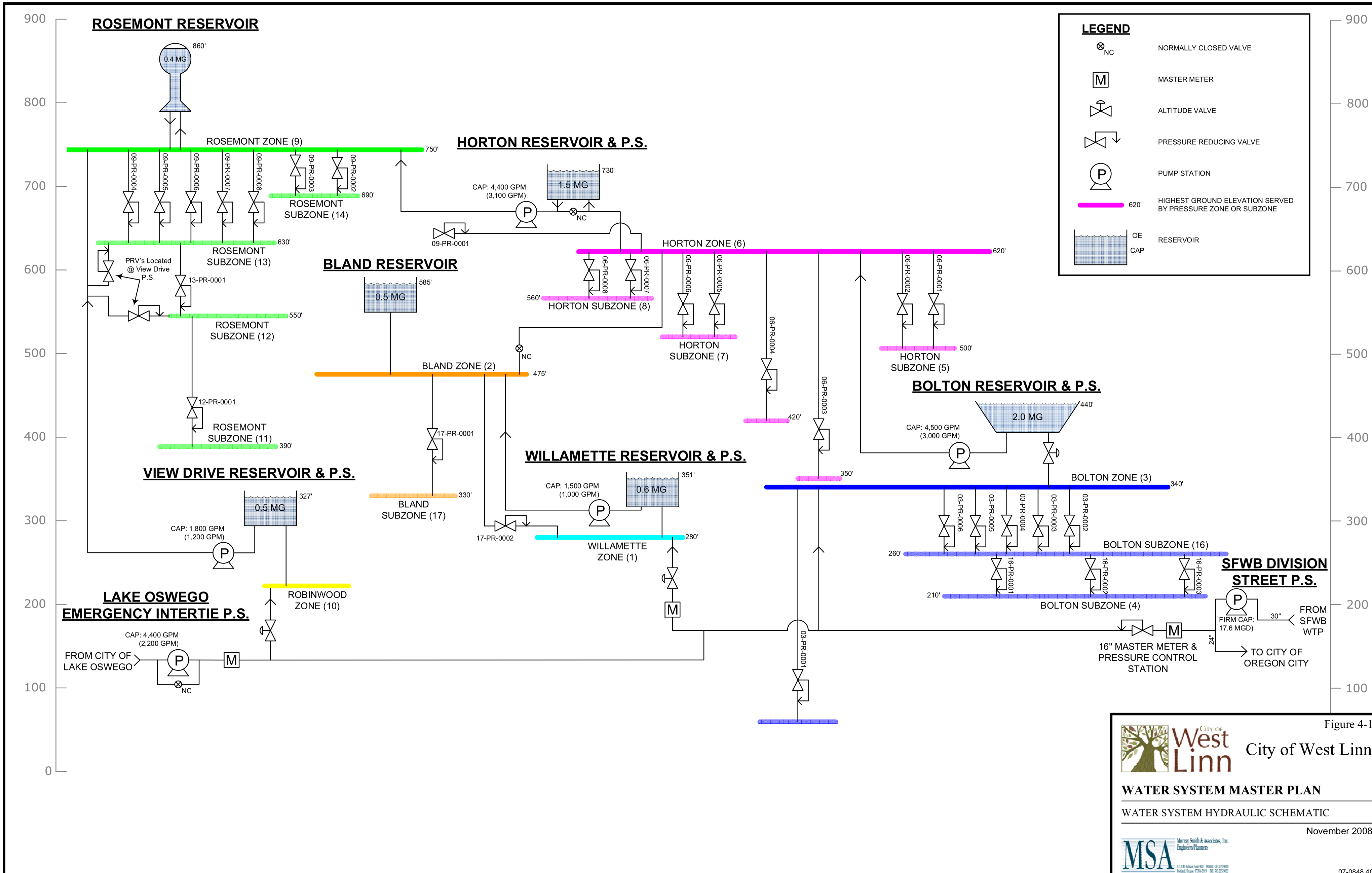


Figure 4-1

City of West Linn

WATER SYSTEM MASTER PLAN

WATER SYSTEM HYDRAULIC SCHEMATIC

November 2008

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

07-0848.409

increasing incidents of AC pipe failures within its distribution system. Recommendations for the systematic replacement of the City's AC piping are presented in Section 8.

Section 8 also contains recommendations for the systematic replacement of the remaining steel and galvanized steel piping, which makes up approximately 3.3 percent of the pipe in the distribution system. Copper and polybutylene piping, which makes up less than 1 percent of the pipe in the distribution system should be replaced as needed or as the opportunity arises. A majority of the distribution system piping is ductile iron, cast iron and PVC and most of this piping is still within its service life. Current water industry literature indicates that the service life of ductile and cast iron may range from 50 years to over 100 years depending on a number of variables. As these pipelines and the existing PVC piping within the City's distribution system begins to develop breakage and repair histories it is recommended that the development of systematic replacement programs be evaluated and implemented.

Storage Reservoirs

General Reservoir Seismic Assessment

The existence and condition of seismic anchorage and restraints varies widely from reservoir to reservoir in the City's system. Through previous evaluation of the water system it was determined that a site-specific evaluation should be completed for each reservoir using the most recent seismic zone criteria. It appears that this analysis and the addition of seismic restraints have not been completed. Budgeting for this assessment and the proposed improvements should be planned. Section 8 will include a recommended budget for completing these assessments.

Bolton Reservoir

The Bolton Reservoir, a concrete slab-on-grade reservoir with 2:1 (horizontal: vertical) side slopes, was constructed in 1913. An interior liner was installed in 1989 and a Hypalon cover was placed over the reservoir in 1995. Previous inspections of the reservoir identified some concrete spalling and some localized cracking that may warrant surface patching. The floating cover for the reservoir appears to be reaching the end of its service life. Based on inspection and recent repairs of one (1) large (18-inches) and four (4) smaller holes/tears in the cover in January 2008, it is beginning to show significant signs of wear, especially at locations where movement occurs, such as around the rain troughs (gutters). Given the findings of this inspection and previous assessments, it is likely that the cover will require more frequent repairs within the next five (5) years.

Approximately 0.5 mg of the total volume of the Bolton Reservoir, which is approximately 2.5 mg, is unusable. Given the functional limitations, condition and age of the reservoir, replacement of the Bolton Reservoir should be considered a high-priority improvement. Further discussion of the storage needs of the water system related to replacement of the Bolton Reservoir is presented in Section 6.

Horton Reservoir

The 1.5 mg ground level welded steel Horton Reservoir, constructed in 1974, is generally in good condition. The exterior of the reservoir was repainted and a new cathodic protection system was installed in 2006. The interior coating of the reservoir is coal tar enamel and should ultimately be considered for replacement when the condition of the coating shows signs of wear.

Rosemont Reservoir

The 0.4 mg Rosemont Reservoir, an elevated welded steel spheroid, constructed in 1991, is the newest reservoir in the City's water system and does not currently have any observed deficiencies. Re-painting of the tank exterior should be planned for sometime in the next 10 years as the original coating system is now approximately 15 years old. This site needs security improvements due to its use by multiple agencies. The City is currently assessing security improvement opportunities at the site.

Bland Reservoir

The 0.5 mg ground level welded steel Bland Reservoir, constructed in 1980, appears to be generally in good condition. The reservoir is in need of interior and exterior repainting and the cathodic protection system is aging and in need of refurbishing. These improvements are included in the City's current CMP and should be completed within the next five (5) years. Interior coating is coal tar enamel and should be considered for replacement.

Willamette Reservoir

The 0.6 mg ground level welded steel Willamette Reservoir constructed in 1970, appears to be in good condition. The reservoir interior and exterior were re-painted and a new cathodic protection system for the steel structure was installed within the past five (5) years.

View Drive Reservoir

The 0.5 mg ground level welded steel View Drive Reservoir, constructed in 1970, appears to be in good condition. The exterior coating, applied in 1991, is showing signs of wear due to age and adjacent overhanging tree limbs. Re-painting of the reservoir exterior should be planned for the next 10 years.

Distribution Booster Pump Stations

Bolton Pump Station

The new Bolton Pump Station is a concrete structure with standby power generator completed in 1999 to replace the aging and undersized Bolton Pump Station. There are no apparent deficiencies or issues with the condition of the new Bolton Pump Station.

Abandonment and removal of the old Bolton Pump Station should be coordinated with the ultimate replacement of the Bolton Reservoir. The old pump station is still in use to provide for flushing of the old pump station discharge main which serves a small number of customers downstream of the pump station prior to the first interconnection with the Horton pressure zone distribution mains.

Horton Pump Station

The Horton Pump Station is a concrete structure located adjacent to the Horton Reservoir. Mechanical and electrical upgrades were completed at the station in 2000, including the installation of two (2) new pumps, telemetry system upgrades and an outdoor standby power generator. The station appears to be in good condition.

Willamette Pump Station

The Willamette Pump Station, constructed in 1994, is a concrete structure located adjacent to the Willamette Reservoir. The station was upgraded in 2001 with the addition of a standby generator City staff related that there have been issues with the performance and operation of the existing motor control center (MCC) and automatic transfer switch (ATS) in the station. Further investigation of the potential issues and the need for modification or replacement of this equipment should be completed and is included in Section 8.

View Drive Pump Station

The View Drive Pump Station is a concrete and concrete masonry unit (CMU) structure located adjacent to the View Drive Reservoir. The pump station, completed in 2006, is the newest pump station in the system, providing a second reliable supply to the Rosemont pressure zone. The station appears to be in good condition. An abandoned pump station structure and partially buried concrete reservoir located behind the existing View Drive Pump Station on the View Drive site should be demolished and removed.

Pressure Reducing Valve Stations

Previous evaluations of the water system identified flooding issues with PRV vaults located below a ground elevation of approximately 175 feet. These vaults should be sealed to reduce groundwater infiltration and surface water inflow, and sump pumps installed to effectively remove any water that enters the vault. Section 8 will include a recommended budget for completion of these improvements.

Supervisory Control and Data Acquisition System

The City's existing Supervisory Control and Data Acquisition (SCADA) system consists of several aging components including the Master Telemetry Unit at the Public Works Shop which is approximately 18 years old. Typically, this type of technology based equipment is replaced on a fairly routine cycle and cannot be expected to provide reliable service beyond

10 years. In addition, as components reach the end of their service life, the availability of replacement parts decreases significantly which could potentially result in extended down time. The SCADA system is a critical piece of the City's water system infrastructure providing for automatic operation of pumping facilities to maintain adequate system pressure as well as providing alarm conditions to alert Public Works Department staff of problems in the water system and provide real-time feedback on the performance and operation of the system. Should the telemetry system fail for some reason, an emergency condition would exist requiring full-time observation and staffing of key water system facilities to maintain water service until the system can be brought back on-line.

The City's water system CMP will include recommendations for evaluation and upgrade of the SCADA system to ensure reliable service. A recommended budget level estimate for these upgrades is included in Section 8.

Existing Facility Evaluation Recommendations Summary

Based on the evaluations documented above, several recommended improvements to be included in the City's water system CMP and CIP are listed below:

1. *Reservoir Seismic Assessment and Improvements* – Assess the current seismic risk at four (4) reservoir sites and determine if the current level of seismic restraint is adequate. Develop recommended improvements to meet current seismic code requirements. It is recommended that these assessments will be completed for the Willamette, View Drive, Bland and Horton reservoirs.

2. *Bolton Reservoir Replacement and old Bolton Pump Station Abandonment* – Based on the current and previous evaluations of the Bolton site, it is recommended that the Bolton Reservoir be abandoned and replaced, and that the old Bolton Pump Station be demolished and removed. The required capacity of the proposed Bolton Reservoir replacement will be further discussed in Section 6. Given the age and condition of the reservoir, it is anticipated that this improvement is included as a near-term (less than five (5) years) improvement in the CIP.

3. *Ongoing Reservoir Lining and Coating Maintenance* – Three (3) of the City's reservoirs (Bland, Rosemont and View Drive) will require re-coating within the next 10 to 20 years. A schedule for completing these re-coatings is included in the CMP. Most coatings have a service life of approximately 20 to 30 years so it is anticipated that all of the reservoirs, with the possible exception of the Willamette and Horton Reservoirs which were re-painted in the past five (5) years, will need coating maintenance within the 20-year planning horizon of this Master Plan.

4. *Willamette Pump Station MCC Assessment* – An assessment of the condition, performance and operation of the existing MCCs in the Willamette Pump Station should be completed to determine if corrective repairs or replacement will be required to address issues identified by City staff.

5. *Demolition of Abandoned View Drive Site Facilities* – The abandoned reservoir and pump station on the View Drive site should be demolished and removed to improve site aesthetics and reduce the risk associated with failure of aging structures.

6. *SCADA System Upgrades* – The SCADA system should be upgraded to replace existing aging infrastructure, including the Master Telemetry Unit and components at remote pump station sites.

Summary

This Section presents an evaluation of the condition of the City's existing water system infrastructure including storage reservoirs, pumping facilities and telemetry components. This section also assesses the City's operations and maintenance program and provides recommendations for developing and documenting a more detailed program building on recent work done by the City's Public Works Department. The recommendations presented in this section are included in the recommended comprehensive capital improvement and capital maintenance programs presented in Section 8.

MSA

SECTION 5

SECTION 5
WATER SUPPLY EVALUATION

General

This section presents an evaluation of the City of West Linn's (City) water supply sources, comparing existing capacities to water needs as presented in Section 3. A detailed discussion of the existing supply system facilities is presented as is a description of currently planned supply system improvements. Supply system improvement alternatives are presented along with a redundancy evaluation. The findings developed in this section are included in system wide storage needs evaluation presented in Section 6.

Existing Water Supply

The City's primary water supply source is from the South Fork Water Board (SFWB). The SFWB was established under Oregon Revised Statutes (ORS) 190 by agreement between the cities of West Linn and Oregon City for the purposes of supplying water to the two (2) cities. The SFWB owns and operates water supply facilities consisting of a river intake on the Clackamas River, which includes 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 City owns a transmission main crossing the Willamette River to supply the City.

Section 2 contained a detailed discussion of the existing water rights, intake, transmission, treatment and pumping facilities supplying the City. Figure 5-1 illustrates the location of the major facilities supplying the City.

Water Demand Projections

The average daily demand (ADD) and maximum day demand (MDD) projections presented in Table 5-1 under current and saturation development, or build-out, conditions are based on City demand projections presented in Section 3, and other SFWB demands as presented in the South Fork Water Board Water Master Plan Update, February 2004, herein referred to as the SFWB WMPU. Demand projections are presented in units of million gallons per day (mgd).

Supply Capacity Analysis

An analysis of the components of the City's water supply sources is presented below in Table 5-2, which identifies each of the components of the supply system, the capacity criteria used to evaluate the component and the actual and required capacity of the component. The criteria presented in Table 5-2 are based on the criteria presented in the SFWB WMPU. These criteria were evaluated and are considered appropriate for the current analysis relative to the City's supply needs. A discussion of the current capacity, required capacity and

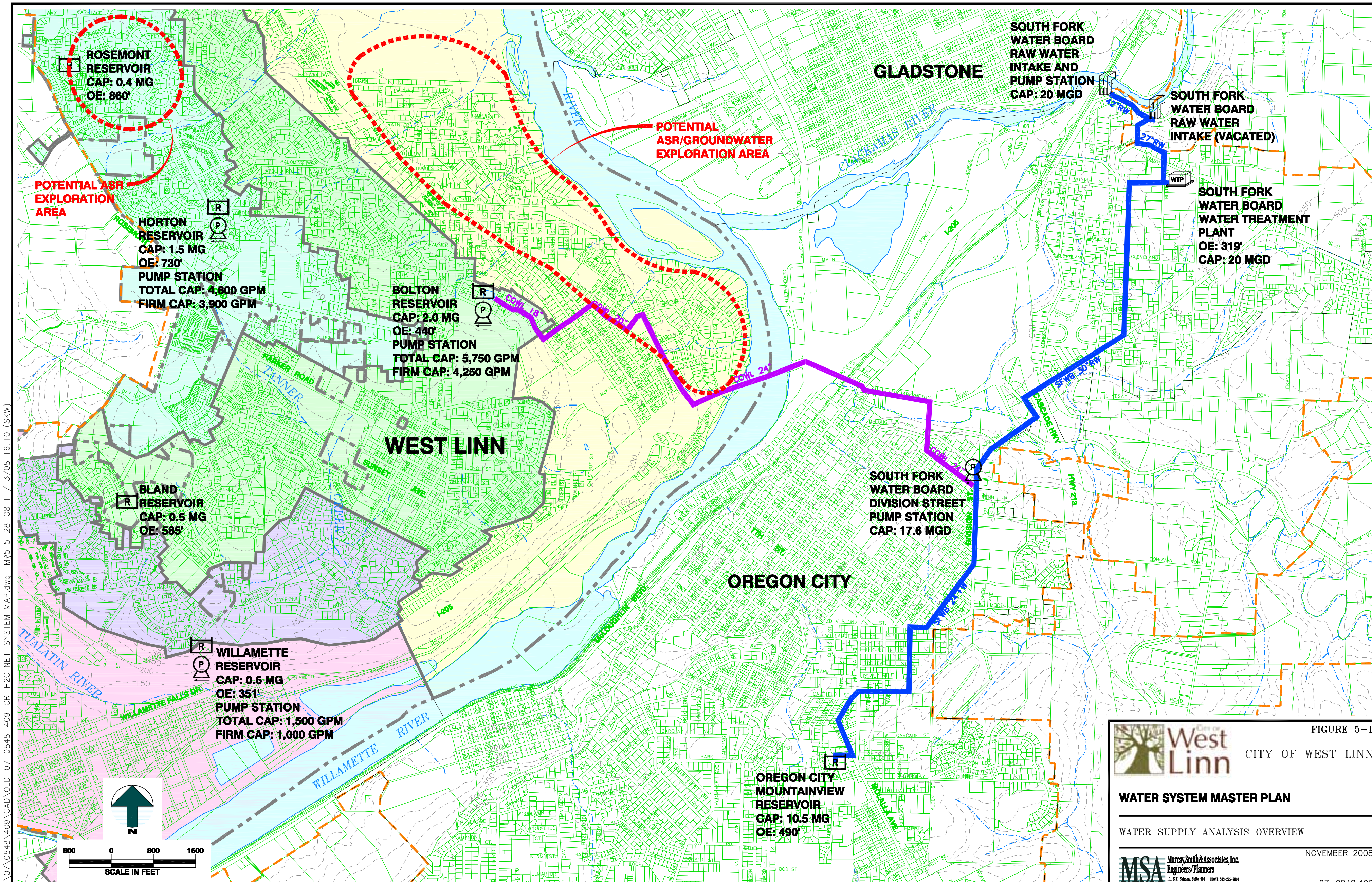


FIGURE 5-1

CITY OF WEST LINN

WATER SYSTEM MASTER PLAN

WATER SUPPLY ANALYSIS OVERVIEW

NOVEMBER 2008

MSA Murray Smith & Associates, Inc. Engineers/Planners

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G:\07\0848\409\CAD\OLD-07-0848-409-OR-H2O NET-SYSTEM MAP.dwg TM#5 5-28-08 11/13/08 16:10 (SKW) planned system improvements for each component of the City's supply from the SFWB follows.

Table 5-1
Water Demand Projection Summary

Water Provider	Year and Demand Projection (mgd)									
	2008 (Current)		2010		2015		2020		Saturation Development	
	ADD	MDD	ADD	MDD	ADD	MDD	ADD	MDD	ADD	MDD
Oregon City	5.0	10.4	5.3	11.1	6.1	12.8	6.9	14.4	7.8	15.0
Clackamas River Water – South	2.0	4.9	2.0	4.9	2.0	4.9	2.0	4.9	2.0	4.9
West Linn	3.5	8.1	3.6	8.3	3.7	8.6	3.9	8.9	4.3	10.0
Total	**10.5**	**23.4**	**10.9**	**24.3**	**11.8**	**26.3**	**12.8**	**28.2**	**14.1**	**29.9**

Table 5-2
Supply Capacity Analysis Summary

Supply System Component	Capacity Criteria	Current Capacity [3] (mgd)	Total Required Capacity (West Linn Capacity Need)	
			Current (mgd)	Build-out (mgd)
River Intake	MDD	53.0	23.4 (8.1)	29.9 (10.0)
Raw Water Pump Station	MDD (Firm Capacity)	30.0	23.4 (8.1)	29.9 (10.0)
Raw Water Transmission	MDD	22.0	23.4 (8.1)	29.9 (10.0)
Water Treatment Plant	MDD	22.0	23.4 (8.1)	29.9 (10.0)
Finished Water Transmission – SFWB WTP to DSPS	MDD	21.9	21.8 (8.1)	26.7 (10.0)
Finished Water Pump Station (D5PS)	MDD (Firm Capacity)	17.6	18.5 (8.1)	22.6 (10.0)
Finished Water Transmission – West Linn	MDD	~10.0	8.1 (8.1)	10.0 (10.0)

Notes: 1. WTP – Water Treatment Plant; DSPS – Division Street Pump Station
2. See the SFWB Water Master Plan Update for detailed breakdown of required component capacities to supply other SFWB customers.
3. Capacities listed are firm capacity for all pump stations.

Clackamas River Intake

The existing SFWB Clackamas River Intake, constructed in 1996, has a rated capacity of approximately 53 mgd. The required capacity of the intake to supply build-out demand conditions for the entire SFWB service area, including the City, is approximately 28.7 mgd. The existing river intake has adequate capacity to supply the City's water supply needs through the 20-year planning horizon and through build-out of the current water service boundary. The City's ultimate supply need is approximately 10 mgd.

Raw Water Pump Station

The existing SFWB raw water pump station (RWPS), constructed in 1996 in the same structure with the river intake, has a current firm capacity of approximately 30 mgd with the addition of a fifth pump (10.65 mgd), 800 horsepower (hp) motor and variable frequency drive (VFD) in 2005. The required capacity of the pump station to supply the current projected MDD (year 2008) conditions for all SFWB customers is approximately 23.4 mgd and the projected future build-out capacity required is approximately 28.7 mgd. The existing RWPS has adequate capacity to meet the City's water supply needs through the 20-year planning horizon and through build-out of the current water service boundary. The City's ultimate supply need is approximately 10 mgd.

Raw Water Transmission

The existing raw water transmission main from the RWPS at the Clackamas River intake to the SFWB Water Treatment Plant (WTP) consists of approximately 600 linear feet of 42-inch diameter steel main from the existing intake (constructed in 1996) to the abandoned SFWB intake. From this location, the raw water transmission main is a 27-inch diameter concrete-cylinder pipe constructed in 1954, extending approximately 1,800 linear feet from the end of the new 42-inch diameter main to the WTP. The current capacity of the transmission main, based on the capacity of the 27-inch diameter section, is approximately 22 mgd. The required capacity of the transmission main to supply the current projected MDD (year 2008) conditions for all SFWB customers is approximately 23.4 mgd and the projected future build-out capacity required is approximately 28.7 mgd.

Construction of a new 48-inch diameter raw water transmission main to replace the aging 27-inch diameter main, as recommended in the 2004 SFWB WMPU, is included in the SFWB Capital Improvement Plan (CIP). With the completion of this improvement, the raw water transmission main capacity will be adequate to supply the City's water supply needs through the 20-year planning horizon and through build-out of the current water service boundary. The City's ultimate supply need is approximately 10 mgd.

Water Treatment Plant

The existing SFWB WTP has a nominal capacity of 22 mgd, with the completion of current improvements underway at the WTP, including the construction of a new 2 mg clearwell.

The required capacity of the WTP to supply the current projected MDD (year 2008) conditions for all SFWB customers is approximately 23.4 mgd and the projected future build-out capacity required is approximately 28.7 mgd. This build-out capacity requirement includes 10 mgd for the City.

The SFWB WMPU included recommendations to complete WTP upgrades by the year 2010 to increase the capacity of the WTP to 30 mgd. These improvements include:

- Sedimentation basin upgrades: Installation of plate settlers and sludge removal system.
- Filter upgrades: Construction of two (2) new filter beds.

With the completion of these improvements, the WTP capacity will be adequate to supply the City's water supply needs through the 20-year planning horizon and through build-out of the current water service boundary.

Finished Water Transmission (SFWB)

The finished water transmission main from the SFWB WTP to the Division Street Pump Station (DSPS), which provides finished water pumping to Oregon City and the City, is a one and a half (1 ½) mile 30-inch diameter concrete-cylinder pipe constructed in 1958. The nominal capacity of this transmission main, dictated by the suction pressure requirements of the DSPS, is approximately 21.9 mgd. The required capacity of the transmission main to supply the current projected MDD (year 2008) conditions for customers served by the transmission main is approximately 21.8 mgd and the projected future build-out capacity required is approximately 26.7 mgd, of which approximately 10.0 mgd is the City's demand.

The SFWB WMPU includes recommendations to complete transmission main upgrades, extending an existing 42-inch diameter transmission main from the WTP to Oregon City's Hunter Avenue Pump Station an additional 4,500 feet to Redland Road to replace segments of the existing 30-inch diameter main and provide expanded suction supply capacity to the DSPS. This improvement will expand the capacity of the finished water transmission main to greater than 30 mgd. With the completion of this improvement, the finished water transmission main capacity to the DSPS will be adequate to supply the City's water supply needs through the 20-year planning horizon and through build-out of the current water service boundary.

Finished Water Pump Station

The DSPS, located in Oregon City near the intersection of 17th Street and Division Street, provides finished water pumping to supply the Oregon City Mountainview Reservoir and the City. Currently, the station is controlled by the level in the Mountainview Reservoir which can backfeed supply to the City when the pump station is not operating. The firm capacity of the DSPS is 17.6 mgd. Supply to the City is through a pressure control station, consisting of two (2) parallel hydraulically actuated 14-inch diameter ball valves, connected to the City's

24-inch diameter transmission main. The required capacity of the DSPS to supply the current projected MDD (year 2008) conditions is approximately 18.5 mgd and the projected future build-out capacity required is approximately 22.6 mgd of which 10 mgd is the City's demand.

The SFWB WMPU includes recommendations to upgrade the DSPS to a firm capacity of approximately 24 mgd by installing one (1) additional pump, motor and VFD by 2010. With the completion of this improvement, the firm capacity of the DSPS will be adequate to supply the City's water supply needs through the 20-year planning horizon and through build-out of the current water service boundary.

Finished Water Transmission Main (West Linn)

The City's 24-inch diameter steel transmission main extends from the DSPS through Oregon City and across the Willamette River as a suspended overcrossing on the I-205 Bridge. The transmission main connects to the City's distribution system in the Bolton pressure zone. Previous analyses have identified the capacity of this transmission main is 13 mgd. Flow testing conducted by City staff in August 2002, in coordination with the SFWB and the City of Lake Oswego, indicated that the current capacity of the transmission system is limited to approximately 7.5 mgd under normal conditions and approximately 9.6 mgd when supplying water to Lake Oswego through the emergency intertie.

As part of this supply analysis, an assessment of the March 5, 2008 flow testing performed by City staff and previous analysis of the capacity of the transmission main was completed. In addition, the computerized model of the City's distribution and transmission system was used to determine the actual capacity of the transmission main and to determine what limited the flow available during the testing in 2002. A summary of the key findings of this assessment are presented below:

- The nominal capacity of the 24-inch diameter transmission main is approximately 9.5 mgd, assuming a maximum velocity of approximately five (5) feet per second (fps).
- Current flow limitations in the transmission main observed during the 2002 flow testing are attributed to flow restrictions at the existing partially open reservoir altitude valves, especially the Bolton Reservoir altitude valve. Operation of this type of globe-style valve requires adequate differential head across the valve, which is not available this close to the reservoir. The City has recently removed this altitude valve and relocated the altitude function to the 14-inch diameter ball valves located near the DSPS. The City had already relocated the Willamette Reservoir altitude valve to a lower elevation near Willamette Falls Drive.
- The SFWB WMPU recommendations include installation of a new electronically actuated control valve at the beginning of the 24-inch diameter transmission main near the DSPS to isolate supply to the City from Oregon City's Mountainview Reservoir, and to allow operation of the DSPS to supply the City based on the level of the Bolton Reservoir. Isolation valves have since been installed on the transmission main and a new

VFD installed at the DSPS, resulting in the removal of the project from the SFWB CIP list.
- An analysis using the water system hydraulic model confirmed that the capacity of the transmission main is a minimum of 9.5 mgd based on velocity criteria of five (5) fps. If velocities greater than five (5) five fps can be achieved for short durations, the transmission main has adequate capacity to transmit the build-out MDD of 10 mgd, resulting in a flow velocity of 5.6 fps. It is acceptable for the transmission main to operate at higher velocities for short durations. Based on the results of flow testing completed in March 2008 and hydraulic analysis of the City's water system using the hydraulic model, the existing transmission main is capable of delivering the projected flow need of 10 mgd.

Based on the findings presented above, and given current and future planned improvements, the capacity of the transmission main is adequate to meet current, 8.1 mgd, and future demand conditions up to the build-out MDD of 10 mgd. Further discussion of the reliability and redundancy of this transmission main are presented below.

Supply Redundancy Evaluation

The key elements of the City's supply source with the greatest vulnerability to complete loss of service are the SFWB's raw water transmission main and the City's finished water transmission main, especially the Willamette River crossing. Of these two (2) facilities, the finished water transmission main has the greatest vulnerability because of the risk and exposure of the I-205 bridge crossing. Currently planned upgrades to the most vulnerable segments of the raw water transmission main, discussed above, greatly reduce the vulnerability of the raw water transmission system. Key pumping facilities are designed with backup power sources, including emergency generators, and are also designed to meet future demand conditions with the largest pump out of service. The WTP includes parallel elements within each component of the treatment process and on-site clearwell storage to limit supply disruption in the event that one (1) element of the treatment process must be taken out of service. The conceptual approaches presented below are discussed in Section 6 where they are compared to a storage only solution approach.

The City's emergency intertie with the City of Lake Oswego provides a reliable backup supply, albeit with limited capacity, to the City in the event of a supply disruption. A discussion of opportunities to reduce the vulnerability of the City's transmission system from SFWB and the overall vulnerability associated with the single supply from the Clackamas River is presented in Section 6 as part of the storage evaluation.

The City is currently engaged in discussions with the cities of Tigard and Lake Oswego concerning partnership opportunities to increase the reliability of the existing emergency supply intertie between the City and Lake Oswego. The configuration of the City's existing supply from SFWB as it connects to the City's distribution system through the existing Bolton Reservoir, the City's largest and oldest reservoir, creates interdependence between system storage needs and providing supply reliability and system redundancy. As such, the supply system evaluation and findings presented in this section are key to the storage analysis element of this water system master plan presented in Section 6.

Finished Water Transmission Main (Willamette River Crossing)

Given that the existing 24-inch diameter transmission main has adequate capacity to meet the long-term transmission needs of the City, it is not recommended that the City pursue development of a new river crossing at this time. However, should the age and vulnerability of the transmission main, or the status of the existing I-205 Bridge ultimately require the City to consider replacement of the transmission main crossing of the Willamette River a conceptual level evaluation of river crossing alternatives was completed to guide future analysis. Opportunities for development of a second bridge crossing are fairly limited and expose the new transmission main to the same vulnerabilities as the existing transmission main. A future transmission main crossing of the Willamette River should be a hardened river undercrossing, and include flexible piping connections and isolation valves on either side of the river. This type of crossing is consistent with the current planning of other regional water suppliers addressing similar river crossing issues, such as the City of Newberg and the City of Portland.

As presented in Section 6, the most cost effective approach to addressing the vulnerability of the City's transmission system may be to develop reliable emergency supply sources in cooperation with neighboring and regional water providers. Should the City be unable to achieve the goal of securing reliable emergency supplies, consideration of a parallel river crossing or other options should be re-evaluated.

Aquifer Storage and Recovery

As part of this supply analysis, an evaluation of the potential for development of aquifer storage and recovery (ASR) as a backup or peaking supply was completed. ASR is the underground storage of treated drinking water that is injected into a suitable aquifer and subsequently recovered from the same well or wells, generally requiring no retreatment other than disinfection. ASR is a water supply management tool for water providers whose peak water demands either approach or exceed supply capacities, while non-peak supply capacities are typically in excess of non-peak demands. A technical memorandum documenting this analysis is included in the Appendix D.

The objectives of this evaluation were (1) to identify potential fatal flaws to implementing an ASR program within the City, and using the Kenthorpe Well in particular, and (2) to identify the next steps and potential risks if the City decides to pursue an ASR program.

This preliminary feasibility evaluation focuses on hydrogeologic considerations. General criteria used as guidelines for evaluating the hydrogeologic feasibility of ASR for the City include the following:

1. To be considered productive, an aquifer should have well yields of at least 700 gallons per minute (gpm) or approximately 1 mgd, and sufficient storage volume to maintain

these well yields during the critical peak demand periods (commonly 50 to 100 million gallons per well site). Well yields and injection rates are determined by the productivity of the aquifer and the efficiency of the well, and also are related to the groundwater level in the well.

2. A suitable target aquifer is confined and has sufficient available space to store the desired volume of injected water, as determined by the boundaries of the aquifer and depth to groundwater (available “headroom”).
3. Other high-capacity wells that could capture stored water are not present.
4. To be considered suitable, the selected aquifer, source water, and native groundwater are geochemically compatible such that chemical interactions will not result in clogging of the aquifer or adversely affect water quality.

The two (2) primary water-bearing geologic units in the City include the Waverly Heights formation and the Columbia River Basalt Group (CRBG). Existing wells completed in the Waverly Heights formation typically have low yields in the City, ranging from 8 to 50 gpm and have insufficient transmissivity for ASR. Well log information shows that the thickness of the CRBG section in the City is highly variable, ranging from less than 100 feet to more than 600 feet in the highlands in the western portion of the City. Well data for wells deeper than 300 feet were not available for the southern and eastern portions of the City, particularly the Willamette, Horton, Robinwood and Bolton areas. However, geologic mapping suggests that the CRBG section on the east side of the City, in the Bolton and Robinwood neighborhoods, could be as thick as 1,500 feet. Mapping also indicates that the CRBG section is relatively thin, less than 200 feet in the Willamette area.

Based on the limited data available for this evaluation, it appears that the northern Rosemont area and the eastern portion of the City, between the highlands and the Willamette River, have the highest potential for relatively thick basalt sections. The CRBG thickness in the northern Rosemont area and between the crest of the highlands and Highway 43 exceeds 600 feet. Although not verified by deep well data, the Bolton and Robinwood areas between Highway 43 and the river potentially are underlain by more than 1,000 feet of CRBG section and therefore may have the highest potential for productive aquifer conditions. In addition, an area between the southern Rosemont and Willamette areas also has a relatively thick CRBG section. This area also has a great deal of faulting, which could limit the extent of productive interflow zones.

Overall, a preliminary evaluation of the hydrogeologic feasibility of implementing ASR in the City indicates that ASR may not be feasible for the Willamette and southern Rosemont areas. Although limited available information did not identify fatal flaws for other portions of the City, evaluating ASR feasibility in these other locations would require conducting an exploratory drilling and testing program to evaluate and verify aquifer characteristics. General locations with the highest apparent opportunities for success have been identified on Figure 5-1. Estimated costs for an exploratory well program likely would range from $200,000 to $250,000 for a single well site, depending on the ultimate depth of the exploratory well. The primary risk associated with an exploratory well program would be that the program would indicate that suitable hydrogeologic conditions are not present near the exploratory well after the invested effort. Further, verification of ASR feasibility at one (1) location may not be sufficient to show that ASR is feasible at other locations with sufficient certainty, requiring additional drilling and testing at those other locations. If no fatal flaws are found, overall programs costs to develop a 6 mgd ASR program for the City is approximately $8 to $9 million.

While it is not recommended that the City immediately pursue development of ASR as a water management tool because of the associated risks and unknowns, it is recommended that ASR be included as a water management supply option as the City considers its supply and storage options. A detailed discussion of how ASR is incorporated into an overall supply system strategy is presented in Section 6.

Supply Source Analysis Recommendations

As discussed above, proposed SFWB system improvements as recommended in the SFWB WMPU are required to meet long-term water supply needs for the City. The City should include these projects in the current water system CIP to track the ultimate timing relative to the City's water supply needs as well as to provide adequate budgeting to fund these projects. The City's estimated cost share of these projects will be included in the CIP.

Summary

This section presents an evaluation of the City's existing supply source, including the intake, raw water pumping, raw water transmission, treatment, finished water pumping and finished water transmission. Also documented is a review of the current SFWB WMPU, an assessment of conceptual level alternatives for a future transmission main Willamette River crossing and an evaluation for the potential development of ASR facilities in the City. The integration of supply system reliability and system wide storage needs is detailed in Section 6, which includes supply system improvement recommendations and a decision process for the ultimate selection and implementation of the recommended improvements.

SECTION 6

SECTION 6
WATER STORAGE REQUIREMENTS

General

This section documents the evaluation of the City of West Linn's (City's) distribution system water storage needs and establishes City-wide water storage requirements as well as storage requirements for the City's six (6) pressure zones. Included in this section is a summary of the City's existing storage reservoirs, a presentation of three (3) storage criteria evaluation methodologies and recommendations to meet the City's storage needs based on the selected analysis methodology.

The findings and conclusions of the supply evaluation presented in Section 5 are incorporated in this section in the development of a comprehensive storage and supply needs strategy. Recommended system improvements for storage and supply needs are presented in Section 8 where the Capital Improvement Plan (CIP) and Capital Maintenance Plan (CMP) are documented and discussed in detail.

Background

Drinking water distribution system storage is an essential component of a water system that serves to:

- Equalize demands on supply sources, booster pump stations and transmission mains.
- Stabilize system flows and service pressures.
- Provide reserve capacity in the distribution system for emergencies.
- Provide reliable "on demand" capacity to meet fire suppression needs.

There are six (6) distribution system storage reservoirs in the City's water system with a combined usable storage volume, or capacity, of 5.5 million gallons (mg). Table 6-1 summarizes the name, location, capacity, overflow elevation and pressure zone served by each of these storage reservoirs.

Criteria Methodology Development

General

A general review of local and regional approaches to establishment of water storage requirements was completed to determine the most appropriate methodology to apply to the City's water system. Three (3) specific approaches were identified for consideration:

- Method No. 1 – Three-Component Methodology
- Method No. 2 – Washington State Department of Health Methodology
- Method No. 3 – System Performance Methodology

Table 6-1
Reservoir Summary

Reservoir Name	General Location	Usable Capacity (mg)	Overflow Elevation (ft)	Pressure Zone Served
Bolton	Skyline Drive	2.0	440	Bolton
Horton	Horton Road & Santa Anita Drive	1.5	731	Horton
Rosemont	Suncrest Drive	0.4	860	Rosemont
Bland	Bland Circle	0.5	585	Bland
Willamette	Salamo Road	0.6	351	Willamette
View Drive	View Drive	0.5	328	Robinwood

A discussion of the key elements, advantages and disadvantages of each method is presented below.

Three-Component Methodology (Method No. 1)

The three-component methodology considers the three (3) primary uses, or components, of distribution system storage and considers the volume of storage necessary for each of those components. The total volume of storage required is the sum of the three (3) component volumes. The three (3) components are:

- *Operational Storage:* Operational storage is required to meet water system demands in excess of delivery capacity from the supply source to system reservoirs. Operational storage volume should be sufficient to meet normal system demands in excess of the maximum day demand (MDD) and is generally considered as the difference between peak hour demand and MDD (on a 24-hour duration basis).
- *Fire Suppression Storage:* Fire suppression storage should be provided to meet the single most severe fire flow demand within each pressure zone. The required fire suppression storage volume is based on the recommended fire flow rate and the expected duration of that flow.
- *Emergency Storage:* Emergency storage is provided to supply water from storage during emergencies such as pipeline failures, equipment failures, power outages or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability. Provisions for emergency storage in other systems vary from none to a volume that would supply a maximum day's flow or higher.

The three-component methodology has historically been used by the City to establish the water storage requirement. The primary advantage of this methodology is that it is fairly simple to apply and allows policymakers latitude in establishing emergency storage requirements relative to acceptable levels of risk. This simplicity and flexibility are also this methodology's major disadvantage. Emergency storage volume requirements are typically subjective and based on typical industry practice rather than a rigorous, methodical assessment of vulnerability and risk.

Washington State Department of Health Methodology (Method No. 2)

The Washington State Department of Health (DOH) has developed and documented a multiple-component methodology for determining water storage requirements that is used by all water system providers in the State of Washington. This methodology is similar to Method No. 1, in that it considers several storage components and the total water storage volume required is based on the sum of the individual components. This methodology contains four (4) storage components that must be considered and also includes a structured, objective process for determining the storage volume needed for each component. The four (4) components and the method for calculating the storage volume required for each is presented below:

- *Equalizing Storage:* When the source pumping capacity cannot meet the periodic daily (or longer) peak demands placed on the water system, equalizing storage must be provided as a part of the total storage for the system and must be available at 30 psi to all service connections. The volume required depends upon several factors, including peak diurnal variations in system demand and source production capacity. The equation for calculating the required volume of equalization storage is presented below:

$$ES = (PHD - Q_S)(150\ min.)$$ *, but in no case less than zero.*

Where: ES = *Equalizing storage component, in gallons.*

PHD = *Peak hourly demand, in gpm.*

Q_S = *Sum of all installed and active source of supply capacities, except emergency sources of supply, in gpm.*

- *Operational Storage:* Operational storage is the volume of the reservoir devoted to supplying the water system while, under normal operating conditions, the sources of supply are in "off" status. The operational storage volume should be approximately 2.5 times the capacity of the largest pump, or the volume of water in the reservoir between the height of the "pump on" and "pump off" set points, whichever is greater.
- *Standby Storage:* The purpose of standby storage, or emergency storage, is to provide a measure of reliability should sources fail or when unusual conditions impose higher demands than anticipated. The volume recommended for systems served by one (1) source may be different than for systems served by multiple sources as described in the following equations:

- Water Systems with a Single Source: The recommended volume for systems served by a single source of supply is two (2) times the system's *average day demand* (ADD) to be available to all service connections at 20 psi.

$$SB_{TSS} = (2\ days)(ADD)$$

Where: SB_{TSS} = *Total standby storage component for a single source system, in gallons;*

ADD = *Average day demand*

- Water Systems with Multiple Sources: The recommended volume for systems served by multiple sources should be based upon the following equation:

$$SB_{TMS} = (2\ days)(ADD) - t_m\ (Q_S - Q_L)$$

Where: SB_{TMS} = *Total standby storage component for a multiple source system; in gallons*

ADD = *Average day demand for the system*

Q_S = *Sum of all installed and continuously available source of supply capacities, except emergency sources, in gpm.*

Q_L = *The largest capacity source available to the system, in gpm.*

t_m = *Time that remaining sources are pumped on the day when the largest source is not available, in minutes. (Unless restricted otherwise, this is generally assumed to be 1440 minutes.)*

- *Fire Suppression Storage:* Fire suppression storage should be provided to meet the single most severe fire flow demand within each pressure zone. The required fire suppression storage volume is based on the recommended fire flow rate and the expected duration of that flow.

The four-component methodology mandated by the Washington State DOH is advantageous to use because it is objective, easy to apply and understand, and provides a standardized, industry-accepted approach to determining storage needs. This methodology does not directly consider variations in system configuration or risk and redundancy to determine appropriate system storage requirements relative to acceptable levels of service under emergency conditions.

System Performance Methodology (Method No. 3)

The system performance methodology is similar to the two (2) previous methodologies in that it considers the different uses for stored water to calculate the total volume of storage needed. This methodology differs in that it takes a more holistic look at those uses and considers all of the components in the water system that function to meet those uses. Specifically, there are three (3) key concepts that distinguish this methodology:

- Booster pump stations supplying the system, or an individual pressure zone, can supply system demands and meet fire suppression requirements if the facilities have a high level of reliability (firm capacity to meet demands and standby power to keep pump station operational in an emergency) and redundancy (more than one (1) facility with firm capacity to meet demands supplies the system/zone).
- Under emergency conditions, storage in a higher level pressure zone may be available to supply a lower zone, if supply to the higher zone is from a different pressure zone than the lower one (1) experiencing the emergency and appropriately sized pressure reducing stations exist to transmit supply to the lower zone.
- Under certain emergency conditions, it may be acceptable to consider a reduced level of service for the water system. For example, if a major earthquake were to result in the loss of the Horton Pump Station and the View Drive Pump Station simultaneously then it may not be reasonable to expect the water system to still supply MDD and fire suppression flow in the Rosemont pressure zone. An acceptable reduced level of service that still provides for public health and safety would be to supply enough water to meet ADD and typical residential fire suppression flows (1,000 gpm for two (2) hours).

While Method No. 3 is more complex than the other two (2) alternatives, it has several key advantages. This methodology recognizes that it is prudent to develop redundant supply facilities throughout the system, that pressure zone interconnectivity provides greater operational flexibility, especially in an emergency, and that it may not be economical or even feasible to maintain normal levels of service under certain emergency conditions with a low likelihood of occurrence.

Preliminary Criteria Screening Process

A general overview of the three (3) methodologies discussed above was reviewed with City staff in preparation for presentations to the Utility Advisory Board (UAB) and the City Council. The ultimate direction from the City Council was to proceed with Method No. 3; however, at least two (2) alternatives should be developed with one (1) of those alternatives focused on providing storage to meet any system performance requirements.

Storage Analysis

General

A detailed storage analysis using Method No. 3 and considering the direction of the City Council is presented below. Two (2) separate approaches to addressing system performance needs were evaluated under existing conditions and under saturation development conditions. The first approach, Approach A, considers providing additional storage volume as the primary means of meeting system performance requirements. Approach B considers system configuration, vulnerabilities and operational flexibility in selecting appropriate storage, booster pumping and transmission system improvements to meet system performance requirements.

System Performance Requirements

While the City may consider further evaluation of reduced system performance requirements in the future, this analysis assumes that reduced levels of service under certain emergency conditions will not be acceptable. As such, for the entire City water system and for individual pressure zones, the system performance requirement is to have adequate supply and storage to meet MDD conditions while simultaneously supplying fire suppression needs in each pressure zone. The maximum fire suppression flow requirement for each pressure zone is 3,000 gpm for 3 hours. Throughout this analysis, it is assumed that only one (1) fire flow condition is occurring at any given time in the system.

It is prudent to consider typical operating conditions for the existing reservoirs, and to recognize that the reservoirs may not be full when an emergency condition exists. For this analysis, it is assumed that all distribution reservoirs are three-fourths (3/4) full.

For future reference, a tabulation of likely emergency conditions and potential reduced system performance responses is presented in Table 6-2. Should the City wish to consider the adoption of reduced levels of service under certain emergency conditions, the next step would be to further define the types of emergency conditions that could occur and the likelihood of these events occurring (recurrence interval). This information would be used to allow policy-makers to assess the risks of accepting reduced levels of service.

System-Wide Storage Requirements

System performance requirements and related storage volume needs are evaluated on a system-wide basis, considering water demand and fire suppression needs relative to the City's supply from the South Fork Water Board (SFWB) and the City of Lake Oswego emergency supply connection as documented in Section 5. Table 6-3 summarizes the MDD, fire suppression flow needs, and the supply capacity available under normal and emergency conditions. Under normal and emergency conditions, the analyses presented throughout this section consider the MDD condition for one (1) day and assume that the City's supply capacity is adequate to refill storage volume used for fire suppression. The emergency condition presented in the table below assumes a loss of the City's SFWB supply for one (1) day. Under emergency conditions it is assumed that emergency supply from the City of Lake Oswego Intertie is unavailable under MDD conditions. It is assumed that the City will address outage durations in excess of one (1) day through the implementation of water curtailment measures. Based on this analysis, the City has a current and future supply deficit under emergency conditions that must be addressed through storage or development of additional reliable emergency supply capacity.

Table 6-2
Potential Reduced System Performance Requirement
Consideration Summary

Condition	Recurrence Interval	System Performance Requirement
Normal Operation	--	MDD + Fire Flow
Distribution Pump Station Out of Service for 24 Hours (Bolton, Horton, Willamette or View Drive)	1 to 5 Year	MDD + Fire Flow
Minor Earthquake - Distribution Pump Station Out of Service for 48 Hours	10 Years	MDD + Fire Flow
Moderate Earthquake – Willamette River crossing out of service for 30 days	100 Years	Peak Season Demand (~1.25 times the ADD) + Fire Flow
Extensive Earthquake – Supply Outage for 30 Days and One (1) or More Distribution Pump Stations Out of Service	500 Years	ADD + Reduced Fire Flow

Table 6-3
System-Wide Performance Requirement Summary

Year	MDD (mg) [1]	Fire Flow (mg) [2]	Total Supply Need (mg) [3]=[1]+[2]	Normal Supply Capacity [1] (mg) [4]	Emergency Supply Capacity[2] (mg) [5]	Normal Supply Deficit (mg) [6]=[3]-[4]	Emergency Supply Deficit (mg) [7]=[3]-[5]
Current	8.1	0.5	8.6	9.5	0.0	(0.9)	8.6
2015	8.6	0.5	9.1	9.5	0.0	(0.4)	9.1
2030	9.7	0.5	10.2	9.5	0.0	0.7	10.2
Saturation Development	10.0	0.5	10.5	9.5	0.0	1.0	10.5

Notes:
1. Normal supply capacity is based on the assumed capacity of the City's finished water transmission main from the Division Street Pump Station across the Willamette River. The actual capacity of this transmission main under typical conditions is 10 mgd, but a reduction in capacity may be expected under certain emergency conditions.
2. Emergency supply capacity is the total available capacity of the City's Lake Oswego Emergency Intertie Pump Station, assumed to be 0.0 under maximum daily demand conditions.

Table 6-4 summarizes the overall supply/storage deficit in the system under normal and emergency conditions from current through saturation development demands. Based on the summary presented in Table 6-4, the City does not currently have adequate storage to meet system-wide needs under emergency conditions. Further analysis of individual pressure zone storage needs presented in this section may result in a need for greater storage volumes to meet individual pressure zone performance requirements.

As identified in Table 6-4, a future system-wide deficit of 6.4 mg is anticipated because of a lack of firm reliable peak season emergency supply. Three (3) alternative solution approaches have been identified to address this deficiency recognizing that replacement of the Bolton Reservoir is a critical need given the age and condition of this facility, and that construction of a new Bolton Reservoir will be part of all alternatives. These alternatives solution approaches are briefly summarized and discussed below.

Table 6-4
System-Wide Supply and Storage Deficit Summary

Year	Normal Conditions			Emergency Conditions		
	Supply Deficit [1] (mgd)	Storage Volume [2] (mg)	Overall Deficit (mgd)	Supply Deficit[1] (mgd)	Storage Volume [2] (mg)	Overall Deficit (mgd)
Current	0	4.1	0	8.6	4.1	4.5
2015	0	4.1	0	9.1	4.1	5.0
2030	0.7	4.1	0	10.2	4.1	6.1
Saturation Development	1.0	4.1	0	10.5	4.1	6.4

Notes: 1. See Table 6-3 for development of supply deficit.
2. Assumes distribution system reservoirs are three-fourths full.

Solution Approach A: Construction of a New 8.4 mg Bolton Reservoir

This approach includes the replacement of the existing Bolton Reservoir with a new 8.4 mg reservoir. The existing 2.0 mg Bolton Reservoir is in need of replacement and based on a conceptual level review of the existing site it appears that it may be possible to construct a new 8.4 mg reservoir on the site. The most economical and practical reservoir configuration on the existing site is a circular reservoir. Construction of a large reservoir may be complicated by site constraints and require the use of unique reservoir layout, shape and configuration features in addition to the use of specialty construction and shoring techniques that will result in higher construction and overall project costs.

A variant of this solution approach is to construct a circular reservoir at the existing Bolton Reservoir site and to construct an additional reservoir or reservoirs elsewhere in the Bolton Pressure Zone. This variant approach could prove costly and controversial as the need for an adequately sized site at the right ground elevation may result in significant local and neighborhood impacts as well as still potentially higher project costs.

Solution Approach B: Build back-up supply from SFWB

This approach includes the construction of a new 2.0 mg or larger reservoir at the Bolton Reservoir site to replace the existing 2.0 mg Bolton reservoir and to address the highest vulnerability of the existing supply system from SFWB. The SFWB's current master plan has recommended a number of improvements to increase the reliability of its supply system.

The element with the highest vulnerability of the City's supply system is the City's existing 24-inch diameter transmission main, including the Willamette River crossing on the I-205 Bridge. Constructing a parallel supply main from the Division Street Pump Station to the Bolton Reservoir, including a sub-surface crossing of the Willamette River, would provide a reliable back up to the existing transmission main. Based on a preliminary review of potential project costs, this approach has the highest probable cost of the approaches under consideration.

Solution Approach C: Improve the Emergency Supply Capacity and Reliability of the Lake Oswego Emergency Supply Connection

This solution approach includes developing a coordinated emergency supply plan that allows the City to fully meet its emergency supply capacity needs through the existing emergency supply connection from the City of Lake Oswego's water system in the Robinwood neighborhood near Lake Oswego's water treatment plant. The City's existing emergency supply connection to Lake Oswego is interruptible and its delivery capacity is dependent on Lake Oswego's supply and demand conditions at the time of the City's need. Under peak use, high demand conditions the actual capacity of this connection may approach zero as Lake Oswego's current maximum water demands are approaching the existing supply system's capacity.

The City of Lake Oswego is currently in discussions with the City of Tigard concerning long-term-water supplies. An element of these discussions includes the construction of a transmission system intertie that connects the City of Portland supply to Tigard through the Washington County Supply Line in such a way that water, which originates at the City of Portland's 50 mg Powell Butte Reservoir, could flow by gravity into Lake Oswego's Waluga Service Zone. With this supply Lake Oswego would have the ability to supply the City and meet its own demand needs at the same time by off-setting demands from the Lake Oswego treatment plant with supplies from the Tigard/Portland intertie. With the Tigard/Lake Oswego emergency supply connection operational Lake Oswego could supply an equal amount of water to the City through the West Linn/Lake Oswego supply connection. A preliminary review indicates that this connection may have a hydraulic capacity in excess of 6 mgd, potentially making an equal amount available to the City in an emergency event. Pursuing this option involves negotiating intergovernmental agreements (IGA) and probable participation in funding a portion of the transmission system intertie improvement. A preliminary review of potential project costs associated with this approach indicates that it has a lower cost than Approaches A and B.

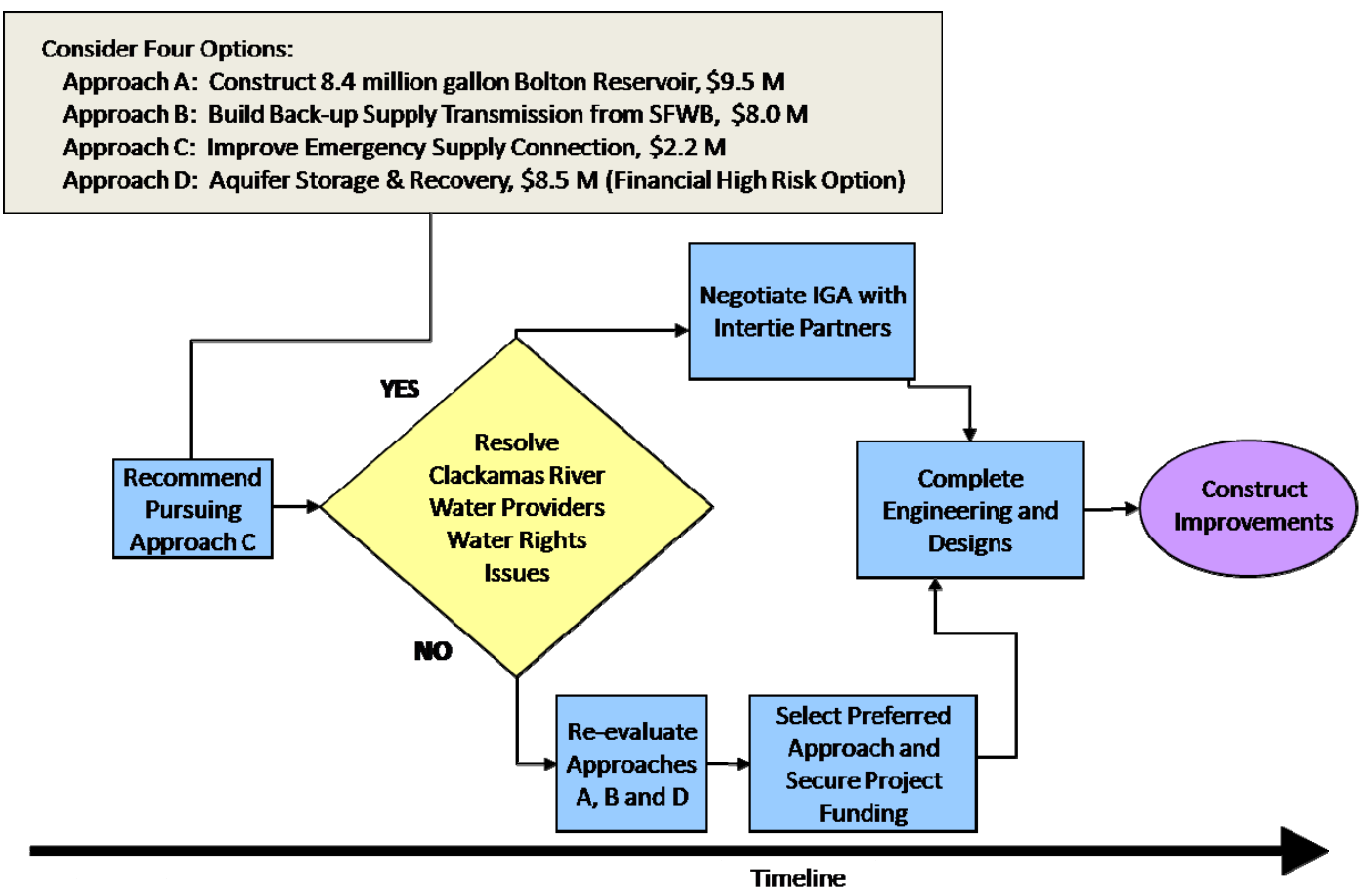
Solution Approach D: Aquifer Storage and Recovery (ASR)

Section 5 presented a preliminary evaluation of the hydrogeologic feasibility of implementing ASR that found the potential development of ASR, while not fatally flawed, presents many uncertainties and risks. Further evaluation of ASR feasibility requires conducting exploratory drilling and testing programs which may cost approximately $8 to $9 million. While immediately pursuing further evaluation of ASR it is not recommended it should be considered as a water supply management option as the City further develops its supply and storage options.

System Wide Storage and Supply Evaluation Summary

The four (4) solution approaches presented above provide varying degrees of certainty, risks and costs. Based on input from and discussions with City staff and policy makers it is recommended that Solution Approach C be pursued. Once fully developed and implemented, this approach most economically meets the City's supply and reliability needs. The successful implementation of this approach requires the resolution of ongoing water rights discussions with a number of Clackamas River water users, primarily, the City of Lake Oswego. Figure 6-1 presents a decision tree diagram summarizing the recommended supply system strategy for the City.

Figure 6-1
Supply Approach Decision Tree



Pressure Zone Storage Requirements

The analysis presented above for the entire City water system was repeated for each individual pressure zone to determine if adequate supply and storage existed under normal and emergency conditions. A summary of the analysis by pressure zone is presented in Tables 6-5 and 6-6. For pressure zones supplying higher level pressure zones, the MDD represents the actual demand in that pressure zone plus the MDD demand of all other pressure zones supplied from that zone. For example, the Bolton pressure zone MDD includes the MDD of all other pressure zones since the entire SFWB supply to the City is delivered through the Bolton pressure zone, although not necessarily through the Bolton Reservoir except in conditions where the SFWB supply is out of service. Given this condition, the Bolton pressure zone analysis is the same as the system-wide analysis and is not repeated in Tables 6-5 and 6-6. For the purpose of the pressure zone analysis, it is assumed that the system-wide deficiency discussed above is addressed and water is available to supply the other pressure zones from the Bolton pressure zone.

Based on the analysis presented in Table 6-5, all of the pressure zones in the City's water system have a current and future supply deficit under emergency conditions that must be addressed through existing storage volumes, if available, or through the development of increased emergency supply capacity through redundant pumped supply and system interties and/or construction of additional storage volume.

Two (2) approaches to address the current and future supply and storage deficits presented in Table 6-6 are discussed below. Both approaches include system improvements that, if implemented, would result in adequate supply and storage through saturation development. Specifically, each approach addresses the following pressure zone supply and storage deficits at saturation development:

- 0.4 mg in the Robinwood pressure zone
- 0.8 mg in the Willamette pressure zone
- 0.7 mg in the Horton pressure zone
- 0.3 mg in the Bland pressure zone
- 0.8 mg in the Rosemont pressure zone

Both approaches also consider the anticipated need to replace the Bolton Reservoir due to concerns over the age of the reservoir, usable capacity and maintenance of the floating cover.

Table 6-5
Pressure Zone Performance Requirement Summary

Year	MDD (mg) [1]	Fire Flow (mg) [2]	Total Supply Need (mg) [3]=[1]+[2]	Normal Supply Capacity [1] (mg) [4]	Emergency Supply Capacity[2] (mg) [5]	Normal Supply Deficit (mg) [6]=[3]-[4]	Emergency Supply Deficit (mg) [7]=[5]-[3]
Bolton Pressure Zone							
See System-Wide Analysis (Table 3)							
Robinwood Pressure Zone							
Current	1.6 (0.6)	0.5	2.1 (1.1)	3.1	0.5	(1.0)	0.6
2015	1.7 (0.7)	0.5	2.2 (1.2)	3.1	0.5	(0.9)	0.7
2030	1.9 (0.8)	0.5	2.4 (1.3)	3.1	0.5	(0.7)	0.8
Saturation Development	2.0 (0.8)	0.5	2.5 (1.3)	3.1	0.5	(0.6)	0.8
Willamette Pressure Zone							
Current	2.2	0.5	2.7	2.6	1.6	0.1	1.1
2015	2.3	0.5	2.8	2.6	1.6	0.2	1.2
2030	2.6	0.5	3.1	2.6	1.6	0.5	1.5
Saturation Development	2.7	0.5	3.2	2.6	1.6	0.6	1.6
Horton Pressure Zone							
Current	3.1 (2.1)	0.5	3.6 (2.6)	4.3	1.3	(0.7)	1.3
2015	3.2 (2.2)	0.5	3.7 (2.7)	4.3	1.3	(0.6)	1.4
2030	3.6 (2.5)	0.5	4.1 (3.0)	4.3	1.3	(0.2)	1.7
Saturation Development	3.8 (2.6)	0.5	4.3 (3.1)	4.3	1.3	0	1.8
Bland Pressure Zone							
Current	0.6	0.5	1.1	1.4	0.5	(0.3)	0.6
2015	0.6	0.5	1.1	1.4	0.5	(0.3)	0.6
2030	0.7	0.5	1.2	1.4	0.5	(0.2)	0.7
Saturation Development	0.7	0.5	1.2	1.4	0.5	(0.2)	0.7
Rosemont Pressure Zone							
Current	1.9	0.5	2.4	6.2	1.7	(3.8)	0.7
2015	2.0	0.5	2.5	6.2	1.7	(3.7)	0.8
2030	2.2	0.5	2.7	6.2	1.7	(3.5)	1.0
Saturation Development	2.3	0.5	2.8	6.2	1.7	(3.4)	1.1

Notes:
1. MDD = Rosemont pressure zone MDD
2. Normal supply capacity = Firm capacity of the Horton Pump Station and View Drive Pump Station
3. Emergency supply capacity = Firm capacity of View Drive Pump Station

Table 6-6
Pressure Zone Supply and Storage Deficit Summary

Year	Normal Conditions			Emergency Conditions		
	Supply Deficit [1] (mgd)	Storage Volume [2] (mg)	Overall Deficit (mgd)	Supply Deficit [2] (mgd)	Storage Volume (mg)	Overall Deficit (mgd)
Bolton Pressure Zone						
See System-Wide Analysis (Table 4)						
Robinwood Pressure Zone						
Current	0	0.4	0	0.6	0.4	0.2
2015	0	0.4	0	0.7	0.4	0.3
2030	0	0.4	0	0.8	0.4	0.4
Saturation Development	0	0.4	0	0.8	0.4	0.4
Willamette Pressure Zone						
Current	0.1	0.8	0	1.1	0.8	0.3
2015	0.2	0.8	0	1.2	0.8	0.4
2030	0.5	0.8	0	1.5	0.8	0.7
Saturation Development	0.6	0.8	0	1.6	0.8	0.8
Horton Pressure Zone						
Current	0	1.1	0	1.3	1.1	0.2
2015	0	1.1	0	1.4	1.1	0.3
2030	0	1.1	0	1.7	1.1	0.6
Saturation Development	0	1.1	0	1.8	1.1	0.7
Bland Pressure Zone						
Current	0	0.4	0	0.6	0.4	0.2
2015	0	0.4	0	0.6	0.4	0.2
2030	0	0.4	0	0.7	0.4	0.3
Saturation Development	0	0.4	0	0.7	0.4	0.3
Rosemont Pressure Zone						
Current	0	0.3	0	0.7	0.3	0.4
2015	0	0.3	0	0.8	0.3	0.5
2030	0	0.3	0	1.0	0.3	0.7
Saturation Development	0	0.3	0	1.1	0.3	0.8

Notes: 1. See Table 6-5 for development of supply deficit.
2. Assumes distribution system reservoirs are three-fourths full.

Approach A – Storage Only

Approach A considers the construction of additional storage facilities to address the long-term supply and storage deficits discussed above. Where feasible, storage improvements are configured to address deficits in more than one (1) pressure zone. Approach A improvements are listed below:

- *Bolton Reservoir Replacement:* Construction of a new ground level 2.5 mg reservoir to replace the existing Bolton Reservoir would address the current issues with the long-term maintenance of the Bolton Reservoir as well as addressing the 0.5 mg deficit in the Willamette pressure zone. The capacity of the Bolton Reservoir Replacement will depend on a number of factors as previously discussed.
- *0.4 mg View Drive Reservoir No. 2:* Construction of a new ground level 0.4 mg reservoir to supplement the existing View Drive Reservoir would address this pressure zone deficit.
- *0.3 mg Bland Reservoir No. 2:* Construction of a new ground level 0.3 mg reservoir in the Bland pressure zone would address this pressure zone deficit.
- *1.5 mg Rosemont Reservoir No. 2:* Construction of a new elevated 1.5 mg reservoir in the Rosemont pressure zone would address the deficit in the Rosemont and Horton pressure zones (supply from the Rosemont pressure zone to the Horton pressure zone is feasible through several PRV connections). Alternatively, a separate 0.7 mg ground level reservoir to serve the Horton pressure zone could be constructed, reducing the required volume of the Rosemount pressure zone to 0.8 mg.

Approach B – Storage and Emergency Supply Improvement

Approach B considers the construction of additional storage facilities as well as the development of expanded, reliable emergency supply facilities to address the long-term supply and storage deficits discussed above. Where feasible, improvements are configured to address deficits in more than one (1) pressure zone. Approach B improvements are listed below:

- *Bolton Reservoir Replacement:* Construction of a new ground level reservoir to replace the existing Bolton Reservoir would address the current issues with the long-term maintenance of the Bolton Reservoir as well as the 0.8 mg deficit in the Willamette pressure zone and the 0.4 mg deficit in the Robinwood pressure zone. The capacity of the Bolton Reservoir Replacement will depend on a number of factors as previously discussed. For the purposes of this analysis, it is recommended that a 4.0 mg reservoir be constructed to replace the existing Bolton Reservoir. This reservoir volume provides replacement capacity for the existing Bolton Reservoir of 2.0 mg, addresses the combined storage deficit of the Willamette and Robinwood pressure zones of 1.2 mg and provides an additional 0.8 mg of storage to offset emergency supply needs. Further refinement of the required capacity should be completed based on the outcome of discussions with neighboring water suppliers to secure reliable peak season emergency supply capacity.

- *0.3 mg Bland Reservoir No. 2:* Construction of a new ground level 0.3 mg reservoir in the Bland pressure zone would address this pressure zone deficit.
- *Bland Intertie Supply to Rosemont:* Construction of a new booster pump station at the Bland Reservoir site to supply the Rosemont pressure zone would address the deficiency in the Rosemont and Horton pressure zones by providing adequate emergency supply capacity. Included with this improvement is a provision for installation of backup power supply to operate the pump station during an emergency.

Water Storage Requirement Summary

Based on the analysis presented above, two (2) alternative approaches have been developed to address current and future storage volume needs in the City's water system. These two (2) alternative approaches were presented to, and reviewed by City staff, the UAB and the City Council. The City Council directed that the development of recommended system improvements be based on Approach B. It was further directed to pursue development of reliable emergency supply capacity with the cities of Lake Oswego, Tigard and others in accordance with Solution Approach C. The recommended improvements and associated project costs are documented in Section 8 which presents the recommended Capital Improvements Plan (CIP) and Capital Maintenance Plan (CMP).

Summary

This section documents the analysis of water storage requirements for the City's water system. The section includes development and selection of a storage criteria methodology and analysis of storage requirements for current and future demand conditions. The findings and recommendations developed and presented in this section are included as part of comprehensive capital improvement and system maintenance recommendations presented in Section 8.

SECTION 7

SECTION 7
DISTRIBUTION SYSTEM ANALYSIS

General

This section documents the planning and analysis criteria, summarizes the analysis process and presents findings for the water distribution system analysis element of the City of West Linn (City) Water System Master Plan (WSMP). The findings presented in this section are further developed as part of the comprehensive capital improvement and capital maintenance recommendations presented in Section 8.

Planning criteria are presented for distribution system piping and service pressures. These distribution system analysis criteria are used in conjunction with the water demand forecasts presented in Section 3 to complete the analysis of the City's water distribution system. A computerized hydraulic model of the distribution system was used to evaluate system performance under a number of demand and fire flow conditions and the results, which include all modeling parameters, relevant modeling approaches, analysis scenarios and subsequent system improvement recommendations are presented below.

Distribution System Analysis Criteria

The City's water distribution system should be capable of operating within certain system performance limits, or guidelines, under varying demand and operational conditions. The recommended criteria used for this plan are based on the following performance guidelines, which have been developed through a review of State requirements, American Water Works Association (AWWA) acceptable practice guidelines, operational practices of similar water providers and discussions with City water system operations staff. The performance guidelines and assumed conditions for the analysis are as follows:

- Supply to the City is through the 24-inch diameter supply main crossing the Willamette River from the Division Street Pump Station and the South Fork Water Board (SFWB) Water Treatment Plant (WTP).
- The distribution system should be capable of supplying the peak hourly demand while maintaining minimum service pressures of not less than approximately 80 percent of system pressures normally experienced under average day demand conditions. The system should meet this criterion with the reservoirs at approximately three-quarters full. The analysis discussion presented in Section 6 outlines the basis for the three-quarters full reservoir condition.
- The distribution system should also be capable of providing the recommended fire flow to a given location while, at the same time, supplying the maximum daily demand (MDD) and maintaining a minimum residual service pressure at any meter in the system of 20 pounds per square inch (psi). This is the minimum water system pressure required by the State of Oregon Department of Human Services, Drinking Water Program. The system should meet this criterion with the reservoirs approximately three-quarters full.

Typically, proposed or new water mains should be at least 8 inches in diameter in order to supply minimum fire flows. In special cases, 6-inch diameter mains are acceptable if no fire hydrant connection is required, there are limited services on the main, the main is dead-ended and looping or future extension of the main is not anticipated.

Service Pressure Criteria

Water distribution systems are typically separated into pressure zones or service levels to provide service pressures within an acceptable range to all customers. As previously discussed, the City's existing water service area distribution system is divided into six (6) main service levels, or pressure zones, and eight subzones. Pressure zones are usually determined by ground topography and designated by overflow elevations of water storage facilities or outlet settings of pressure reducing facilities serving the zone. Typically, water from a reservoir will serve customers by gravity within a specified range of ground elevations so as to maintain acceptable minimum and maximum water pressures at individual service connections. When it is not feasible or practical to have a separate reservoir serving each pressure zone, pumping facilities or pressure reducing facilities are used to serve customers in different pressure zones from a single reservoir.

Generally, 100 psi is considered the desirable upper static pressure limit and 40 psi the lower limit. Whenever feasible, it is desirable to achieve the 40 psi lower limit at the point of the highest fixture within a given building being served. Conformance to this pressure range may not always be possible or practical due to topographical relief, existing system configurations and economic considerations. Maximum pressures typically should not exceed 125 psi. Table 7-1 summarizes the service pressure criteria used in the analysis of the water system. The pressure zone analysis performed for this planning effort will review previous analyses and recommendations regarding the City's pressure zones.

Table 7-1
Recommended Service Pressure Criteria

Condition	Pressure (psi)
Minimum Service Pressure Under Fire Flow Conditions	20
Minimum Normal Static Service Pressure	40
Desired Maximum Static Service Pressure	100

Pressure Zone Analysis

The City's service area is currently divided into six (6) main pressure zones and eight (8) smaller lower elevation sub-zones supplied by pressure reducing valve (PRV) stations from the main zones. Table 7-2 summarizes the highest elevation in each of the main pressure zones, the overflow elevation of the reservoir serving the zone and the static pressure at the highest elevation location. As Table 7-2 shows the existing pressure zone boundaries are generally adequate to provide the recommended minimum service pressures throughout the water system.

Table 7-2
Pressure Zone Service Pressure Analysis Summary

Pressure Zone	Highest Ground Elevation (feet)	Reservoir Overflow Elevation (feet)	Static Service Pressure (psi)
Robinwood	207	327	52
Willamette	257	351	40
Bolton	336	440	45
Bland	490	585	41
Horton	632	730	42
Rosemont	754	860	45

Fire Flow Criteria

While the water distribution system provides water for domestic uses, it is also expected to provide water for fire suppression. The amount of water recommended for fire suppression purposes is typically associated with the local building type or land use of a specific location within the distribution system. Fire flow recommendations are typically much greater in magnitude than the normal maximum day demand present in any local area. Adequate hydraulic capacity must be provided for these large occasional fire flow demands.

Fire protection for the City's service area is provided by Tualatin Valley Fire and Rescue (TVFR). TVFR has established guidelines for determining fire flow requirements based on the 2007 Edition of the State of Oregon Fire Code and ordinances adopted by TVFR. The following definitions are based on current TVFR ordinances and are the basis for developing recommended fire flows within the City.

- ***Required Fire Flow:*** The amount of water necessary to fight a fire for a particular building. The required fire flow is based on the type of construction, building size and fire hazard of the occupancy. TVFR does not allow new building construction or alterations to existing buildings which creates a need for a required fire flow greater than

3,000 gallons per minute (gpm). The required fire flow cannot exceed the available fire flow (3,000 gpm).

- ***Available Fire Flow:*** The amount of water available at the hydrants or hydrants at a given location in the distribution system.

Residential Fire Flow Criteria

According to TVFR, dwelling units whose fire area is 3,600 square feet or less shall have a minimum fire flow requirement of 1,000 gpm. Buildings with fire areas greater than 3,600 square feet shall have a minimum fire flow requirement of 1,500 gpm. The City's previous WSMP recommended a residential fire flow of 1,000 gpm based on TVFR and State of Oregon Fire Code requirements at that time. Recent adoption (2007) of the new International Fire Code by the State of Oregon has resulted in a higher fire flow standard, especially for larger sized homes. For the purpose of this plan, a minimum residential fire flow of 1,500 gpm is recommended. Based on a review of the size of typical residential development within the City, it is recommended that system planning allows for a minimum available fire flow of 1,500 gpm.

Discussions with TVFR staff indicate that certain areas designated for medium-high density residential development should be provided with a minimum available fire flow of 3,000 gpm. This is because the "medium-high density" designation may allow for attached housing units or apartments which constitute a "commercial fire event".

Commercial and Industrial Fire Flow Criteria

As previously discussed, TVFR does not allow new building construction or alterations to existing buildings which creates a need for a required fire flow greater than 3,000 gpm. Discussions with TVFR officials indicate that, even though commercial and institutional facilities exist within the City that may have been constructed prior to current building regulations, available flow capacities of 3,000 gpm are sufficient for planning purposes. It is therefore recommended that 3,000 gpm be established as the minimum available fire flow for areas of existing and proposed commercial, industrial and institutional development.

A summary of fire flow recommendations by land use designation is presented in Table 7-3. The recommended fire flows presented in Table 7-3 were developed through discussions with TVFR officials, fire flow guidelines as developed by the AWWA, the National Fire Protection Association (NFPA), the Insurance Services office (ISO) and a review of fire flow criteria adopted by similar communities.

Fire flow requirements for structures with fire sprinkler systems were examined as part of the development of recommended fire flows. Fire flow requirements can be reduced for structures with sprinkler systems. Discussions with TVFR officials indicate that required fire flows may be reduced by up to 50 percent depending on building construction and the type of fire extinguishing system installed. The application of these flow reductions, however, must be examined on a case by case basis.

Table 7-3
Summary of Land Use and Recommended Fire Flows

Zone	Zoning Description	Recommended Fire Flow (gpm)	Duration (Hours)
LDR	Low Density Residential	1,500	2
MDR	Medium Density Residential	1,500	2
MHDR	Medium-High Density Residential	1,500	2
MU	Mixed Use Transition	3,000	3
NC	Neighborhood Commercial	3,000	3
GC	General Commercial	3,000	3
OBC	Office-Business Center	3,000	3
CI	Campus Industrial	3,000	3
GI	General Industrial	3,000	3
FU-10	Future Urban	1,500	2
	No Zoning (River and Freeway ROW)	N/A	N/A
FU-10	Area Outside City Limits (within UGB)	1,500	2

For the purposes of this study it is assumed that the water distribution system must provide fire flows for unsprinklered service conditions for the following reasons:

- Major portions of the City are already developed. While a number of buildings have fire sprinkler systems, many existing buildings do not.
- In order for reductions to be considered, all buildings in an area must have sprinkler systems. In most cases this is not realistic or feasible.

Distribution System Analysis

A hydraulic network analysis computer program was used to evaluate the performance of the existing distribution system and to aid in the development of proposed system improvements. The network analysis program utilizes a digital base map of the water distribution system prepared using AutoCAD computer aided drafting (CAD) software and H2ONet hydraulic network analysis software.

The purpose of the computer network modeling is to determine pressure and flow relationships throughout the distribution system under a variety of hydraulic conditions. System performance and adequacy is evaluated based on the criteria presented above to identify areas of deficiency and develop recommended system improvements.

Computerized Hydraulic Network Analysis Model

For modeling purposes, the water distribution system was digitized onto a digital base map drawing file. This drawing file was then used to perform the system analysis and to illustrate recommended improvements. This drawing file is presented as Plate 1 in Appendix A.

All pipes on the map are shown as “links” between “nodes” which represent pipeline junctions or changes in pipe size. Pipes and nodes are numbered to allow for easy system updating and revision. These numbers have not been shown on Plate 1 for drawing clarity but are available within the computer model for future use. Diameter and length are specified for each pipe, and an approximate ground elevation is specified for each node. For drawing clarity, only pipe diameters are illustrated. Pipe lengths are drawn to approximate scale. Hydraulic elements, such as pressure reducing valves and reservoirs, are also illustrated and operating parameters are incorporated into the model database.

Modeling Calibration

For a computer model to provide accurate results under test conditions it is essential that the model be calibrated with field conditions to reflect actual system operation. Model calibration was performed using actual measured demand distributed over the existing distribution system. The water system hydraulic model was previously developed for the City’s 1999 Water System Master Plan and subsequently updated in 2004. As part of this model development and update a thorough calibration of the hydraulic model was completed. In this process, the Hazen-Williams roughness coefficients of the pipes were adjusted until the modeled flow test results fell within approximately 10 to 15 percent of the actual results. This is typically considered an acceptable level of calibration. Based on the calibration results, a Hazen-Williams roughness coefficient or C-Factor range of 65 to 150 was used for existing pipes based on age, location and material. The calibration procedure was reviewed and verified with recent flow test data associated with the City’s 24-inch diameter transmission main and determined to be adequate for master planning level analysis of the distribution system.

Modeling Conditions

The analysis of the existing and proposed system was performed to assess the distribution system’s ability to provide peak hour water demands while maintaining system pressures at acceptable levels for operation of typical customer fixtures and irrigation systems, and provide recommended fire flows throughout the system during MDD conditions.

The analysis of the existing system was performed with year 2007 water demands applied to the system and the analysis of the proposed improved system was performed with estimated water demands at saturation development applied to the system.

All fire flow modeling was performed assuming that the City's primary storage reservoirs were approximately three-fourths full and that the system must be capable of providing the recommended fire flow to a given location while at the same time supplying the MDD and maintaining a minimum residual service pressure of 20 pounds per square inch (psi) at all services in the system.

Analysis of the existing and proposed system assumed that all supply necessary to meet the maximum daily water demands within each pressure zone was provided through the City's existing storage facilities under normal operating conditions.

Modeling Results

The results of the modeling analysis revealed distribution system deficiencies during fire flow events under existing conditions and saturation development conditions in all six (6) of the pressure zones resulting in unacceptable pressure drops below 20 psi. In other words, certain localized areas of the distribution system lack the hydraulic capacity to deliver the full recommended fire flow rate while simultaneously supplying maximum day demands. Potential system improvements were systematically input into the model and tested to determine the most effective and economical improvements to address the deficiencies. The recommended distribution system improvements are tabulated and can be found in the appendix. Plate 1 also illustrates the location and proposed size of recommended improvements.

System performance was generally found to be adequate under the full range of domestic water supply needs including existing and future peak hour conditions with minimal pressure fluctuation. However, under existing and future maximum day demand with fire flow conditions, certain areas in the distribution system were found to be inadequate. Approximately 79,000 linear feet of piping improvements are recommended to address these deficiencies. With the completion of these improvements the system is expected to perform adequately under future saturation development demand conditions while simultaneously supplying the required fire flow event at any location in the system. Section 8 includes detailed cost estimates, individual project data sheets and a Capital Improvements Plan (CIP) prioritizing the recommended improvements.

Summary

The planning criteria developed in this section were used to assess the system's ability to provide adequate water service under existing conditions and to guide improvements needed to provide service for future water needs. This section also documents the analysis of the distribution system, identification of system deficiencies and recommended system improvements to provide adequate and reliable service under existing and future conditions. The analysis results presented in this section and other previous sections are further developed into comprehensive capital improvement and capital maintenance programs documented in Section 8.

SECTION 8

SECTION 8
CAPITAL IMPROVEMENT PLAN, CAPITAL MAINTENANCE PLAN, PROJECT COST ALLOCATIONS AND FINANCING OPTIONS

General

This section presents recommended water system improvements for the City of West Linn (City) that provide for the correction of existing deficiencies and expansion of the distribution system to support anticipated future development within the Urban Growth Boundary (UGB). These improvements, based on the analysis and findings presented in Sections 4, 5, 6 and 7, include proposed additional water storage volume, pumping capacity and piping improvements as well as maintenance improvements for existing water system facilities. This section also includes a discussion of System Development Charge (SDC) allocations for the proposed improvements and outlines potential options for financing the proposed improvements.

Cost Estimating Data

An estimated project cost has been developed for each recommended improvement presented in this section. The American Association of Cost Engineers (AACE) classifies cost estimates depending on project definition, end usage and other factors. The cost estimates presented in this document are considered Class 4 with an end usage being a study or feasibility evaluation and an expected accuracy range of -30 percent to +50 percent. As the projects are better defined the accuracy level of the estimates can be narrowed. Itemized project data sheet summaries are presented in Appendix E. Project costs include construction costs and an allowance for administrative, engineering and other project related costs. The estimated costs included in this plan are planning level budget estimates presented in 2008 dollars. 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 20-City average, August 2008 ENR CCI of 8,362 was used for project cost estimates in this report.

Recommended Improvements

The analyses presented in previous sections form the basis for the recommended water distribution system improvements discussed in Section 8. Recommended improvements include maintenance projects to improve the reliability or performance of existing facilities and proposed new or replacement facilities to address existing inadequacies or inadequacies found under future demand conditions. System improvements include recommendations for improvements to reservoirs, pump stations, distribution system water lines and other facilities. The recommended improvements in this section are presented by project type and include projects related to the City's Capital Maintenance Plan (CMP) and Capital Improvement Plan (CIP). Project cost estimates are presented for all recommended improvements and annual budgets are presented which support on-going programs. All recommended improvements are located within the City's existing UGB and are intended to server existing development and planned growth that occurs inside the UGB.

Capital Maintenance Program

Based on the evaluations documented in Section 4, several improvements were identified for inclusion in the City's water system CMP. The CMP is recommended for major maintenance and replacement needs of existing facilities. Table 8-1 lists the projects included in the CMP and itemizes the estimated project costs associated with these maintenance projects for the 20-year study period of the master plan. A discussion of each CMP project follows Table 8-1. All estimates are in 2008 dollars.

Table 8-1
Recommended CMP Project Cost and Budget Summary

CMP Project	Estimated Project Cost
Asbestos Cement Pipe Replacement	$6,900,000
Galvanized/Steel Pipe Replacement	750,000
Pressure Reducing Valve Vault Improvements	100,000
Reservoir Seismic Assessment and Improvements	390,000
Reservoir Coating Maintenance and Replacement	360,000
Willamette Pump Station Motor Control Center Assessment and Upgrades	120,000
Demolish Abandoned View Drive Site Facilities	75,000
SCADA System Upgrades	150,000
Total	**$8,845,000**

Asbestos Cement Pipe Replacement

It is recommended that the City continue the asbestos cement (AC) water main replacement program. Aging AC pipe has been shown to have higher occurrences of leaks and failures than other piping materials and special precautions must be taken when working near, tapping into, or connecting to this pipe material. The City's current AC main replacement program should continue to be funded by the CMP until all AC pipe in the system has been replaced. Approximately 54,300 linear feet of 4-, 6-, 8- and 10-inch diameter AC pipe are included in the CMP for replacement. Main piping 8-inch diameter and smaller should be replaced with new 8-inch diameter pipes and 10-inch diameter mains should be replaced with 10-inch diameter piping. As discussed in Section 7, 8-inch diameter is the minimum size recommended for new and replacement mains in order to support fire flow requirements as outlined in the State of Oregon Fire Code and as adopted by Tualatin Valley Fire & Rescue. Where a dead-end main is being replaced that does not support a fire hydrant, and no plans for future looping are anticipated, a 6-inch diameter main size may be considered. An annual budget of $345,000 is included in the CMP for complete replacement of the AC pipe over the 20-year planning horizon, resulting in a total CMP budget of $6,900,000.

Galvanized/Steel Pipe Replacement

It is recommended that the City continue to replace existing undersized and aging galvanized and steel pipelines. These waterlines, typically 3 inches in diameter or less, are generally dead-end mains providing service to a limited number of homes. For these small diameter dead-end mains that do not support fire hydrants and will not be looped in the future, construction of an 8-inch diameter main will result in excess unused capacity with no benefit to the distribution system and may result in water quality issues. As such, it is recommended that replacement of these mains be completed with 4-inch diameter ductile iron piping. An annual budget of $75,000 from fiscal year (FY) 2010 through FY 2019 is included in the CMP to allow the City to completely replace the remaining 11,500 linear feet of galvanized and steel piping in the system.

Pressure Reducing Valve Stations

It is recommended that the City complete drainage improvements at existing Pressure Reducing Valve (PRV) vaults below a ground elevation of approximately 175 feet to address potential flooding issues. These vaults should be sealed to reduce groundwater infiltration and surface water inflow, and sump pumps installed to effectively remove any water that enters the vault. A budget of $20,000 per year from FY 2010 through FY 2014 is included in the CMP resulting in a total of $100,000 for all five (5) years.

Reservoir Seismic Assessment and Improvements

It is recommended that the City complete a seismic assessment of the selected existing reservoirs to assess the current seismic risk at each site, determine if the current level of seismic restraint is adequate and develop recommended improvements as needed to meet current seismic code requirements. It is anticipated that these assessments will be completed for the Willamette, View Drive, Bland and Horton Reservoirs. Other existing reservoirs are not recommended for assessments because the Rosemont Reservoir is assumed to be adequate given its recent design which included seismic considerations and a CIP project is recommended for replacement of the Bolton Reservoir. The estimated project cost for this assessment is $90,000 and it is recommended that the assessment be completed in FY 2012. A budget of $100,000 is included in the CMP for FY 2014 through FY 2016 for completion of recommended improvements developed during the assessment.

Ongoing Reservoir Lining and Coating Maintenance

It is recommended that the City's existing Bland, Rosemont and View Drive reservoirs be re-coated within the 20-year planning horizon. A schedule for completing these re-coatings is included in the CMP. It is recommended that the Bland Reservoir interior and exterior coating be replaced in FY 2017 after construction of Bland Reservoir No. 2 is completed (this project is included in the CIP for construction in FY 2015). The estimated project cost for this improvement is $150,000. It is also recommended that the exterior coating of the View Drive and Rosemont reservoirs be replaced. These improvements are considered medium-term improvements and a budget of $210,000 is included in the CMP for completion of these improvements.

Willamette Pump Station Motor Control Center (MCC) Assessment

It is recommended that an assessment of the condition, performance and operation of the existing MCCs in the Willamette Pump Station to be completed to determine if corrective repairs or replacement will be required to address issues identified by City staff. These issues include pump performance and operational concerns. It is recommended that the City proceed with the completion of this assessment in FY 2010 to determine the extent of improvements required. A budget of $20,000 is included in the CMP for completion of the assessment and an approximate budget of $100,000 is included in FY 2011 for completion of recommended improvements developed during the assessment. This budget amount should be confirmed as part of the assessment.

Demolition of Abandoned View Drive Site Facilities

It is recommended that the abandoned reservoir and pump station on the View Drive site be demolished and removed to improve site aesthetics and reduce the risk associated with failure of aging structures. A project cost of $75,000 is included in the CIP for FY 2012 to complete these site improvements.

Supervisory Control and Data Acquisition (SCADA) System Upgrades

It is recommended that the City complete upgrades to the water SCADA system. Recommended upgrades include replacement of existing aging infrastructure, including the Master Telemetry Unit and components at remote pump station sites. The upgraded telemetry system should be capable of allowing remote operator interface and control from a portable computer via an internet connection. The software interface should also allow for efficient review, analysis, charting, plotting and exporting of historical water system trend data including water demand, meter readings, reservoir levels and pump run times. It is recommended that the City proceed with the completion of SCADA system upgrades in FY 2010. A budget level project cost estimate of $150,000 for completion of the necessary system upgrades is included in the CMP.

CMP System Development Charge Allocation

The proposed CMP projects itemized above are generally considered maintenance projects and do not provide expanded capacity to the system. As such, there is no SDC allocation for these projects.

Capital Improvement Program

Based on the analysis of the water system's storage, pumping, transmission, and distribution facilities presented in previous sections, a list of recommended system improvements for each category has been developed for inclusion in the CIP. A discussion of CIP elements is presented below.

Reservoirs

It is recommended that two new reservoirs be constructed in the water service area within the planning horizon. Table 8-2 presents a summary listing of these recommendations and includes project cost estimates for each reservoir as well as timing for a recommended project start. Also included in Table 8-2 is an SDC allocation for each project. Allocation assumptions for each project are included in the discussion below.

Table 8-2
Recommended Reservoir Improvement Summary

Project Start (Fiscal Year)	Project Description	Estimated Project Cost	SDC Allocation
2010	Bolton Reservoir Replacement – 4.0 MG	$8,000,000	30% [1]
2014	Bland Reservoir No. 2 – 0.3 MG	$525,000	33%
	Total	**$8,525,000**	

Note: 1. The SDC allocation for the Bolton Reservoir is based on the capacity required to serve future growth within the UGB which is approximately 1.2 mg. This reflects the future expanded storage needs of the Bolton, Robinwood and Willamette pressure zones.

Bolton Reservoir Replacement

It is recommended that the existing 2.0 mg Bolton Reservoir be abandoned, removed and replaced with a new reservoir on the same parcel. The proposed Bolton Reservoir replacement should have a total capacity of 4.0 mg. It is anticipated that the new reservoir will be a partially-buried, circular, strand-wrapped, pre-stressed, concrete structure. The overflow elevation of the proposed reservoir should be approximately 450 feet, 10 feet higher than the overflow elevation of the existing reservoir, with a sidewall height of 30 to 35 feet. This additional sidewall height provides more effective service to the Bolton pressure zone from the reservoir when the South Fork Water Board (SFWB) Division Street Pump Station is not in operation and provides improved suction pressure to the Bolton Pump Station. Preliminary engineering, preliminary designs and final designs for replacement of the Bolton Reservoir are recommended to begin in FY 2010 with construction occurring in FY 2011 and FY 2012.

The SDC allocation for this project assumes that the replacement capacity of the existing 2.0 mg reservoir and an additional 0.8 mg is for existing customers. The additional 1.2 mg capacity beyond that is to serve growth within the service area through saturation development.

Bland Reservoir No. 2

It is recommended that the City construct a new 0.3 mg welded steel reservoir in the Bland pressure zone. The proposed reservoir should be located adjacent to the existing Bland Reservoir and should match the floor and overflow elevations of this existing reservoir. It is recommended that preliminary design and final design of this proposed reservoir begin in FY 2014 with construction occurring in FY 2015.

The SDC allocation for this project assumes that the existing reservoir provides service to existing customers and the proposed reservoir will address the existing Bland pressure zone storage deficit and serve future customers.

Pump Stations

General

It is recommended that two (2) pump stations be modified or upgraded. Booster pump station recommendations are based on analysis presented in prior sections. A detailed description of each recommendation is presented below in order of priority. Table 8-3 presents a summary of recommended pump station improvements including project priority and an estimated project start and cost for each recommendation.

Table 8-3
Recommended Pump Station Improvement Summary

Project Start (Fiscal Year)	Project Description	Estimated Project Cost
2011	Emergency Intertie Pump Station Expansion	$75,000
2013	3rd Rosemont Pressure Zone Supply PS – Bland Reservoir Site	$ 1,250,000
	Total	**1,325,000**

Emergency Intertie Pump Station Expansion

The supply and storage analysis identified that the City lacks adequate reliable emergency supply to meet future needs in the event that the SFWB supply is interrupted. The City is considering coordinating with the cities of Lake Oswego and Tigard to facilitate development of system interconnections to ensure reliable emergency supplies through the use of broader regional resources. It is anticipated that this emergency supply will be available to the City through the Emergency Intertie Pump Station. It is recommended that the City proceed with the installation of a third pump in the station to increase the firm capacity to approximately 6 mgd. The estimated project cost for this improvement is $75,000 and this improvement is scheduled in the CIP for completion in FY 2011.

The SDC allocation for this project which will improve the capacity of the City's emergency supply system, providing equal benefit to all existing and future customers, is based on the ratio of existing population to future population.

Bland Intertie Supply to Rosemont

The storage and pumping analysis identified a deficiency in supply to the Rosemont pressure zone under future conditions. Construction of a third pump station to boost water from a lower pressure zone into the Rosemont pressure zone is recommended. Through discussions with City staff it was determined that the best location for this pump station is at the Bland Reservoir site. Siting the pump station at this location provides a geographical distribution of the supply to the Rosemont pressure zone, is a hydraulically suitable location with adequate suction supply to the pump station and is located relatively close (approximately one-half mile) from an existing 12-inch diameter transmission main in the Rosemont pressure zone. The estimated project cost for this improvement including approximately 2,500 linear feet of 12-inch diameter pump station discharge piping to the Rosemont pressure zone is $1,250,000. It is recommended that this project be constructed in fiscal year 2016.

The SDC allocation for this project, intended to address future deficiencies, is 100 percent to growth.

Distribution System Improvements

General

The distribution system analysis found that water line improvements are needed to provide improved hydraulic transmission capacity, increased fire flow capacities and provide for system expansion. For the purpose of this section, recommended distribution system improvements are grouped in the following categories presented in Table 8-4 representing relative priority, with 1 being the highest priority and 5 being the lowest. These groupings are also used to establish the SDC allocation based on the City's current methodology.

Table 8-5 presents recommended distribution system water line improvements for each pressure zone. Each improvement is identified by category and includes existing diameter and pipe material, proposed replacement or new diameter, linear feet of main and SDC allocation.

Table 8-4
Recommended Distribution System Improvement Prioritization

Priority Category	Description	SDC Allocation Methodology
1	Improvements related to increasing transmission capacity between supply facilities.	These improvements are intended to address deficiencies in transmission capacity. New mains are allocated to growth and the expanded capacity of replacement mains are allocated to growth. These are the highest priority improvements because they provide the broadest benefit to the greatest number of customers.
2	Improvements related to improving fire flow capacities, addressing existing system deficiencies.	These improvements address existing deficiencies and are therefore allocated to existing customers. If a project must be increased in size to accommodate future needs then the oversized portion is allocated to growth.
3	Improvements related to improving fire flow capacities, addressing build-out system deficiencies.	These improvements address deficiencies resulting from future customer demand and are allocated to future customers.
4	Improvements intended to increase system looping and proposed for opportunistic completion with planned developments.	These improvements are required to meet the demands of future development and are allocated entirely to growth within the UGB. A number of these projects are anticipated to be required as a condition of development.
5	Local improvements addressing fire flow capacities for a small number of customers, such as dead-end mains.	These improvements address existing deficiencies and are for local system needs. Allocation of these projects is entirely to existing customers.

Pressure Reducing Valve Station

It is recommended that a PRV station and associated connection piping be constructed on Scenic Drive for supply between two subzones in the Rosemont pressure zone, pressure zone 13 and pressure zone 12. This improvement will provide additional hydraulic capacity to subzone 12 and improve the reliability of supply to this pressure zone. It is recommended that this improvement be completed in FY 2014. The estimated project cost of this improvement is approximately $120,000.

Table 8-5
Recommended Distribution System Piping Improvement Summary

No.	Location	Pressure Zone	Existing Diameter (inches)	Proposed Diameter (inches)	Priority	Length (feet)	SDC Allocation	Unit Cost ($/lf)	Estimated Project Cost[1]
	Willamette Pressure Zone								
1	Willamette Falls Dr. from PRV to Pump Station	Willamette	10	20	1	3,710	75%	320	$ 1,187,200
2	Willamette Falls Dr. from Britton to Ostman	Willamette	3, 4	12	2	1,686	56%	185	$ 311,910
3	Dollar St. from 16th to Fields Dr.	Willamette	6	12	2	2,733	56%	185	$ 505,605
4	16th St & 8th Ave. to 10th St.	Willamette	4, 6	8	3	2,809	100%	125	$ 351,125
5	12th St. from Tualatin Ave. to Volpp St. on to 9th St. up to 5th Ave.	Willamette	6	8	5	2,845	0%	125	$ 355,625
6	10th St. from 5th Ave. to Leslies Way	Willamette	2	8	5	678	0%	125	$ 84,750
7	19th St. from Dollar St. to Blankenship Rd.	Willamette	6	8	3	1,958	100%	125	$ 244,750
8	Ostman Rd. from Dollar St. to Blankenship Rd.	Willamette	6	8	3	1,365	100%	125	$ 170,625
9	Michael Dr.	Willamette	4, 6	8	5	743	0%	125	$ 92,875
10	Blankenship Rd. from Ostman Rd. to 19th	Willamette	6	8	3	980	100%	125	$ 122,500
11	19th St. from Blankenship Rd. to Johnson Rd.	Willamette	6	8	3	1,412	100%	125	$ 176,500
12	Blankenship Rd. from 19th to Willamette Terrace Apartments	Willamette	6	8	3	378	100%	125	$ 47,250
			6	10	3	643	100%	155	$ 99,665
13	Johnson Rd. from Blankenship Rd. to Willamette River	Willamette	6	8	3	4,147	100%	125	$ 518,375
14	Ostman Rd.& Dollar St. to Rancho Lobo Ln & Swiftshore Dr.	Willamette	6	8	3	2,565	100%	125	$ 320,625
15	South of Willamette Falls Dr. & 19th to Swiftshore Dr.	Willamette	6	8	5	720	0%	125	$ 90,000
16	Swiftshore Dr.	Willamette	6	8	5	874	0%	125	$ 109,250
			6	12	5	340	0%	185	$ 62,900
17	Evah Ln	Willamette	4	8	5	507	0%	125	$ 63,375
18	From Willamette Falls Dr. to Dollar St.	Willamette	-	10	4	1,450	100%	155	$ 224,750
20	Debok Rd. from Blankenship Rd. to Margery St.	Willamette	6	10	2	1,268	36%	155	$ 196,540
21	Village Park Pl.	Willamette	6	8	5	532	0%	125	$ 66,500
23	Debok Rd. from Village Park Pl. to Tamarisk Dr.	Willamette	6	10	2	1,614	36%	155	$ 250,170
24	Farrvista Dr. & Debok Rd. to Farrvista Ct.	Willamette	6	8	5	597	0%	125	$ 74,625
			6	10	5	411	0%	155	$ 63,705
25	Tamarisk Dr.	Willamette	6	8	3	716	100%	125	$ 89,500
26	Troy Ct.	Willamette	6	8	5	551	0%	125	$ 68,875
27	Wisteria Ct.	Willamette	6	8	5	320	0%	125	$ 40,000
34	I-205 crossing west of Tamarisk Dr.	Willamette	-	8	4	1,208	100%	125	$ 151,000
	Bland Pressure Zone								
19	Barnes Circle from Greene St. to Lois Ln.	Bland	6	8	5	546	0	125	$ 68,250
22	Riverknoll Ct.	Bland	6	8	5	547	0	125	$ 68,375
28	Killarney Dr. from Debok Rd. to PRV	Bland	6	8	1	1,200	44%	125	$ 150,000
	Killarney Dr. from PRV to Tipperary Ct.	Bland	6	8	1	354	44%	125	$ 44,250

Table 8-5
Recommended Distribution System Piping Improvement Summary

No.	Location	Pressure Zone	Existing Diameter (inches)	Proposed Diameter (inches)	Priority	Length (feet)	SDC Allocation	Unit Cost ($/lf)	Estimated Project Cost[1]
	Horton Pressure Zone								
29	Weatherhill Rd. from S. Salamo Rd to S. Bland Circle and then south	Horton	-	8	4	2,312	100%	125	$ 289,000
31	Sussex St. south of Sunset Ave.	Horton	4	8	5	248	0%	125	$ 31,000
32	From River View Ave. to Falls View Dr.	Horton	4	8	5	213	0%	125	$ 26,625
39	Clark St. south of Skyline	Horton	6	8	5	425	0%	125	$ 53,125
42	North of Linn Ln.	Horton	6	8	5	369	0%	125	$ 46,125
43	Parkview Terrace and Rosepark Dr.	Horton	6	8	5	765	0%	125	$ 95,625
47	Apollo Rd. west of Athena Rd.	Horton	6	8	5	385	0%	125	$ 48,125
48	Palomino Way from Saddle Ct. to Palomino Circle	Horton	6	8	4	246	100%	125	$ 30,750
	Bolton Pressure Zone								
36	River St. from Burns St. to Holly St.	Bolton	4, 6	8	2	2,107	0%	125	$ 263,375
			4	8	5	251	0%	125	$ 31,375
38	Burns St. from Hood St. to River St.	Bolton	6	8	2	1,228	0%	125	$ 153,500
40	Caufield St.	Bolton	6	8	5	711	0%	125	$ 88,875
49	Mark Ln. from Willamette Dr. to Lowell Ave	Bolton	6	8	3	759	100%	125	$ 94,875
50	Magone Ln. west of Tulane St.	Bolton	4	8	5	293	0%	125	$ 36,625
51	Dillow Dr. and Larson Ave. area	Bolton	4,6	8	2	1,334	0%	125	$ 166,750
			6	10	2	901	36%	155	$ 139,655
52	Hidden Springs Rd. southwest of Willamette Dr.	Bolton	6	8	3	319	100%	125	$ 39,875
	Rosemont Pressure Zone								
30	Weatherhill Rd.	Rosemont	-	8	4	861	100%	125	$ 107,625
37	Suncrest Ave. from Carriage Way to Valley View Dr.	Rosemont	8	12	2	1,656	56%	185	$ 306,360
41	Ridge Ln. area	Rosemont	2	8	4	1,300	100%	125	$ 162,500
44	S. Shannon Ln. north of Rosepark Dr.	Rosemont	6	8	5	602	0%	125	$ 75,250
46	Parker Rd. to Horton Reservoir	Rosemont	-	18	1	3,240	56%	290	$ 939,600
45	Rosemont Rd. from Salamo Rd to Wild Rose Dr	Rosemont	8	12	2	1,843	56%	185	$ 340,955
61	Upper Midhill Circle from Robinwood Way to Marylhurst Dr	Rosemont	4	8	3	795	100%	125	$ 99,375
62	View Drive Pump Station to Marylhurst Drive	Rosemont	8	10	2	170	36%	155	$ 26,350
63	Arbor Dr. from Upper Midhill Dr. to Lower Midhill Dr	Rosemont	6	8	3	406	100%	125	$ 50,750
64	Scenic Drive and Hillside Dr. area	Rosemont	-	8	4	680	100%	125	$ 85,000
	Robinwood Pressure Zone								
35	Transmission to View Dr. Reservoir	Robinwood	10	12	1	4,211	31%	185	$ 779,035
53	Elmran Dr. from Cedaroak Dr. to Nixon Ave.	Robinwood	-	8	4	988	100%	125	$ 123,500
54	Nixon Ave.	Robinwood	2, 6	8	2	2,536	0%	125	$ 317,000
			6	8	2	492	0%	125	$ 61,500
55	Elmran Dr. from Trillium Dr. to Calaroga Dr	Robinwood	-	8	4	860	100%	125	$ 107,500
56	Parkwood Way west of Calaroga Dr.	Robinwood	2	8	5	225	0%	125	$ 28,125
57	River Rd south of Riverwood Pl.	Robinwood	6	8	3	411	100%	125	$ 51,375
59	Vista Ct.	Robinwood	6	8	5	584	0%	125	$ 73,000
60	Shady Hollow Way and Willamette Dr. to Fairview Way	Robinwood	3, 6	8	2	2,002	0%	125	$ 250,250

Supply and Treatment

The SFWB is responsible for planning, sequencing, managing and constructing improvements related to the City's water supply source. Section 5 documented a review of the SFWB Water Master Plan Update completed in 2004 and verified that current planning adequately addresses the City's long-term water supply needs. The majority of the proposed improvements to the SFWB system are understood to be primarily for growth and as such the cost of these improvements will be borne by future customers through the payment of SDCs. Capital improvement costs for these improvements are accounted for separately by the SFWB and not included in the City's CIP presented herein.

CMP and CIP Schedule Summary

A summary of the recommended improvements is presented in Table 8-6. The table provides for prioritized project sequencing by illustrating annual project needs for each facility or improvement category in the next eight (8) years. Those improvements recommended for construction beyond FY 2017 and within the 20-year horizon are identified as medium term projects and those beyond the 20-year planning horizon are identified as long-term improvements. It is recommended that the City's CMP be funded at approximately $550,000 per year for the first five (5) years and then approximately $410,000 per year for the next 15 years. It is recommended that the City's CIP be funded at approximately $1,570,000 annually for storage, pumping and distribution system piping improvements over the 20-year planning horizon. While the funding needs for certain water system improvements may exceed this amount, especially in the first several years as proposed storage improvements in the Bolton pressure zone are recommended for completion, the proposed improvements listed in Table 8-6 are phased and sequenced so that the ultimate 20-year average annual capital requirement is approximately $1,570,000.

Plate 1 in Appendix A illustrates the City's water system and identifies proposed CIP and CMP projects discussed herein. Individual project data sheets, contained in Appendix E, include further detail about each CIP project.

Funding Sources

The City may fund the water capital maintenance and improvement programs from a variety of sources. In general, these sources can be summarized as: 1) governmental grant and loan programs; 2) publicly issued debt; and 3) cash resources and revenues. These sources are described below.

Government Loan and Grant Programs

Oregon State Safe Drinking Water Financing Program

Annual grants from the U.S. Environmental Protection Agency (EPA) and matching state resources support the Safe Drinking Water Fund. The program is managed jointly by the

Table 8-6
Capital Improvement and Capital Maintenance Program Summary

Category	Project Description	Project Location	2010	2011	2012	2013	2014	2015	2016	2017	Medium-Term (2018 -2030)	Long-Term (2030+)	Estimated Project Cost
			CIP and CMP Schedule and Project Cost Summary (Fiscal Year)										
			Capital Maintenance Projects										
	Distribution System	AC Pipe Replacement	$ 345,000	$ 345,000	$ 345,000	$ 345,000	$ 345,000	$ 345,000	$ 345,000	$ 345,000	$ 4,140,000		$ 6,900,000
		Galvanized Pipe Replacement	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 75,000	$ 150,000		$ 750,000
		Pressure Reducing Valve Vault Improvements	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000						$ 100,000
	Reservoir Improvements	Seismic Assessment and Improvements			Assessment $ 90,000		$ 100,000	Improvements $ 100,000	$ 100,000				$ 390,000
		Reservoir Re-coating	Bland $ 150,000								View Drive and Rosemont $ 210,000		$ 360,000
	General System Improvements	Willamette Pump Station MCC Assessment and Upgrades	Assessment $ 20,000	Upgrades $ 100,000									$ 120,000
		Demolish Abandoned View Drive Site Facilities			$ 75,000								$ 75,000
		SCADA System Upgrades		$ 150,000									$ 150,000
		Capital Maintenance Plan (CMP) Total	*$ 610,000*	*$ 690,000*	*$ 605,000*	*$ 440,000*	*$ 540,000*	*$ 520,000*	*$ 520,000*	*$ 420,000*	*$ 4,500,000*	*$ -*	*$ 8,845,000*
			Capital Improvement Projects										
Storage and Pumping Facilities	Bolton Pressure Zone	Bolton Reservoir Replacement (4.0 MG)	$ 500,000	$ 4,000,000	$ 3,500,000								$ 8,000,000
	Bland Pressure Zone	Bland Reservoir No. 2 (0.3 mg)					$ 125,000	$ 400,000					$ 525,000
	Rosemont Pressure Zone	Bland Intertie Supply to Rosemont							$ 1,250,000				$ 1,250,000
	Emergency Intertie	Emergency Intertie PS Expansion		$ 75,000									$ 75,000
		Sub-Total	*$ 500,000*	*$ 4,075,000*	*$ 3,500,000*	*$ -*	*$ 125,000*	*$ 400,000*	*$ 1,250,000*	*$ -*	*$ -*	*$ -*	*$ 9,850,000*
Distribution System Piping	Willamette Pressure Zone	CIP - 1	$ 1,187,200										$ 1,187,200
		CIP - 2					$ 311,910						$ 311,910
		CIP - 3						$ 505,605					$ 505,605
		CIP - 4									$ 351,125		$ 351,125
		CIP - 5										$ 355,625	$ 355,625
		CIP - 6										$ 84,750	$ 84,750
		CIP - 7									$ 244,750		$ 244,750
		CIP - 8									$ 170,625		$ 170,625
		CIP - 9										$ 92,875	$ 92,875
		CIP - 10									$ 122,500		$ 122,500
		CIP - 11									$ 176,500		$ 176,500
		CIP - 12									$ 146,915		$ 146,915
		CIP - 13									$ 518,375		$ 518,375
		CIP - 14									$ 320,625		$ 320,625
		CIP - 15										$ 90,000	$ 90,000
		CIP - 16										$ 172,150	$ 172,150
		CIP - 17										$ 63,375	$ 63,375
		CIP - 18									$ 224,750		$ 224,750
		CIP - 20									$ 196,540		$ 196,540
		CIP - 21										$ 66,500	$ 66,500
		CIP - 23									$ 250,170		$ 250,170
		CIP - 24										$ 138,330	$ 138,330
		CIP - 25									$ 89,500		$ 89,500
		CIP - 26										$ 68,875	$ 68,875
		CIP - 27										$ 40,000	$ 40,000
		CIP - 34									$ 151,000		$ 151,000
	Bland Pressure Zone	CIP - 19										$ 68,250	$ 68,250
		CIP - 22										$ 68,375	$ 68,375
		CIP - 28					$ 194,250						$ 194,250
	Horton Pressure Zone	CIP - 29									$ 289,000		$ 289,000
		CIP - 31										$ 31,000	$ 31,000
		CIP - 32										$ 26,625	$ 26,625
		CIP - 39										$ 53,125	$ 53,125
		CIP - 42										$ 46,125	$ 46,125
		CIP - 43										$ 95,625	$ 95,625
		CIP - 47										$ 48,125	$ 48,125
		CIP - 48									$ 30,750		$ 30,750
	Bolton Pressure Zone	CIP - 36									$ 294,750		$ 294,750
		CIP - 38									$ 153,500		$ 153,500
		CIP - 40										$ 88,875	$ 88,875
		CIP - 49									$ 94,875		$ 94,875
		CIP - 50										$ 36,625	$ 36,625
		CIP - 51									$ 306,405		$ 306,405
		CIP - 52									$ 39,875		$ 39,875
	Rosemont Pressure Zone	CIP - 30									$ 107,625		$ 107,625
		CIP - 37									$ 306,360		$ 306,360
		CIP - 41									$ 162,500		$ 162,500
		CIP - 44										$ 75,250	$ 75,250
		CIP - 45									$ 340,955		$ 340,955
		CIP - 46								$ 939,600			$ 939,600
		CIP - 61									$ 99,375		$ 99,375
		CIP - 62									$ 26,350		$ 26,350
		CIP - 63									$ 50,750		$ 50,750
		CIP - 64									$ 85,000		$ 85,000
	Robinwood Pressure Zone	CIP - 35							$ 779,035				$ 779,035
		CIP - 53									$ 123,500		$ 123,500
		CIP - 54									$ 378,500		$ 378,500
		CIP - 55									$ 107,500		$ 107,500
		CIP - 56										$ 28,125	$ 28,125
		CIP - 57									$ 51,375		$ 51,375
		CIP - 59										$ 73,000	$ 73,000
		CIP - 60									$ 250,250		$ 250,250
	Pressure Reducing Facilities	Scenic Drive PRV Station					$ 120,000						$ 120,000
		Sub-Total	*$ 1,187,200*	*$ -*	*$ -*	*$ -*	*$ 626,160*	*$ 505,605*	*$ 779,035*	*$ 939,600*	*$ 6,262,570*	*$ 1,911,605*	*$ 12,211,775*
Supply	Emergency Supply	Tigard/Lake Oswego Intertie	$ 700,000			$ 1,500,000							$ 2,200,000
		Sub-Total	*$ 700,000*	*$ -*	*$ -*	*$ 1,500,000*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ 2,200,000*
Other	Planning Studies	Water System Master Plan Update									$ 150,000		$ 150,000
													$ -
		Sub-Total	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ -*	*$ 150,000*	*$ -*	*$ 150,000*
		Capital Improvement Plan (CIP) Total	*$ 2,387,200*	*$ 4,075,000*	*$ 3,500,000*	*$ 1,500,000*	*$ 751,160*	*$ 905,605*	*$ 2,029,035*	*$ 939,600*	*$ 6,412,570*	*$ 1,911,605*	*$ 24,411,775*
		CMP & CIP TOTAL	**$ 2,997,200**	**$ 4,765,000**	**$ 4,105,000**	**$ 1,940,000**	**$ 1,291,160**	**$ 1,425,605**	**$ 2,549,035**	**$ 1,359,600**	**$ 10,912,570**	**$ 1,911,605**	**$ 33,256,775**
							$ 15,098,360 5 Year Total			$ 20,432,600 8 Year Total	$ 31,345,170 20 Year Total		
							$ 3,019,672 Annual Ave.			$ 2,554,075 Annual Ave.	$ 1,567,259 Annual Ave.		

Department of Human Services (DHS), Drinking Water Program and the Oregon Economic and Community Development Department (OECDD).

The Safe Drinking Water Fund program provides low-cost financing for construction and/or improvements of public and private water systems. This is accomplished through two (2) separate programs; Safe Drinking Water Revolving Loan Fund (SDWRLF) for collection, treatment, distribution and related infrastructure, and Drinking Water Protection Loan Fund (DWPLF) for sources of drinking water prior to system intake.

SDWRLF lends up to $8 million per project, with a possibility of subsidized interest rate and principal forgiveness for a Disadvantaged Community.

The standard loan term is 20 years or the useful life of project assets, whichever is less, with interest rates at 80 percent of the current state/local bond rate.

The maximum award for the DWPLF is $100,000 per project.

Special Public Works Fund

The Special Public Works Fund program provides funding for the infrastructure that supports job creation in Oregon. Loans and grants are made to eligible public entities for the purpose of studying, designing and building public infrastructure that leads to job creation or retention.

There are four (4) major project categories eligible for funding under this program:

- Public infrastructure needed to support job creation
- Community facilities that support the local economy
- Essential Community Facilities Emergency Projects
- Railroads

Water systems are listed among the eligible infrastructure projects to receive funding. The Special Public Works Fund is comprehensive in terms of the types of project costs that can be financed. As well as actual construction, eligible project costs can include costs incurred in conducting feasibility and other preliminary studies and for the design and construction engineering.

The Fund is primarily a loan program. Grants can be awarded, up to the program limits, based on job creation or on a financial analysis of the applicant's capacity for carrying debt financing.

The total loan amount per project cannot exceed $15 million. The OECDD is able to offer discounted interest rates that typically reflect low market rates for very good quality creditors. In addition, the Department absorbs the associated costs of debt issuance thereby saving applicants even more on the overall cost of borrowing. Loans are generally made for 20-year terms, but can be stretched to 25 years under special circumstances.

Water/Wastewater Fund

The Water/Wastewater Fund was created by the Oregon State Legislature in 1993. It was initially capitalized with lottery funds appropriated each biennium and with the sale of state revenue bonds since 1999. The purpose of the program is to provide financing for the design and construction of public infrastructure needed to ensure compliance with the Safe Drinking Water Act or the Clean Water Act.

Eligible activities include costs for construction improvement or expansion of drinking water, wastewater or stormwater systems. To be eligible a system must have received, or is likely to soon receive, a Notice of Non-Compliance by the appropriate regulatory agency, associated with the Safe Drinking Water Act or the Clean Water Act. Projects also must meet other state or federal water quality statutes and standards.

Funding criteria include projects that are necessary to ensure that municipal water and wastewater systems comply with the Safe Drinking Water Act or the Clean Water Act.

In addition, other limitations apply including:

- The project must be consistent with the acknowledged local comprehensive plan.
- The municipality will require the installation of meters on all new service connections to any distribution lines that may be included in the project.
- The funding recipient shall certify that a registered professional engineer will be responsible for the design and construction of the project.

The Water/Wastewater Fund provides both loans and grants, but it is primarily a loan program. The loan/grant amounts are determined by a financial analysis of the applicant's ability to afford a loan including the following criteria: debt capacity, repayment sources and other factors.

The Water/Wastewater Fund financing program's guidelines, project administration, loan terms and interest rates are similar to the Special Public Works Fund program. The maximum loan term is 25 years or the useful life of the infrastructure financed, whichever is less. The maximum loan amount is $15,000,000 per project through a combination of direct and/or bond funded loans.

Loans are generally repaid with utility revenues or voter-approved bond issuance. A limited tax general obligation pledge may also be required. Certain entities may seek project funding within this program through the sale of state revenue bonds.

Public Debt

Revenue Bonds

Revenue bonds are commonly used to fund utility capital improvements. The bond debt is secured by the revenues of the issuing utility and the debt obligation does not extend to other City resources. With this limited commitment, revenue bonds typically require security conditions related to the maintenance of dedicated reserves referenced as bond reserves and financial performance measures which are added to the bond debt as service coverage. In order to qualify to sell revenue bonds, the City must show that the net revenue defined as total revenue less operating and maintenance expense, for the water fund is equal to or greater than a standard factor, typically 1.2 to 1.4 times the annual revenue bond debt service. This factor is commonly referred to as the coverage factor, and is applicable to revenue bonds sold on the commercial market. There is no bonding limit, except the practical limit of the utility's ability to generate sufficient revenue to repay the debt and meet other security conditions. In some cases, poor credit may impair a community's ability to acquire and use revenue bonds.

Revenue bonds incur relatively higher interest rates than government programs, but due to the highly competitive nature of the low-interest government loans, revenue bonds are assumed to be a more reliable source of funding as they typically can be obtained by most communities.

Water Fund Cash Resources and Revenues

The City's financial resources available for capital funding include rate funding, cash reserves, and SDCs.

SDCs are sources of funding generated through development and system growth and are typically used by utilities to support capital funding needs. The charge is intended to recover a fair share of the costs of existing and planned facilities that provide capacity to serve new growth.

Oregon Revised Statue (ORS) 223.297 – 223.314 defines SDCs and specifies how they shall be calculated, applied, and accounted for. By statue, an SDC amount can be structured to include one or both of the following two components:

- *Reimbursement Fee* – Intended to recover an equitable share of the cost of facilities already constructed or under construction.
- *Improvement Fee* – Intended to recover a fair share of future, planned, capital improvements needed to increase the capacity of the system.

The reimbursement fee methodology must consider such things as the cost of existing facilities and the value of unused capacity in those facilities. The calculation must also ensure that future system users contribute no more than their fair share of existing facilities costs. Reimbursement fee proceeds may be spent on any capital improvements or debt service repayment related to the system for which the SDC is applied. For example, water reimbursement SDCs must be spent on water improvements or water debt service.

The improvement fee methodology must include only the cost of projected capital improvements needed to increase system capacity. In other words, the cost of planned projects that correct existing deficiencies, or do not otherwise increase capacity, may not be included in the improvement fee calculation. Improvement fee proceeds may be spent only on capital improvements (or related debt service), or portions thereof, that increase the capacity of the system for which they were applied.

Water System CIP and CMP Funding

It is recommended that the City complete a detailed water rate and SDC analysis with the completion of this Master Plan to determine specific funding needs and potential funding sources associated with the adopted CIP and CMP. It is anticipated that changes in rates and SDCs will be required to keep pace with inflation and fund the proposed improvements through build-out of the system. It is recommended that these studies also provide guidance to the City on the best use of the funding options described above.

Summary

A summary of all recommended improvements is presented in Table 8-6. The table provides prioritized project sequencing by illustrating FY project needs for each facility or improvement category. It is recommended that the City's capital improvement program (CIP) be funded at approximately $1,570,000 annually for storage, pumping and distribution system piping improvements, and the City's CMP be funded at approximately $550,000 annually for the next 10 years.

APPENDIX

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APPENDIX A
Plate 1

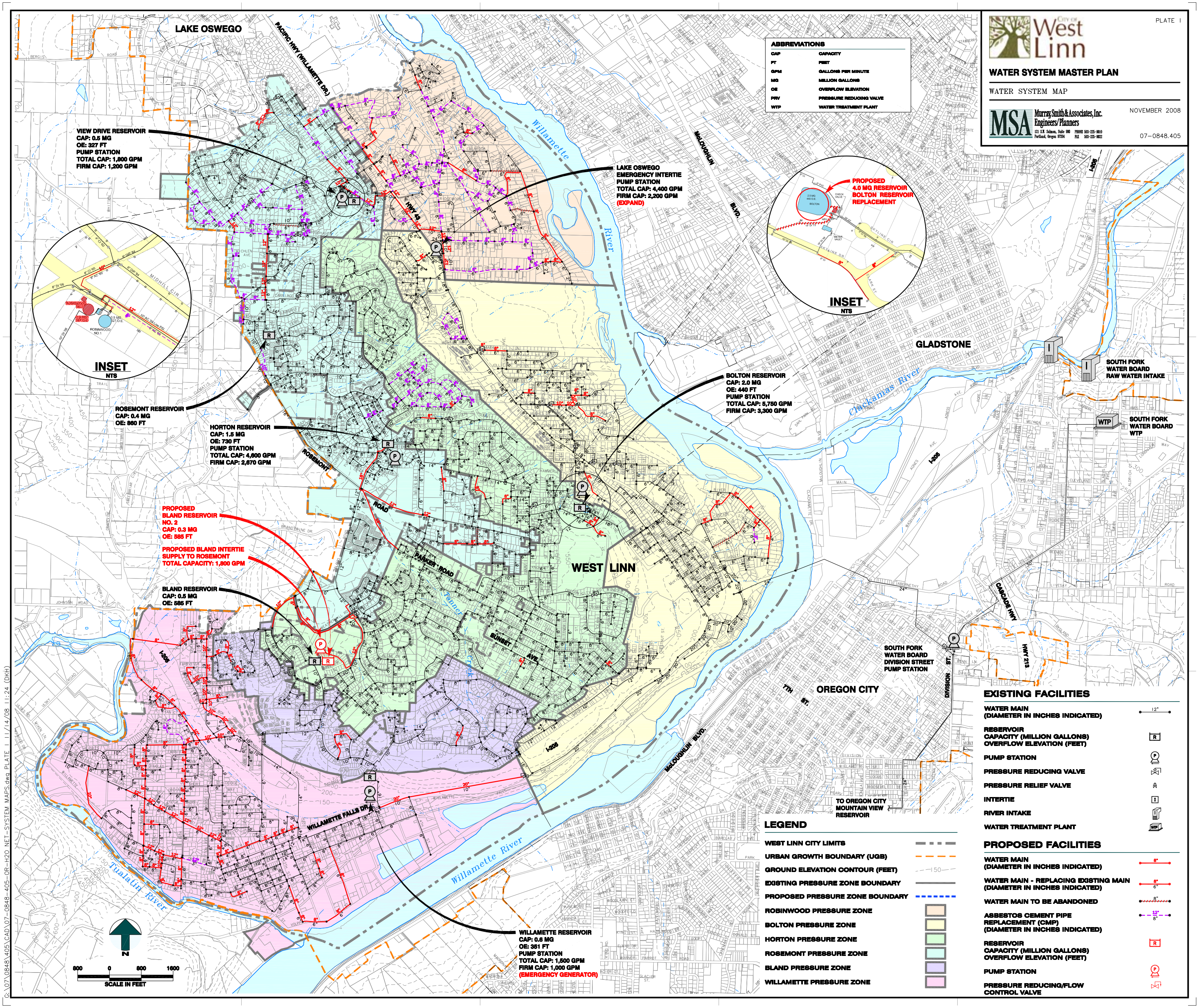


PLATE 1
City of West Linn
WATER SYSTEM MASTER PLAN
WATER SYSTEM MAP
NOVEMBER 2008
MSA Murray, Smith & Associates, Inc. Engineers/Planners
07-0848.405
ABBREVIATIONS
CAP CAPACITY
FT FEET
GPM GALLONS PER MINUTE
MG MILLION GALLONS
OE OVERFLOW ELEVATION
PRV PRESSURE REDUCING VALVE
WTP WATER TREATMENT PLANT
LAKE OSWEGO
PACIFIC HWY (WILLAMETTE DR.)
VIEW DRIVE RESERVOIR
CAP: 0.5 MG
OE: 327 FT
PUMP STATION
TOTAL CAP: 1,800 GPM
FIRM CAP: 1,200 GPM
LAKE OSWEGO
EMERGENCY INTERTIE
PUMP STATION
TOTAL CAP: 4,400 GPM
FIRM CAP: 2,200 GPM
(EXPAND)
PROPOSED
4.0 MG RESERVOIR
BOLTON RESERVOIR
REPLACEMENT
INSET
NTS
INSET
NTS
ROSEMONT RESERVOIR
CAP: 0.4 MG
OE: 860 FT
HORTON RESERVOIR
CAP: 1.5 MG
OE: 730 FT
PUMP STATION
TOTAL CAP: 4,600 GPM
FIRM CAP: 2,670 GPM
BOLTON RESERVOIR
CAP: 2.0 MG
OE: 440 FT
PUMP STATION
TOTAL CAP: 5,750 GPM
FIRM CAP: 3,300 GPM
GLADSTONE
SOUTH FORK
WATER BOARD
RAW WATER INTAKE
SOUTH FORK
WATER BOARD
WTP
Clackamas River
Willamette River
PROPOSED
BLAND RESERVOIR
NO. 2
CAP: 0.3 MG
OE: 585 FT
PROPOSED BLAND INTERTIE
SUPPLY TO ROSEMONT
TOTAL CAPACITY: 1,800 GPM
BLAND RESERVOIR
CAP: 0.5 MG
OE: 585 FT
WEST LINN
OREGON CITY
SOUTH FORK
WATER BOARD
DIVISION STREET
PUMP STATION
TO OREGON CITY
MOUNTAIN VIEW
RESERVOIR
WILLAMETTE RESERVOIR
CAP: 0.6 MG
OE: 351 FT
PUMP STATION
TOTAL CAP: 1,500 GPM
FIRM CAP: 1,000 GPM
(EMERGENCY GENERATOR)
Tualatin River
HWY 43
ROSEMONT
ROAD
PARKER ROAD
SUNSET AVE
WILLAMETTE FALLS DR.
I-205
McLOUGHLIN BLVD.
CASCADE HWY
HWY 213
7TH ST.
DIVISION ST.
SCALE IN FEET
800 0 800 1600
N
LEGEND
WEST LINN CITY LIMITS
URBAN GROWTH BOUNDARY (UGB)
GROUND ELEVATION CONTOUR (FEET)
EXISTING PRESSURE ZONE BOUNDARY
PROPOSED PRESSURE ZONE BOUNDARY
ROBINWOOD PRESSURE ZONE
BOLTON PRESSURE ZONE
HORTON PRESSURE ZONE
ROSEMONT PRESSURE ZONE
BLAND PRESSURE ZONE
WILLAMETTE PRESSURE ZONE
EXISTING FACILITIES
WATER MAIN
(DIAMETER IN INCHES INDICATED)
RESERVOIR
CAPACITY (MILLION GALLONS)
OVERFLOW ELEVATION (FEET)
PUMP STATION
PRESSURE REDUCING VALVE
PRESSURE RELIEF VALVE
INTERTIE
RIVER INTAKE
WATER TREATMENT PLANT
PROPOSED FACILITIES
WATER MAIN
(DIAMETER IN INCHES INDICATED)
WATER MAIN - REPLACING EXISTING MAIN
(DIAMETER IN INCHES INDICATED)
WATER MAIN TO BE ABANDONED
ASBESTOS CEMENT PIPE
REPLACEMENT (CMP)
(DIAMETER IN INCHES INDICATED)
RESERVOIR
CAPACITY (MILLION GALLONS)
OVERFLOW ELEVATION (FEET)
PUMP STATION
PRESSURE REDUCING/FLOW
CONTROL VALVE
G:\07\0848\405\CAD\07-0848-405-OR-H20 NET-SYSTEM MAPS.dwg PLATE 1 11/14/08 11:24 (DKH)

MSA

APPENDIX B
Residential Unit Tracking Analysis

Memo

To: Chris Jordan, Gene Green, Ken Worcester, John Atkins,
Dennis Wright, Dave Davies, Jim Whynot, Boris Piatski

CC: Gordon Howard, Kathy Aha

From: Bryan Brown

Date: March 5, 2007

Re: Residential Development Unit Tracking Map & Summary

Attached is the map and summary for the Planning Department's Residential Unit Tracking. This information identifies existing residential dwelling units and buildable lands through December 31, 2006.

Existing residential units are reported and displayed by current land use (LDR, MDR, and MHDR). Residential units outside city limits, but inside the Metro Urban Growth Boundary are identified. The buildable lands inventory identifies approved, vacant, and infill potential parcels and estimated build-out numbers for those locations. Additionally, this report includes summaries by neighborhood associations and water pressure zones.

There is a larger wall map available upon request. If you need additional copies or would like digital copy sent via email, please contact Kathy Aha.

Data Summary for Residential Unit Tracking

(Prepared March 2007, Reporting through 12/31/06)

Existing Residential Units by Current Land Use	Number of Units as of 12/31/06	Persons Per Household (PPH)*	Population Estimate	PSU's Certified Population July 2006**
Low Density Residential (LDR)	7,440	2.77	20,609	
Medium Density Residential (MDR)	225	1.54	347	
Medium High Density Residential (MHDR)	2,303	1.54	3,547	
Total Current Residential inside the City	9,968		24,502	24,180
Additional Residential units outside the city limits, but inside the UGB	41	2.77	114	
Total Current Residential	10,009		24,615	

Residential Buildable Land Inventory by Type (Inside UGB)	Number of Potential Units	Persons per Household (PPH)*	Potential Population Increase
Approved for Development			
Single-Family Residential	260	2.77	720
Multi-Family Residential	0	1.54	0
Vacant Parcels			
Single-Family Residential	717	2.77	1,986
Multi-Family Residential	101	1.54	156
Infill Parcels			
Single-Family Residential	937	2.77	2,595
Multi-Family Residential	254	1.54	391
Accessory Dwelling Units (additional 5% of Low Density Residential)	467	1.00	467
Total Potential Residential	2,736		6,315

Estimate of Maximum Build-out (Inside the UGB)	Number of Units		Population
Current Residential	10,009		24,615
Potential Residential	2,736		6,315
Total Potential Residential	12,745		30,931

**Population estimates are based on PSU's formula for West Linn:*
Single Family Residential: 2.77 PPH, Multi-Family Residential: 1.54 PPH.
***PSU's certified estimates may be lower since they account for vacancy.*

Buildable housing unit numbers are rough theoretical maximum estimates under current zoning and regulatory structure and are not intended to serve as a projection and are to be utilized for general long-range planning purposes only.

Residential Unit Tracking Trends, 2000-2006

West Linn Residential Unit Counts GIS Unit Tracking			**Sept. 2001**	**Dec. 2002**	**Dec. 2003**	**Dec. 2004**	**Dec. 2005**	**Dec. 2006**
Current Residential Units			9,354	9,646	9,733	9,788	9,825	10,009
Potential Residential Units			2,576	2,399	2,308	2,230	2,343	2,736
Total Potential Residential			11,930	12,045	12,041	12,018	12,168	12,745

West Linn Population Estimates GIS Unit Trackinig				**Dec. 2002**	**Dec. 2003**	**Dec. 2004**	**Dec. 2005**	**Dec. 2006**
Current Population				23,725	23,960	24,095	24,277	24,616
Potential Population				5,885	5,651	5,544	5,894	6,315
Maximum Build-Out Estimate				29,610	29,611	29,639	30,171	30,931

PSU's Population Research Center		**July 2000**	**July 2001**	**July 2002**	**July 2003**	**July 2004**	**July 2005**	**July 2006**
PRC's Certified Population Estimate		22,440	23,090	23,430	23,820	23,970	24,075	24,180
	July 2000	**July 2001**						
U.S. Census	16,389	22,261						

Population estimates are based on PSU's formula for West Linn:
Single Family Residential: 2.77 PPH, Multi-Family Residential: 1.54 PPH.
Unit and Population estimates include residents both inside & outside the West Linn City Limits and extend to the Urban Growth Boundary.
Changes from previous years are due to new building permits that were issued, changes in property specific estimates, adjustments, methodology changes, and corrections in the GIS tracking system database.
More Information on PSU's Population Research Center is available at http://www.pdx.edu/prc or contact their office at (503) 725-3922

Buildable housing unit numbers are rough theoretical maximum estimates under current zoning and regulatory structure and are not intended to serve as a projection and are to be utilized for general long-range planning purposes only.

Data Summary for Residential Unit Tracking by Neighborhood Association

(Prepared March 2007, Reporting through 12/31/06)

Neighborhood Association	Land Area (Acres)	Low Density Residential (Single Family) Units	Medium Density Residential (Multi-Family) Units	Medium-High Density Residential (Multi-Family) Units	Non-Annexed (Single Family) Units	Accessory Dwelling Units (additional 5% LDR density)	Total Number of Residential Units	Current Population Estimates	Percent of Total Population	Buildable Land Potential Population Increase	Future Population Estimates
BHT	133	288	0	0	0	14	302	798	3.2%	69	867
Bolton	600	986	61	249	0	49	1,345	3,209	13.0%	446	3,655
Hidden Springs	478	1,009	20	179	4	51	1,263	3,112	12.6%	428	3,540
Marylhurst	171	271	0	0	0	14	285	751	3.0%	139	890
Parker Crest	245	195	0	248	19	11	473	975	4.0%	1266	2,241
Robinwood	684	1,027	8	215	0	51	1,301	3,188	13.0%	890	4,078
Rosemont Summit	270	596	0	0	0	30	626	1,651	6.7%	397	2,048
Skyline Ridge	61	134	0	0	0	7	141	371	1.5%	23	394
Sunset	495	802	96	115	2	40	1,055	2,552	10.4%	390	2,942
Tanner Basin	354	550	8	405	13	28	1,004	2,196	8.9%	973	3,169
Unspecified (B.H.)	22	17	0	0	0	1	18	47	0.2%	22	69
Willamette	1,124	1,565	32	892	3	78	2,570	5,766	23.4%	1273	7,039
TOTALS		7,440	225	2,303	41	374	10,383	24,615	100%	6,316	30,931

Population estimates are based on PSU's formula for West Linn:
Single Family Residential: 2.77 PPH, Multi-Family Residential: 1.54 PPH.
Unit and Population estimates include residents both inside & outside the West Linn City Limits and extend to the Urban Growth Boundary.

Buildable housing unit numbers are rough theoretical maximum estimates under current zoning and regulatory structure and are not intended to serve as a projection and are to be utilized for general long-range planning purposes only.

Data Summary for Residential Unit Tracking by Water Pressure Zone

(Prepared March 2007, Reporting through 12/31/06)

Pressure Zone	Current LDR Units	Current MDR Units	Current MHDR Units	**Total Existing Res. Units**	Outside City Receiving City Water	Outside City Not Receiving City Water	**Total Existing Res. Units**	Buildable Lands Potential Units	Accessory Dwelling Units (additional 5% LDR density)	**Maximum Build-out Total**
Bland	599	2	151	752	0	4	756	99	43	898
Bolton	1,219	145	435	1,799	0	0	1,799	260	72	2,131
Horton	2,089	18	215	2,322	3	14	2,339	577	124	3,040
Robinwood	669	8	32	709	0	0	709	192	42	943
Rosemont	1,522	22	737	2,281	18	0	2,299	676	100	3,075
Willamette	1,342	30	733	2,105	1	1	2,107	465	86	2,658
Totals	7,440	225	2,303	9,968	22	19	10,009	2,269	467	12,745

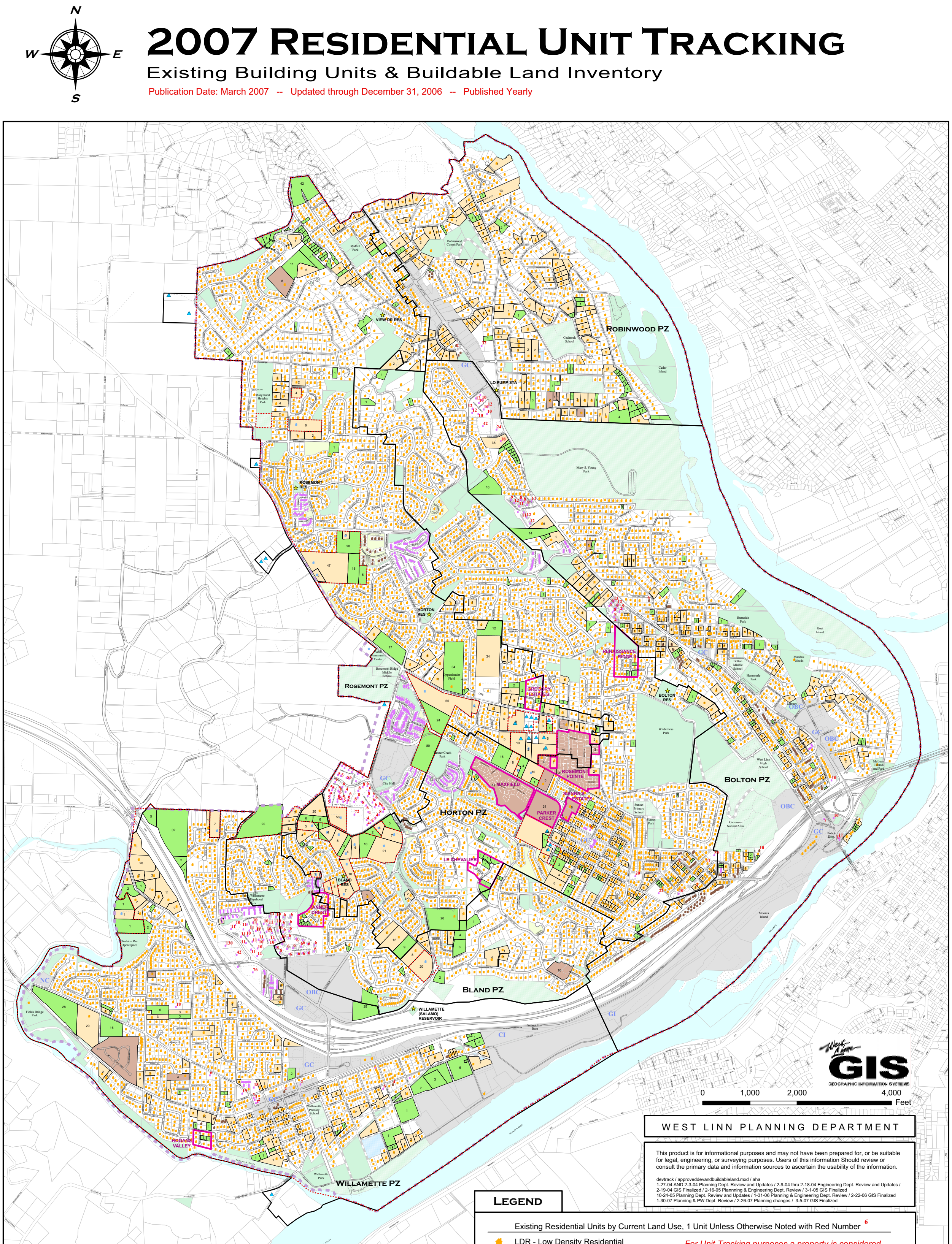
City / UGB / Water Services Unit Counts	In City	In UGB	City Water Services	Total Res. Units		
A, B	YES	YES	YES	9,987		
A, B	NO	YES	YES	15		
B	NO	NO	YES	7		
A	NO	YES	NO	26		
					Potential Units	**Maximum Build-out Total**
A -- Calculations for Population --				10,028	2,736	12,764
B -- Calculations for Water Usage --				10,009	2,736	12,745

Buildable housing unit numbers are rough theoretical maximum estimates under current zoning and regulatory structure and are not intended to serve as a projection and are to be utilized for general long-range planning purposes only.

2007 Residential Unit Tracking

Existing Building Units & Buildable Land Inventory

Publication Date: March 2007 -- Updated through December 31, 2006 -- Published Yearly



West Linn Certified Population July 2006: 24,180

WEST LINN PLANNING DEPARTMENT

This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. Users of this information Should review or consult the primary data and information sources to ascertain the usability of the information.

devtrack / approveddevandbuildableland.mxd / aha
1-27-04 AND 2-3-04 Planning Dept. Review and Updates / 2-9-04 thru 2-18-04 Engineering Dept. Review and Updates / 2-19-04 GIS Finalized / 2-16-05 Plannning & Engineering Dept. Review / 3-1-05 GIS Finalized
10-24-05 Planning Dept. Review and Updates / 1-31-06 Planning & Engineering Dept. Review / 2-22-06 GIS Finalized
1-30-07 Planning & PW Dept. Review / 2-26-07 Planning changes / 3-5-07 GIS Finalized

Legend

Existing Residential Units by Current Land Use, 1 Unit Unless Otherwise Noted with Red Number 6

- LDR - Low Density Residential
- MDR - Medium Density Residential
- 6 MHDR - Medium-High Density Residential
- ANX -- Not Annexed into the City of West Linn
- ANX -- Not Annexed, but receiving City Water

For Unit Tracking purposes a property is considered "current" if a permit has been issued at the location.

Buildable Lands Inventory by Type. 4 Numbers Shown are Potential Additional Units

- Vacant
- Infill Potential
- Approved for Development
- Other Vacant Lots

Buildable housing unit numbers are rough theoretical maximum estimates under current zoning and regulatory structure and are not intended to serve as a projection and are to be utilized for general long-range planning purposes only.

- Commercial and Industrial Zoning
- City Owned Property
- Other Property, Public or Pseudo Public
- Other Property, Homeowners Assoc.
- PZ: Water Pressure Zones
- City Reservoirs
- West Linn City Limits
- Taxlot Base (Source: Clackamas Co GIS)
- Potential Subdivision Development for 2007

Property ownership is derived from the Clackamas County Assessor Database for the properties within West Linn's UGB. Ownership for Public and Pseudo Public properties includes: West Linn Wilsonville School District (developed school properties), City of Lake Oswego, State of Oregon, Oregon Dept. of Transportation, Oregon Parks & Rec. Dept, Tri-City Service Dist., Three Rivers Land Conservancy, The Nature Conservancy, and Portland General Electric Co. Vacant and infill properties owned by these agencies may be covered up by the Vacant and Infill GIS layers and may not be visible on this map.

MSA

APPENDIX C

Water System Operations & Maintenance Guide

CITY OF WEST LINN, PUBLIC WORKS DEPARTMENT

Water Systems Operations and Maintenance Guide

4100 Norfolk St., West Linn , Oregon 97068
Phone 503.656.6081 • Fax 503.657.3237

Water System Operations and Maintenance

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7.1.1

8 Water Main Repairs

8.1

8.2

9. Water Operator Protocol's

10. [illegible]

APPENDIX D
Preliminary ASR Feasibility Evaluation

GSI Water Solutions, Inc.

DRAFT Technical Memorandum

To: Brian Ginter, PE – Murray, Smith & Associates, Inc.

From: Walter Burt, RG – GSI Water Solutions, Inc.
Robyn Cook, GIT – GSI Water Solutions, Inc.

Date: January 22, 2008

Re: **Preliminary ASR Feasibility Evaluation, City of West Linn, Oregon**

Introduction

This technical memorandum (TM) summarizes GSI Water Solutions, Inc.'s (GSI), preliminary feasibility evaluation of implementing an aquifer storage and recovery (ASR) program for the City of West Linn (City). The purpose of this work was to evaluate, as part of an update of the City's water master plan, whether ASR could be a viable alternative for the City to consider as part of its long-range water supply strategy. The objectives of this evaluation were (1) to identify potential fatal flaws to implementing an ASR program within the City, and using the Kenthorpe Well in particular, and (2) to identify the next steps and potential risks if the City decides to further pursue an ASR program.

This evaluation used existing and readily available information. The following primary sources of information were used:

- Well reports from the Oregon Water Resources Department (OWRD)
- Published U.S. Geological Survey (USGS), Oregon Department of Geology and Mineral Industries (DOGAMI), and unpublished geologic mapping and interpretations from Terry Tolan (pers. comm., 2007).

For those areas where fatal flaws to ASR development were not identified in this evaluation, key uncertainties and a cost estimate for taking the next step in determining ASR feasibility are summarized.

Definition of ASR

ASR is the underground storage of treated drinking water that is injected into a suitable aquifer and subsequently recovered from the same well or wells, generally requiring no retreatment other than disinfection. ASR is a water supply management tool for water providers whose peak use water demands either approach or exceed supply capacities, while non-peak supply capacities are typically in excess of non-peak demands. Several municipalities and water districts in the Portland metropolitan area have implemented ASR programs, including the Cities of Beaverton, Tigard, and Tualatin, and the Tualatin Valley Water District. Each of these entities currently has ASR wells, completed in the Columbia River Basalt Group (CRBG) aquifers, which is the target ASR storage zone for the City of West Linn (see Figure 1).

Criteria for ASR Feasibility

The feasibility of implementing an ASR program for the City would be determined by hydrogeologic, engineering infrastructure, and source water considerations, which would ascertain the costs and benefits of the program. This preliminary feasibility evaluation focuses on hydrogeologic considerations. General criteria used as guidelines for evaluating the hydrogeologic feasibility of ASR for West Linn include the following:

1. A productive aquifer with well yields of at least 700 gallons per minute (gpm) or approximately 1 million gallons per day (mgd), and sufficient storage volume to maintain these well yields during the critical peak demand periods (commonly 50 to 100 million gallons per well site). Well yields and injection rates are determined by the productivity of the aquifer and the efficiency of the well, and also are related to the groundwater level in the well.
2. The target aquifer is confined and has sufficient available space to store the desired volume of injected water, as determined by the boundaries of the aquifer and depth to groundwater (available "headroom").
3. Other high-capacity wells that could capture stored water are not present.
4. The aquifer, source water, and native groundwater are geochemically compatible such that chemical interactions will not result in clogging of the aquifer or adversely affect water quality.

The remainder of this TM describes the hydrogeologic setting in the West Linn area and evaluates existing information relative to these hydrogeologic criteria.

Hydrogeologic ASR Feasibility Criteria Evaluation

Hydrogeologic Setting

The two primary water-bearing geologic units in the West Linn area include the Waverly Heights formation and the CRBG (see Figure 2). The Waverly Heights formation is Eocene in age (roughly 40 to 60 million years ago [mya]) and underlies the CRBG. The most significant characteristic of the Waverly Heights basalt formation relative to this evaluation is that it is highly weathered and altered, with the pore spaces commonly filled with secondary minerals. The primary relevant effect is a significant decrease in the permeability and transmissivity of otherwise productive zones. (Transmissivity is a measure of how easily water is transmitted in an aquifer.) Consequently, wells completed in the Waverly Heights formation typically have low yields in the West Linn area, ranging from 8 to 50 gpm. Thus, the Waverly Heights formation is insufficiently transmissive for ASR, and the remainder of this evaluation focuses on the CRBG.

The CRBG consists of a series of tabular basalt sheet lava flows that originated from eastern Washington, Oregon, and western Idaho between 17 and 6 mya, and underlie a large area in the Willamette and Tualatin valleys. The thickness of the CRBG depends on the amount of paleotopography in the area when the CRBG flows were emplaced, as well as the degree of uplift and erosion since emplacement. Near the City of Tualatin, the CRBG section is approximately 1,070 feet thick and consists of 13 separate flows. However, well log information shows that the thickness of the CRBG section in West Linn is highly variable, ranging from less than 100 feet to more than 600 feet in the highlands in the western portion of the City. Deep (more than 300 feet deep) well data were not available for the southern and eastern portions of West Linn, particularly the Willamette, Horton, Robinwood, and Bolton areas. However, geologic mapping suggests that the CRBG section on the east side of West Linn, in the Bolton and Robinwood neighborhoods, could be as thick as 1,500 feet because of the filling of a structural low. Mapping also indicates that the CRBG section is relatively thin (less than 200 feet) in the Willamette area. The variability in CRBG thickness is the result of vertical offset of the CRBG by faulting and removal by erosion (Figure 2). Figure 3 is a schematic depiction of the spatial distribution of estimated CRBG thicknesses in the City. Areas shown in dark blue and green have a greater estimated CRBG thickness, whereas yellow and reddish shades denote thinner CRBG sections.

Groundwater in the CRBG is predominantly derived from interflow zones, which represent the contact between the top and bottom of individual basalt flows. Certain interflow zones are porous and rubbly, and thus can transmit water easily, whereas others are less so because of the presence of soils representing weathering horizons or lack of flow emplacement features that create connected pore space for groundwater to move. The interiors of the basalt flows typically are dense and hydraulically separate the interflow zones, except possibly in certain places where disrupted by structural features, such as geologic faults.

Suitability of CRBG Aquifer for ASR in West Linn

Aquifer Productivity

Transmissivity and specific capacity are commonly used as measures of potential aquifer productivity for ASR feasibility. Transmissivity for basalt aquifers in the Tualatin Valley ranges from several thousand gallons per day per foot (gpd/ft) to several hundred thousand gpd/ft. Transmissivity values in CRBG aquifers where ASR currently is being implemented are 15,000 to 150,000 gpd/ft. Transmissivity is determined from controlled pumping tests of wells, and also can be estimated from specific capacity data for wells. Pumping test data for wells in the West Linn area were not available for this evaluation.

Specific capacity of a well, measured in gallons per minute per foot (gpm/ft) of drawdown, is an indication of both the overall productivity of the aquifer and the efficiency of the well. Specific capacity is derived from the pumping rate and pumping water level in the well. In the Tualatin Valley, specific capacities of viable ASR wells range from 7 to 30 gpm/ft.

We reviewed available pumping data for wells completed in the CRBG in the West Linn area. The pumping rates ranged from 1 to 100 gpm, not including the Kenthorpe Well, which was reported to pump 200 gpm (Figure 4). In most cases, the pumping water level was not reported for these wells; consequently, specific capacities and the overall productivity of the CRBG aquifer in the West Linn area could not be confirmed. However, we noted that several wells were drilled through the CRBG and into the Waverly Heights formation in certain areas, suggesting that the available CRBG section is relatively unproductive at these locations.

The quantity and characteristics of basalt interflow zones generally determine the overall productivity of the CRBG aquifer at a given location. Thus, thicker CRBG sections, with generally a greater number of interflows, will increase the potential for the aquifer to be sufficiently productive to host an ASR system. Because data directly describing aquifer productivity were unavailable or inconclusive, we used the thickness of the CRBG section as an alternate method to indirectly assess locations where aquifer productivity potential may be higher than others. CRBG thickness was interpreted from well logs, where available, and geologic mapping.

As discussed in the previous section, the thickness of the CRBG is highly variable because of extensive faulting, which has uplifted the underlying Waverly Heights formation and reduced the CRBG thickness. The schematic cross section in Figure 2 illustrates the faulted and compartmentalized nature of the CRBG in West Linn. Figure 3 is a schematic depiction of the spatial distribution of estimated CRBG thicknesses in the City. Areas shown in dark blue and green have a greater estimated CRBG thickness, whereas yellow and reddish shades denote thinner CRBG sections.

The thickness of the CRBG section in West Linn ranges from less than 100 feet in the southern and central portions of the City, to 600 feet or more in the northern and eastern portions of the City (Figure 3). The CRBG is particularly thin in the western highlands, southern Rosemont, and Willamette areas. Based on the limited data available for this evaluation, it appears that the northern Rosemont area and the eastern portion of the City, between the highlands and the Willamette River, have the highest potential for relatively thick basalt sections. The CRBG thickness in the northern Rosemont area and between the crest of the highlands and Highway 43 exceeds 600 feet. Although not verified by deep well data, the Bolton and Robinwood areas between Highway 43 and the river potentially are underlain by more than 1,000 feet of CRBG section and therefore have the highest potential for productive aquifer conditions. In addition, an area between the southern Rosemont and Willamette areas also has a relatively thick CRBG section. However, this area also has a great deal of faulting, which could limit the extent of productive interflow zones.

Storage Volume

The volume of available aquifer storage is controlled by the extent and thickness of the aquifer, and the available "headroom," or depth to the groundwater table in an area. While a bounded aquifer can be desirable for ASR, the storage capacity of the aquifer may be inadequate where the extent of the aquifer is overly limited. As discussed above, the CRBG is highly faulted in West Linn, potentially compartmentalizing the aquifer. In particular, faults in the southern portion of West Linn are relatively closely spaced and may highly compartmentalize or limit storage in the aquifer. The aquifer in the northern and eastern portions of the City also may be compartmentalized, but the extent of possible compartments appears greater, allowing for greater storage and thus potentially more suitable for ASR.

Static groundwater levels from well logs were reviewed to evaluate potential storage "headroom" in the aquifer. The depth to water in most of the basalt wells in the highlands in West Linn is several hundred feet below ground surface, which should be sufficient for ASR operations, if the aquifer productivity is adequate. The depth to water in the aquifers in the lowlands, toward the Willamette River, are expected to be significantly less than in the highlands. While a shallow depth to water is desirable for pumping because of reduced lift requirements, a shallow depth to water presents problems for ASR operations because it reduces the available hydraulic head to inject at optimal rates without high wellhead pressures. Consequently, the lower elevation areas with higher groundwater levels require a higher aquifer transmissivity to accept the desired flow rates without unacceptably high injection levels at the ASR well.

Capture of Stored Water

No municipal or industrial high-capacity (>200 gpm) wells were identified in the West Linn area for this evaluation. Although there are several domestic wells in the area, it does not appear that any would capture large quantities of water stored in the CRBG. Roughly half of the domestic wells analyzed in this evaluation are open to the Waverly Heights formation and do not draw water from the CRBG.

Geochemical Compatibility

Groundwater quality and source water quality data were not available for an evaluation of geochemical compatibility. Other CRBG ASR systems in the Portland metropolitan area have not experienced significant geochemical compatibility issues that have affected the feasibility of ASR. Water quality issues have been encountered at some facilities, including relatively high radon concentrations in native groundwater, as well as taste and odor issues. However, these issues have been satisfactorily managed to produce good quality water, allowing development of the ASR systems.

Kenthorpe Well Evaluation

The City owns a former Robinwood Water District supply well, now called the Kenthorpe Well. The Kenthorpe Well is located on Kenthorpe Avenue in northeast West Linn (Figure 1). Based on the OWRD well report, the well is 8 inches in diameter, approximately 278 feet deep, had a static water level of 137 ft bgs at the time of drilling, and was pumped at a rate of 200 gpm with 62 feet of drawdown for a specific capacity of 3.2 gpm/ft. Although a geologic log is not available as part of the OWRD well report, the location of the well relative to the understanding of the geology in the area indicates that the well likely is completed in the upper portion of the CRBG aquifer. No other information regarding the well construction, capacity, pumping history, or water quality was available for review when this TM was being prepared.

The City conducted a site visit to assess the accessibility of the Kenthorpe Well for this evaluation. The well was not accessible because a concrete slab covers the location of the well. Consequently, the condition of the well could not be determined for this TM.

Based on available information, the Kenthorpe Well is not suitable for ASR pilot testing because of capacity limitations, the size of the well, and the lack of accessibility. However, the well penetrates only the upper portion of the CRBG section, and the CRBG near the Kenthorpe Well is potentially 1,000 feet or more thick. Thus, the CRBG in the area of the Kenthorpe Well has a potential to have suitable production and storage characteristics for groundwater supply or ASR development. Completion of an exploratory test well and aquifer testing would be necessary to verify the groundwater supply or ASR potential in this area.

Conclusions

A preliminary evaluation of the hydrogeologic feasibility of implementing ASR in the City indicates that ASR is not feasible for the Willamette and southern Rosemont areas. Although limited available information did not identify fatal flaws for other portions of the City; evaluating ASR feasibility in these other locations would require conducting an exploratory drilling and testing program to evaluate and verify aquifer characteristics. The outcome of drilling and testing in each area is uncertain given the current level of understanding. Specific conclusions from the preliminary ASR evaluation include the following:

- The limited thickness of the CRBG aquifer and extensive faulting in the southern Rosemont and Willamette neighborhood indicate that hydrogeologic conditions are not favorable for ASR in these areas.

- Available hydrogeologic data are insufficient to conclusively identify potential fatal flaws and evaluate ASR feasibility potential in other areas of the City primarily because deep well data to verify the thickness of the CRBG or desirable aquifer characteristics are not available.

- Geologic mapping information indicates that certain areas of the City have a higher potential for hydrogeologic conditions favorable for ASR, primarily based on potentially greater CRBG thicknesses. These areas include the northern Rosemont, Robinwood, Horton, and Bolton neighborhoods. The portion of these neighborhoods near the base of the ridge along Highway 43 likely holds the most promise because of the combination of potentially thick CRBG section and available "headroom" (lower groundwater levels). The northwestern Rosemont and Horton neighborhoods may have somewhat less favorable conditions for ASR because the CRBG section likely is thinner, and the aquifer may be more compartmentalized by faulting.

- The Kenthorpe Well could not be directly evaluated for ASR suitability because it is no longer accessible. However, available information about the well indicates that the as-built construction of the well is not suitable, and the portion of the CRBG aquifer penetrated by the well is not sufficiently productive for ASR.

- The key hydrogeologic uncertainties remain the location and extent of a suitable aquifer in the CRBG.

- Resolving the uncertainties with regard to hydrogeologic characteristics and determining the overall feasibility of an ASR program will require an exploratory test well drilling program.

Next Steps

Should the City elect to further pursue evaluating the feasibility of ASR, the next step would be to drill and test an exploratory well for each specific site or area the City would like to evaluate. An exploratory program would entail the following sequence of work:

1. <u>Well Siting Evaluation</u>. A siting evaluation to choose the exploratory well location(s) would use the following criteria: hydrogeology, land ownership, water demand, and infrastructure (conveyance and storage) to choose a well site or sites.

2. <u>Exploratory Well Drilling and Testing.</u> An exploratory well would be drilled to the base of the CRBG section at the chosen site(s). The base of the CRBG may range from 600 to 1,500 ft/bgs, depending on the location. The exploratory well would be pumped for an extended period of time (e.g., 5 days) and water levels in the well and other nearby wells would be monitored to evaluate the long-term production and storage potential of the aquifer.

3. <u>Geochemical Compatibility Evaluation.</u> Samples of native groundwater and injection source water would be collected and analyzed for geochemical parameters to evaluate potential geochemical reactions that either could clog the aquifer or adversely affect water quality.

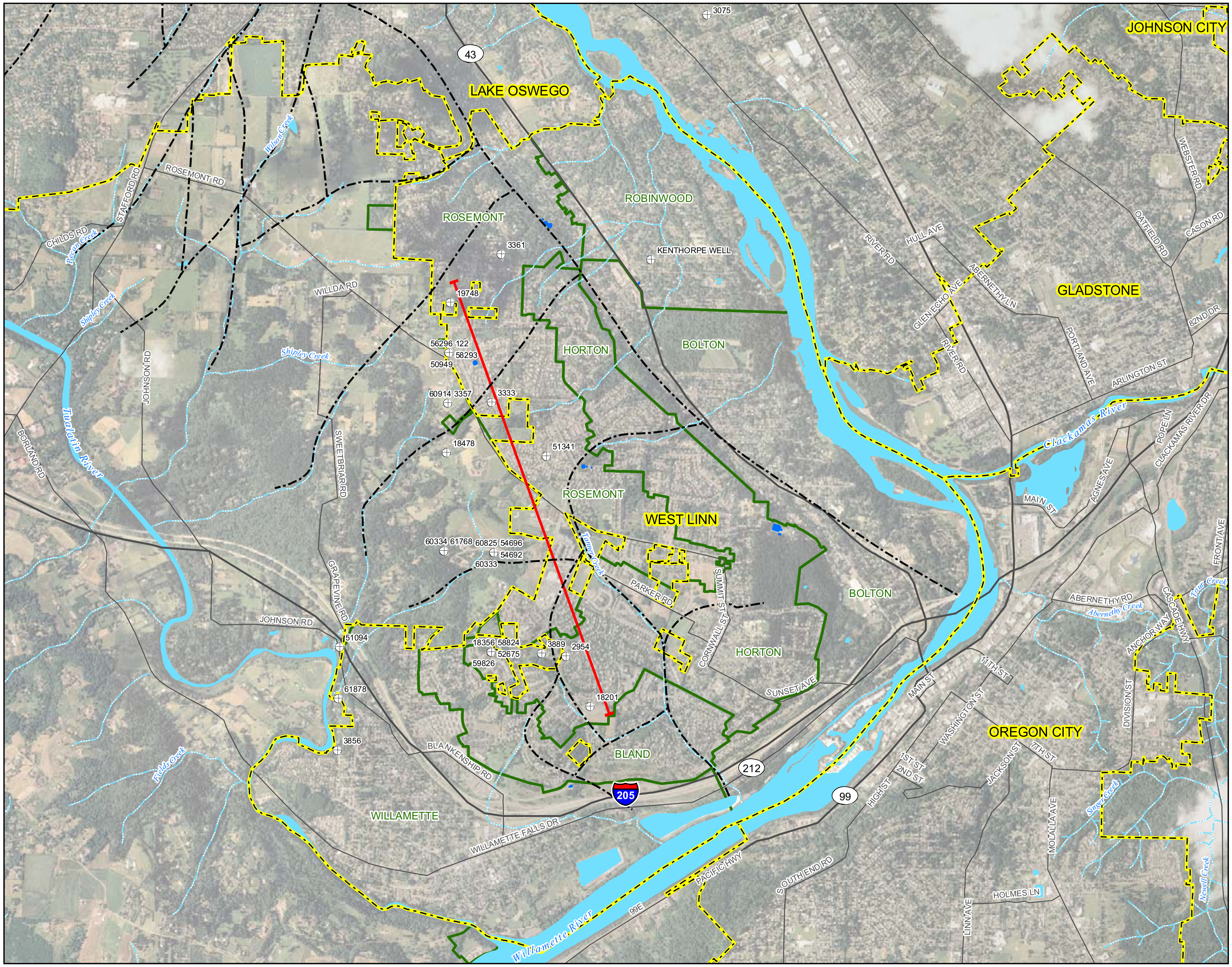
4. <u>ASR Feasibility Report and Program Plan.</u> The results of the exploratory program would be summarized in an ASR feasibility report. If the exploratory well project indicates that ASR is feasible, the report also would lay out a phased ASR program plan, including permitting, infrastructure improvements, ASR well drilling and testing, pilot testing, and expansion options. The plan also would provide planning level cost estimates for the ASR program.

Estimated costs for the outlined exploratory well program likely would range from $200,000 to $250,000 for a single well site, depending on the ultimate depth of the exploratory well. Additional exploratory wells to evaluate other areas within the City would cost between $130,000 and $160,000 per site. The primary risk associated with an exploratory well program would be that the program would indicate that suitable hydrogeologic conditions are not present near the exploratory well after the invested effort. Further, verification of ASR feasibility at one location may not be sufficient to show that ASR is feasible at other locations with sufficient certainty, requiring additional drilling and testing at those other locations.

FIGURE 1

Location Map

City of West Linn



LEGEND

- Existing Wells
- Faults
- Geologic Cross Section
- City Pressure Zones
- City Boundaries
- Watercourses
- Waterbodies
- Reservoirs
- Freeways and Highways
- Major Roads

N

Scale
1:30,000

0 1250 2500 3750 5000
Feet

MAP NOTES:
Projection: Oregon State Plane North Zone
Datum: North American Datum of 1983
Date: December 20, 2007
Data Sources: Murray, Smith, and Associates, OWRD, Oregon Geospatial Data Clearinghouse

GSI Water Solutions, Inc.

File Path: \\gsi-sbs-001\Projects\274 - City of West Linn\001 - ASR Feasibility\Project_GIS\Project_mxds\Figure1_Location_Map.mxd, Date: December 20, 2007 3:35:20 PM

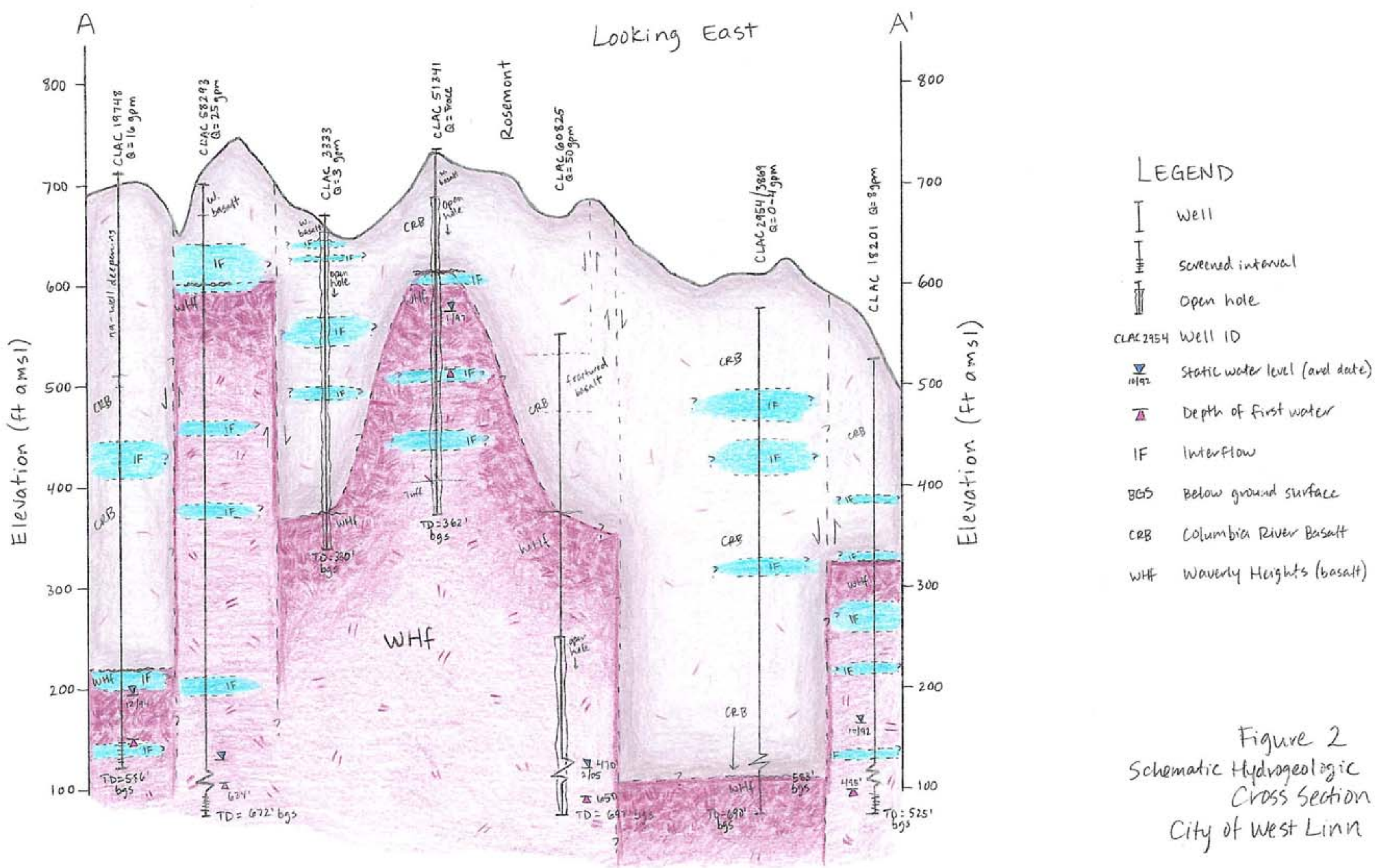


Figure 2
Schematic Hydrogeologic Cross Section
City of West Linn

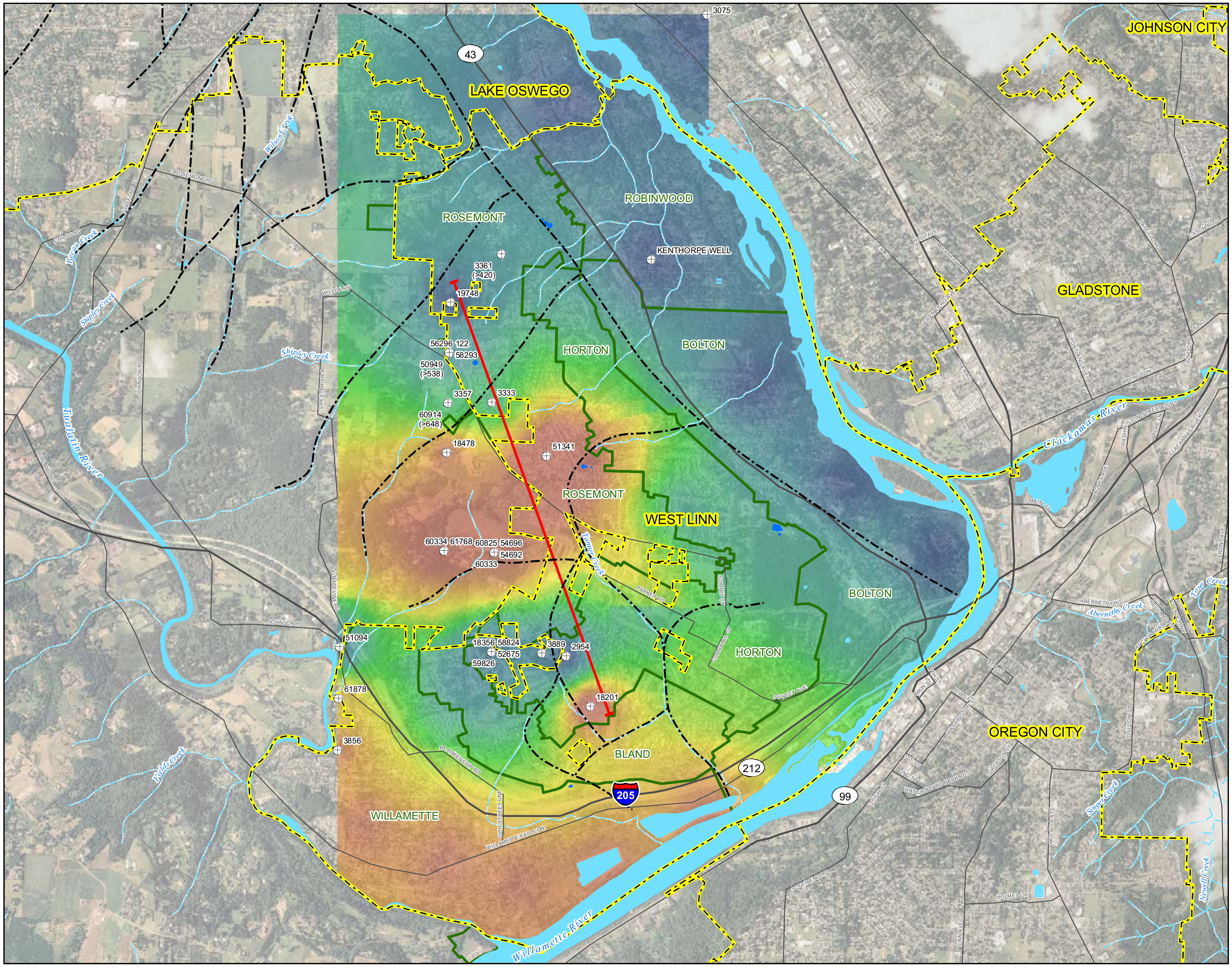


FIGURE 3

Estimated Thickness of CRBG

City of West Linn

LEGEND

Thickness of CRBG

- >580 feet
- 124 feet
- Existing Wells
- Faults
- Geologic Cross Section
- City Pressure Zones
- City Boundaries
- Watercourses
- Waterbodies
- Reservoirs
- Freeways and Highways
- Major Roads

NOTE: The interpreted thickness of the CRBG is based on well logs, published and unpublished mapping of the West Linn, Lake Oswego Quadrangles by the USGS, DOGAMI, and Terry Tolan (GSI).

N

Scale
1:30,000

0 1250 2500 3750 5000
Feet

MAP NOTES:
Projection: Oregon State Plane North Zone
Datum: North American Datum of 1983
Date: January 16, 2008
Data Sources: Murray, Smith, and Associates, OWRD, Oregon Geospatial Data Clearinghouse

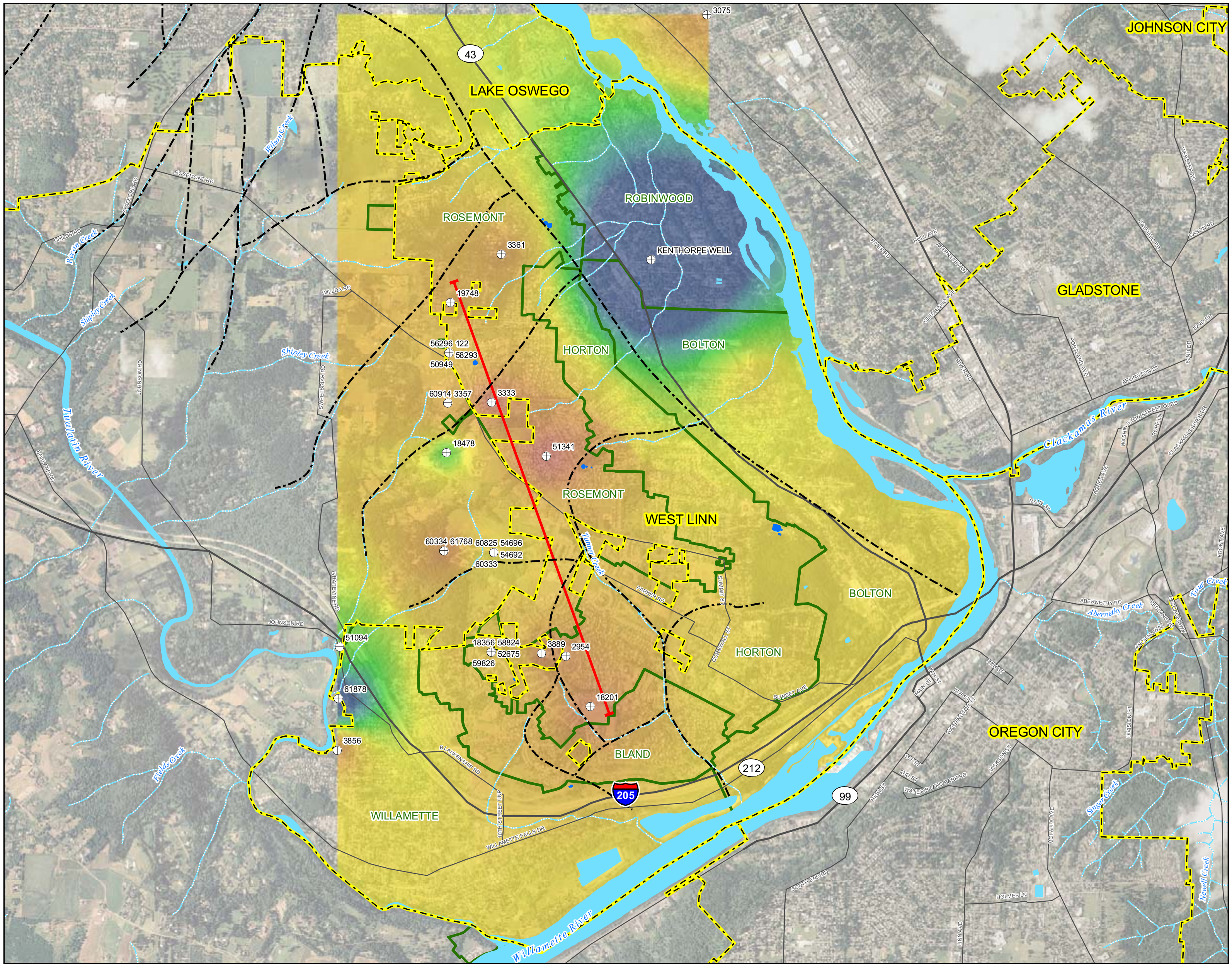
GSI Water Solutions, Inc.

File Path: \\gsi-sbs-001\Projects\274 - City of West Linn\001 - ASR Feasibility\Project_GIS\Project_mxds\Figure3_Estimated_Thickness_of_CRBG.mxd, Date: January 16, 2008 3:55:15 PM

FIGURE 4

Well Yield

City of West Linn



LEGEND

Discharge (gallons per minute)

- 200 gpm
- 1 gpm
- Existing Wells
- Faults
- Geologic Cross Section
- City Pressure Zones
- City Boundaries
- Watercourses
- Waterbodies
- Reservoirs
- Freeways and Highways
- Major Roads

N

Scale
1:30,000

0 1250 2500 3750 5000
Feet

MAP NOTES:
Projection: Oregon State Plane North Zone
Datum: North American Datum of 1983
Date: January 14, 2008
Data Sources: Murray, Smith, and Associates, OWRD, Oregon Geospatial Data Clearinghouse

GSI Water Solutions, Inc.

File Path: \\gsi-sbs-001\Projects\274 - City of West Linn\001 - ASR Feasibility\Project_GIS\Project_mxds\Figure4_Well_Yield.mxd, Date: January 14, 2008 1:44:45 PM

MSA

APPENDIX E
Project Data Sheets

Murray, Smith & Associates, Inc.
Engineers/Planners

DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 1
PRIORITY: 1
PROPOSED PROJECT: Pipeline Replacement

Location: Willamette Falls Dr. from PRV to Pump Station

Project Description: Installation of approximately 3,710 linear feet of 20-inch diameter ductile iron piping along Willamette Falls Dr. in the Willamette pressure zone is expected to improve transmission capacity under existing and future peak demand conditions.

Existing Pipe Diameter: 10 in. **Proposed Pipe Diameter:** 20 in.

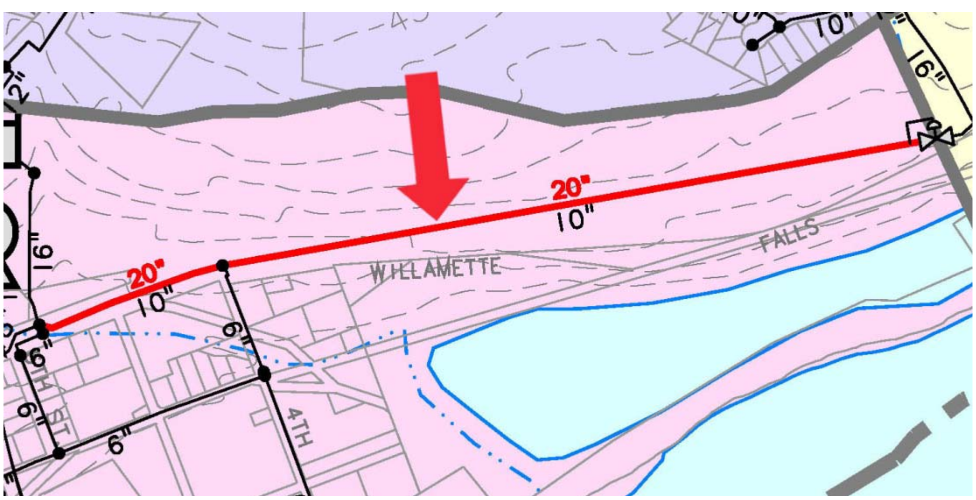
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $320

Estimated Project Cost: $1,187,200

Project Area Map:



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

DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 2
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Willamette Falls Dr. from Britton to Ostman

Project Description: Installation of approximately 1,686 linear feet of 12-inch diameter ductile iron piping along Willamette Falls Dr. in the Willamette pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 3,4 in. **Proposed Pipe Diameter:** 12 in.

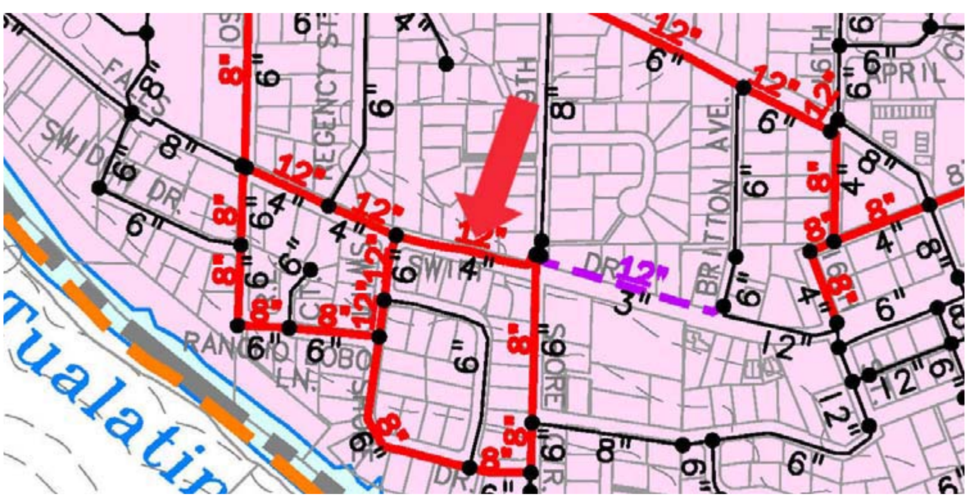
Existing Pipe Material: WI **Proposed Pipe Material:** DI

Cost

Unit Cost: $185

Estimated Project Cost: $311,910

Project Area Map:



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

DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 3
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Dollar St. from 16th to Fields Dr.

Project Description: Installation of approximately 2,733 linear feet of 12-inch diameter ductile iron piping along Dollar St. in the Willamette pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 12 in.

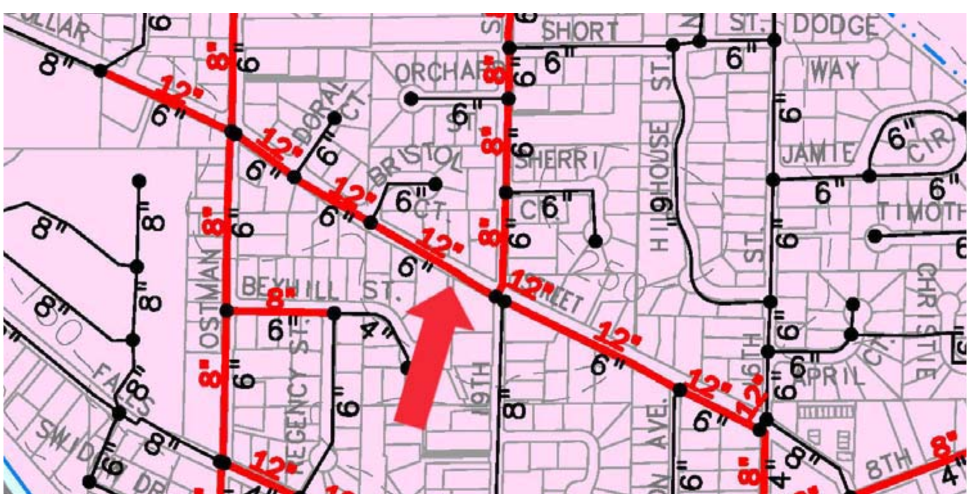
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $185

Estimated Project Cost: $505,605

Project Area Map:



Murray, Smith & Associates, Inc.
Engineers/Planners

DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 4
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: 16th St. & 8th Ave. to 10th St.

Project Description: Installation of approximately 2,809 linear feet of 8-inch diameter ductile iron piping along 16th St. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 4, 6 in.

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: CI

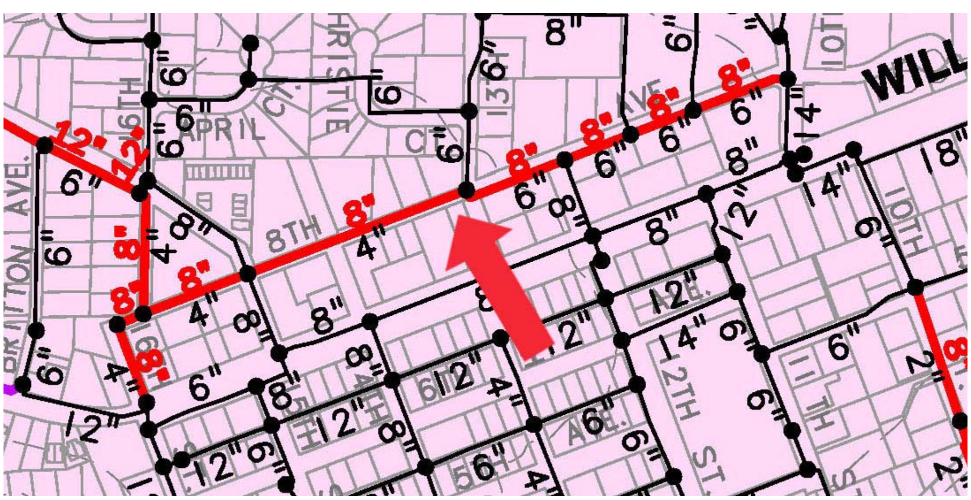
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $351,125

Project Area Map:



DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 5
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: 12th St. from Tualatin Ave. to Volpp St. on to 9th St. up to 5th Ave.

Project Description: Installation of approximately 2,845 linear feet of 8-inch dimeter ductile iron piping along 12th St. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

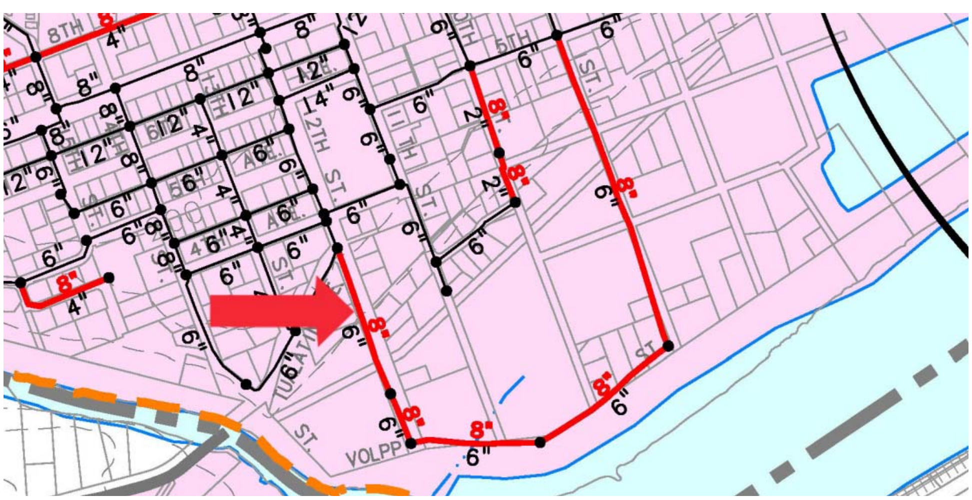
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $355,625

Project Area Map:



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

DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 6
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: 10th St. from 5th Ave. to Leslies Way

Project Description: Installation of approximately 678 linear feet of 8-inch diameter ductile iron piping along 10th St. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 2 in. **Proposed Pipe Diameter:** 8 in.

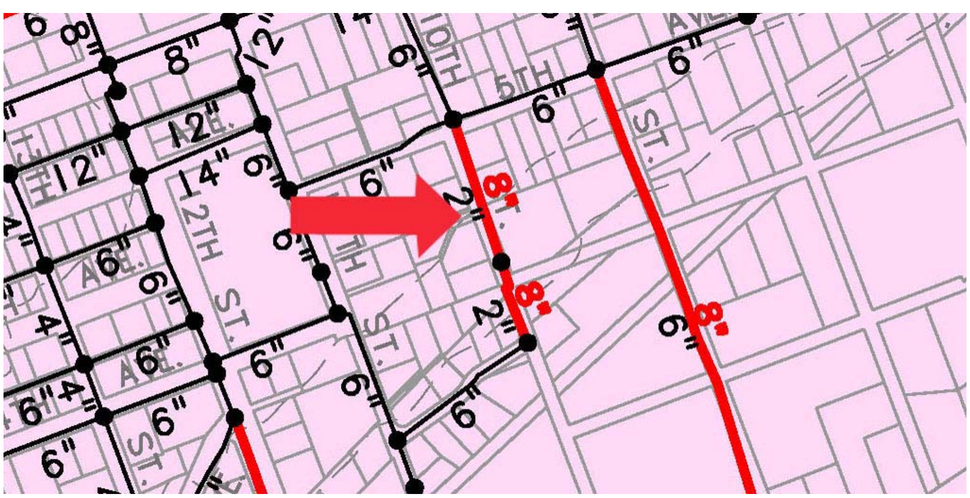
Existing Pipe Material: PVC **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $84,750

Project Area Map:



DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 7
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: 19th St. from Dollar St. to Blankenship Rd.

Project Description: Installation of approximately 1,958 linear feet of 8-inch diameter ductile iron piping along 19th St. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

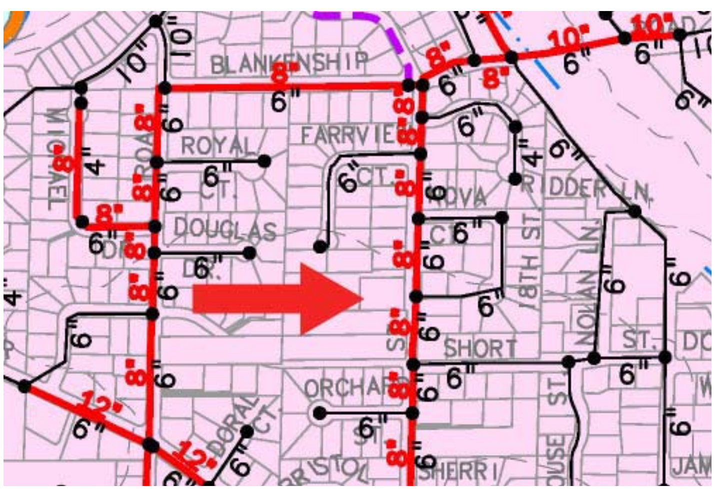
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $244,750

Project Area Map:



Murray, Smith & Associates, Inc.
Engineers/Planners

DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 8
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Ostman Rd. from Dollar St. to Blankenship Rd.

Project Description: Installation of approximately 1,365 linear feet of 8-inch diameter ductile iron piping along Ostman Rd. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in.   **Proposed Pipe Diameter:** 8 in.

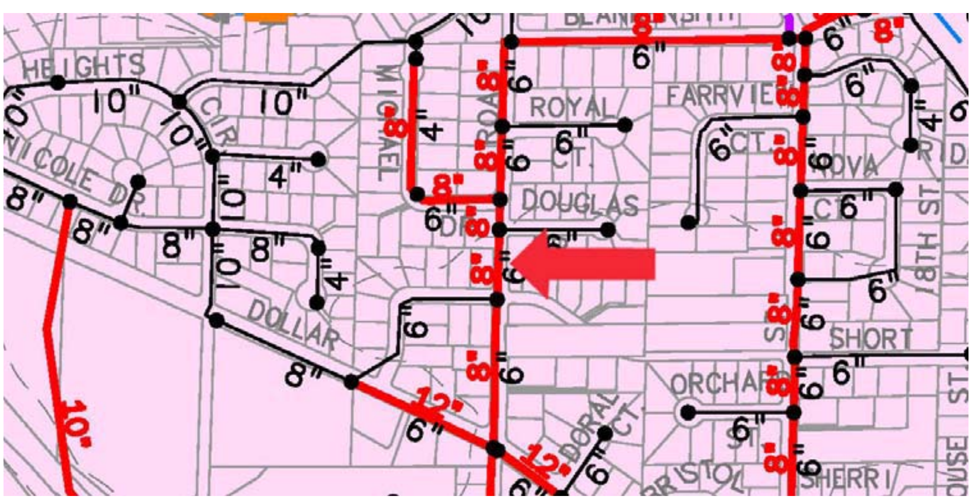
Existing Pipe Material: CI   **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $170,625

Project Area Map:



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

DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 9
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Michael Dr.

Project Description: Installation of approximately 743 linear feet of 8-inch diameter ductile iron piping along Michael Dr. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 4, 6 in. **Proposed Pipe Diameter:** 8 in.

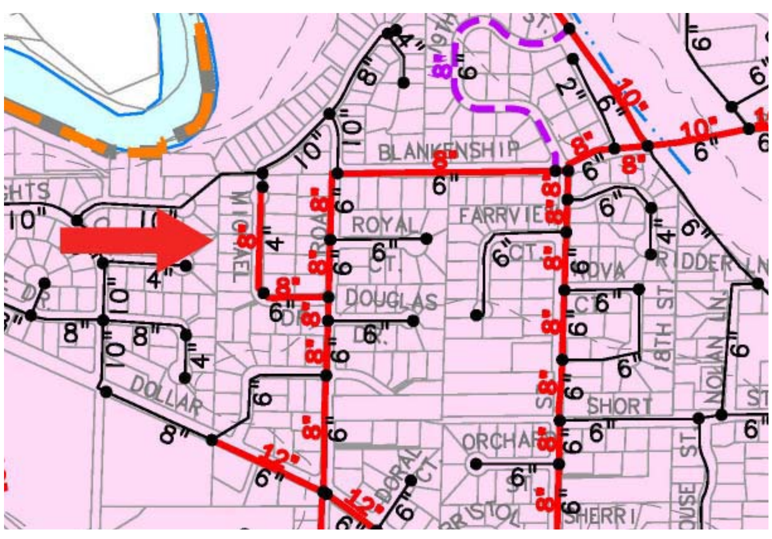
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $92,875

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 10
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Blankenship Rd. from Ostman Rd. to 19th

Project Description: Installation of approximately 980 linear feet of 8-inch diameter ductile iron piping along Blankenship Rd. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

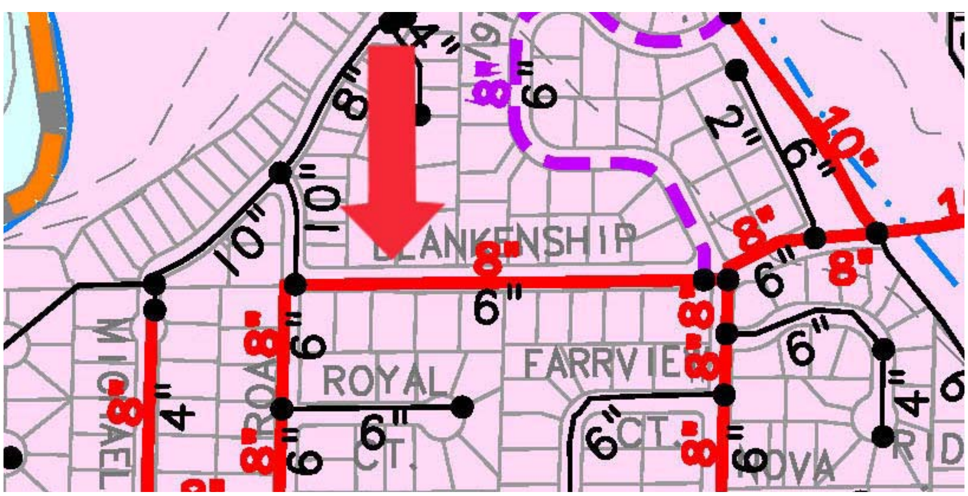
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $122,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.):	11
PRIORITY:	3
PROPOSED PROJECT:	Pipeline Replacement

Location: 19th St. from Blankenship Rd. to Johnson Rd.

Project Description: Installation of approximately 1,412 linear feet of 8-inch diameter ductile iron piping along 19th St. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

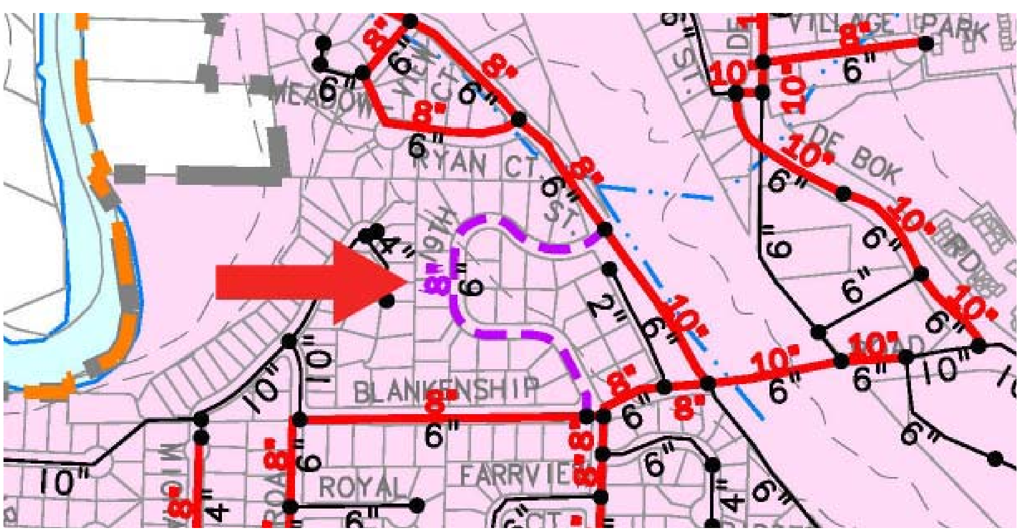
Existing Pipe Diameter:	6 in.	**Proposed Pipe Diameter:**	8 in.
Existing Pipe Material:	AC	**Proposed Pipe Material:**	DI

Cost

Unit Cost: $125

Estimated Project Cost: $176,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 12
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Blankenship Rd. from 19th to Willamette Terrace Apartments

Project Description: Installation of approximately 378 linear feet of 8-inch diameter and 643 linear feet of 10-inch diameter ductile iron piping along Blankenship Rd. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in.

Proposed Pipe Diameter: 8, 10 in.

Existing Pipe Material: CI

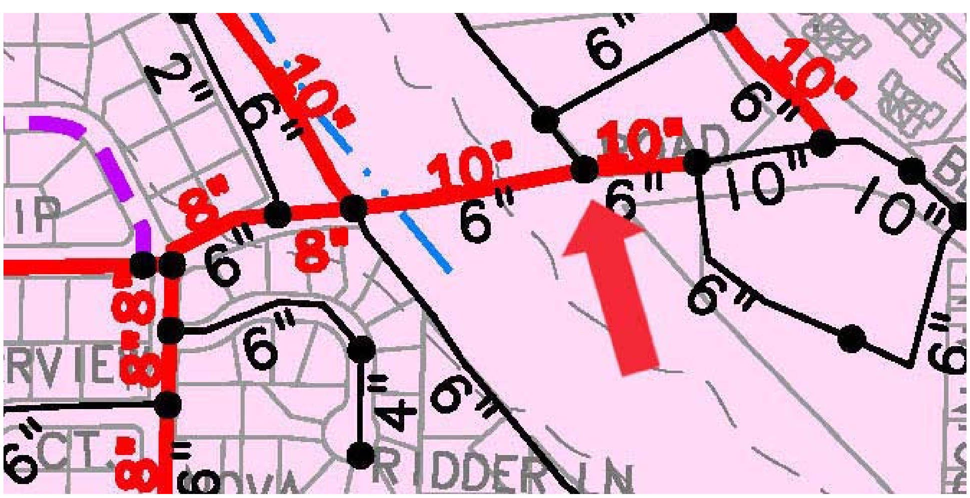
Proposed Pipe Material: DI

Cost

Unit Cost: $125/$155

Estimated Project Cost: $146,915

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 13
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Johnson Rd. from Blankenship Rd. to Willamette River

Project Description: Installation of approximately 4,147 linear feet of 8-inch diameter ductile iron piping along Johnson Rd. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

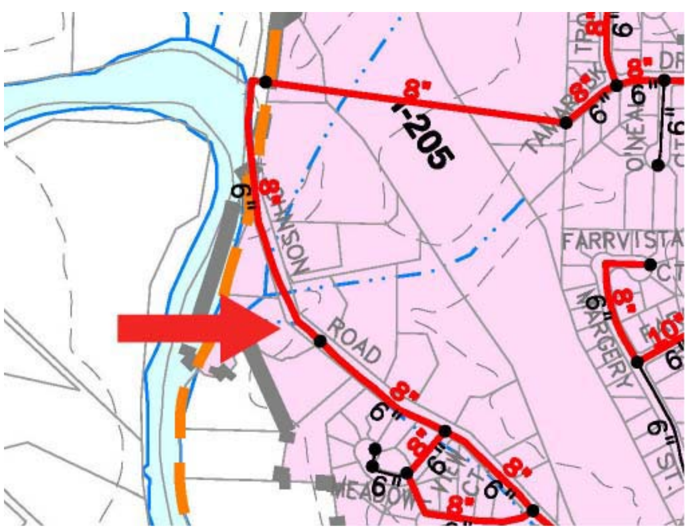
Existing Pipe Material: DI, CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $518,375

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 14
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Ostman Rd. & Dollar St. to Rancho Lobo Ln. & Swiftshore Dr.

Project Description: Installation of approximately 2,565 linear feet of 8-inch diameter ductile iron piping along Ostman Rd. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

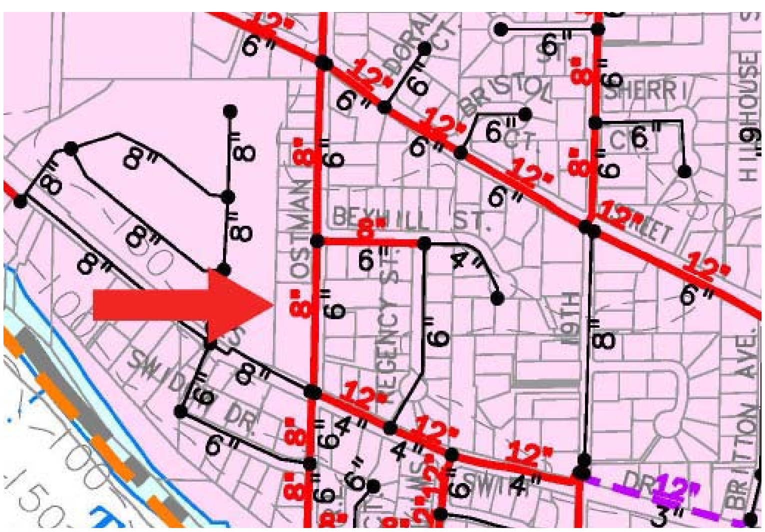
Existing Pipe Material: DI, CI, PVC **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $320,625

Project Area Map:



DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 15
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: South of Willamette Falls Dr. & 19th to Swiftshore Dr.

Project Description: Installation of approximately 720 linear feet of 8-inch diameter ductile iron piping along Willamette Falls Dr. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

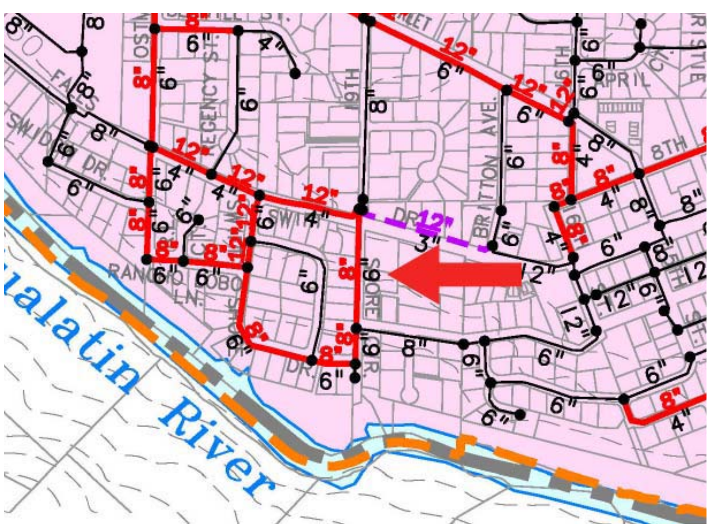
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $90,000

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 16
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Swiftshore Dr.

Project Description: Installation of approximately 874 linear feet of 8-inch diameter and 340 linear feet of 12-inch diameter ductile iron piping along Swiftshore Dr. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in.

Proposed Pipe Diameter: 8, 12 in.

Existing Pipe Material: DI

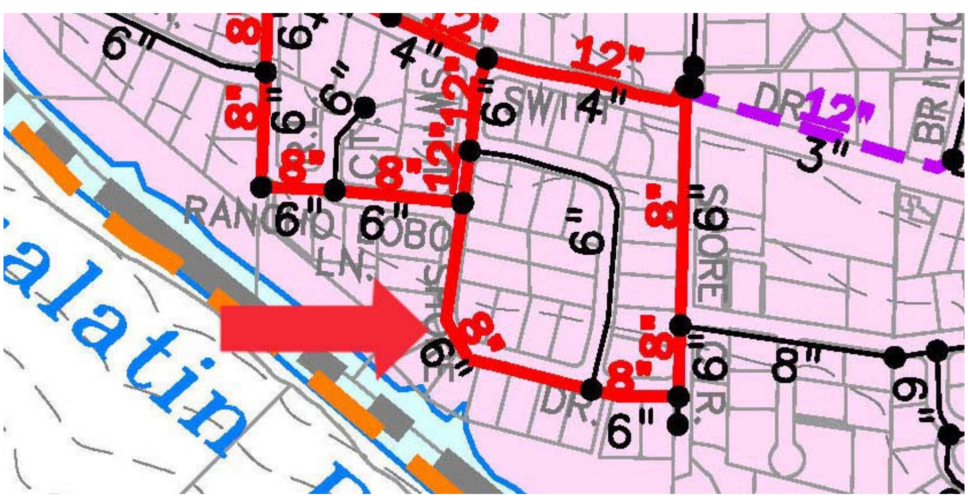
Proposed Pipe Material: DI

Cost

Unit Cost: $125/$185

Estimated Project Cost: $172,150

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 17
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Evah Ln.

Project Description: Installation of approximately 507 linear feet of 8-inch diameter ductile iron piping along Evah Ln. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 4 in. **Proposed Pipe Diameter:** 8 in.

Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $63,375

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 18
PRIORITY: 4
PROPOSED PROJECT: Proposed Pipeline

Location: From Willamette Falls Dr. to Dollar St.

Project Description: Installation of approximately 1,450 linear feet of 10-inch diameter ductile iron piping along Willamette Falls Dr. in the Willamette pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 10 in

Existing Pipe Material: -

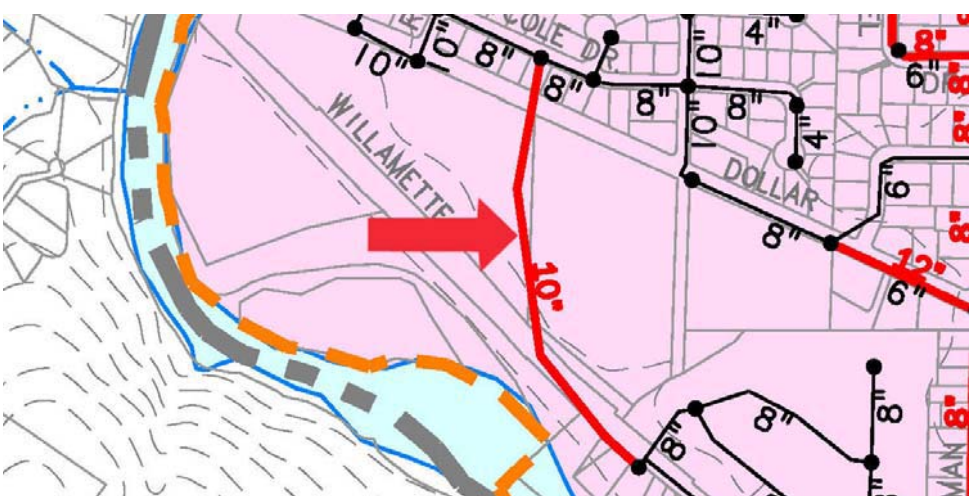
Proposed Pipe Material: DI

Cost

Unit Cost: $155

Estimated Project Cost: $224,750

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 19
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Barnes Circle from Greene St. to Lois Ln.

Project Description: Installation of approximately 546 linear feet of 8-inch diameter ductile iron piping along Barnes Circle in the Bland pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in.

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: CI

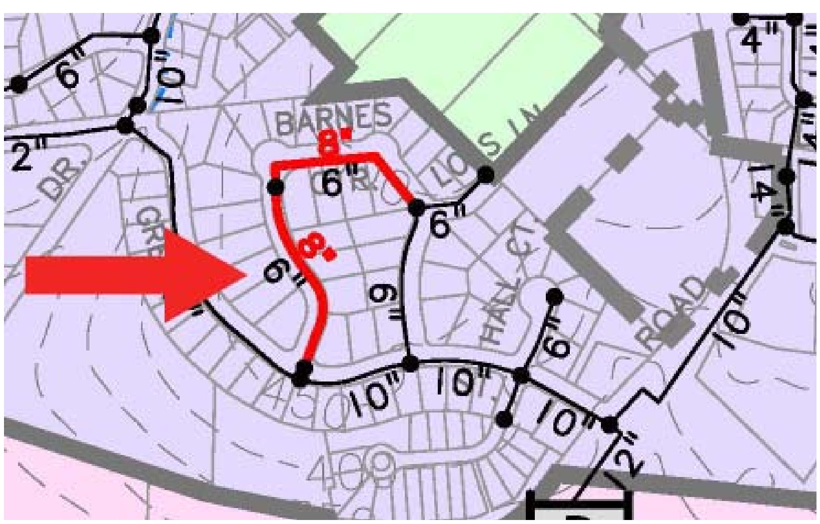
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $68,250

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 20
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Debok Rd. from Blankenship Rd. to Margery St.

Project Description: Installation of approximately 1,268 linear feet of 10-inch diameter ductile iron piping along Debok Rd. in the Willamette pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 10 in.

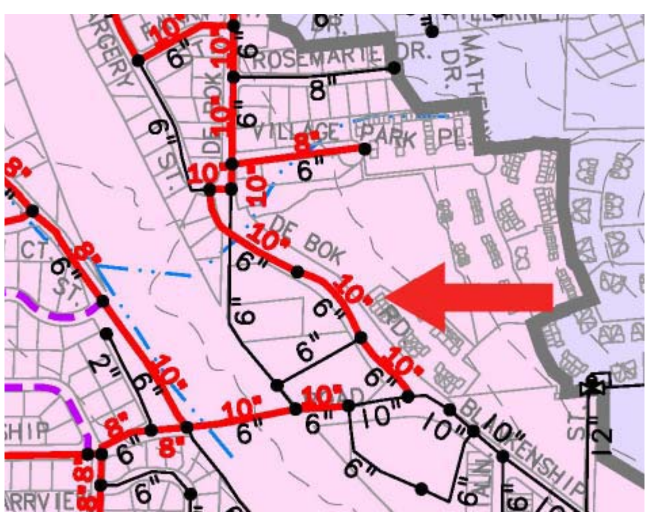
Existing Pipe Material: CI, DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $155

Estimated Project Cost: $196,540

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 21
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Village Park Pl.

Project Description: Installation of approximately 532 linear feet of 8-inch diameter ductile iron piping along Village Park Pl. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in.

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: CI

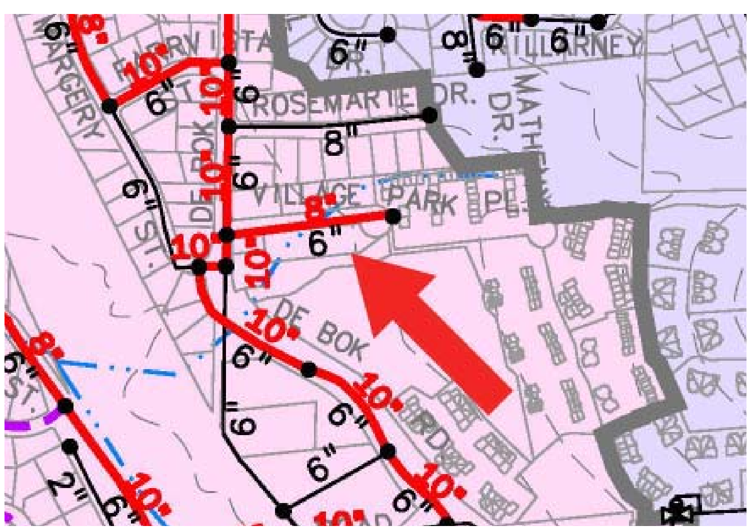
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $66,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 22
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Riverknoll Ct.

Project Description: Installation of approximately 547 linear feet of 8-inch diameter ductile iron piping along Riverknoll Ct. in the Bland pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

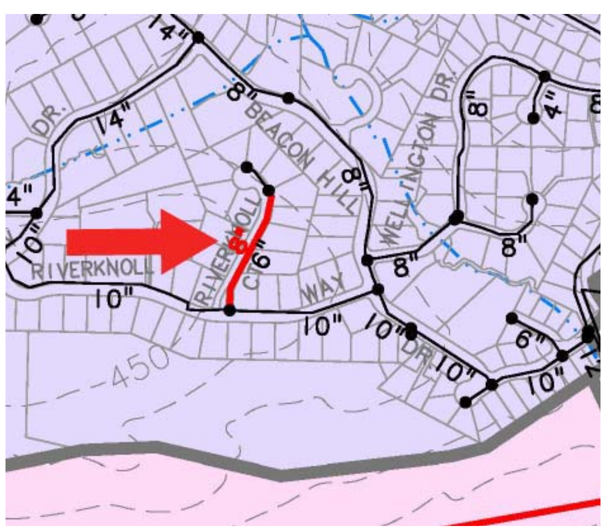
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $68,375

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 23
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Debok Rd. from Village Park Pl. to Tamarisk Dr.

Project Description: Installation of approximately 1,614 linear feet of 10-inch diamter ductile iron piping along Debok Rd. in the Willamette pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 10 in.

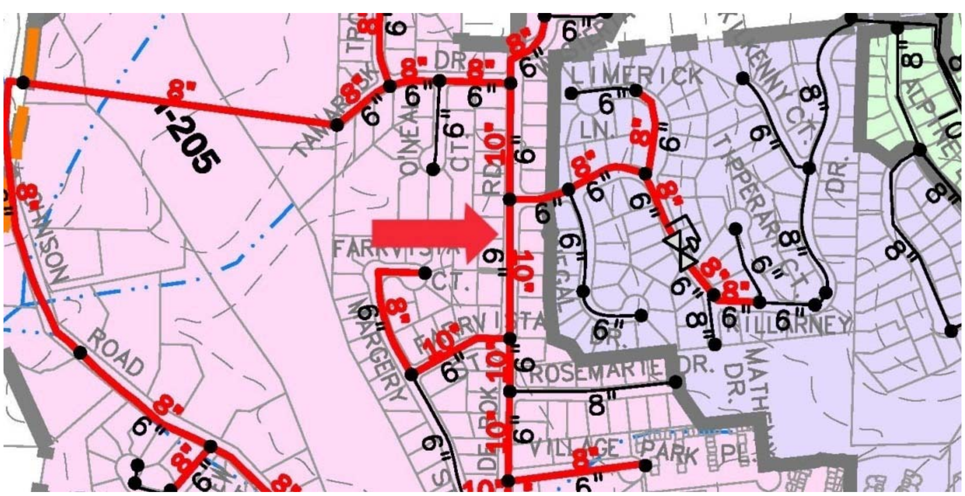
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $155

Estimated Project Cost: $250,170

Project Area Map:



DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 24
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Farrvista Dr. & Debok Rd. to Farrvista Ct.

Project Description: Installation of approximately 597 linear feet of 8-inch diameter and 411 linear feet of 10-inch diameter ductile iron piping along Farrvista Dr. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8, 10 in.

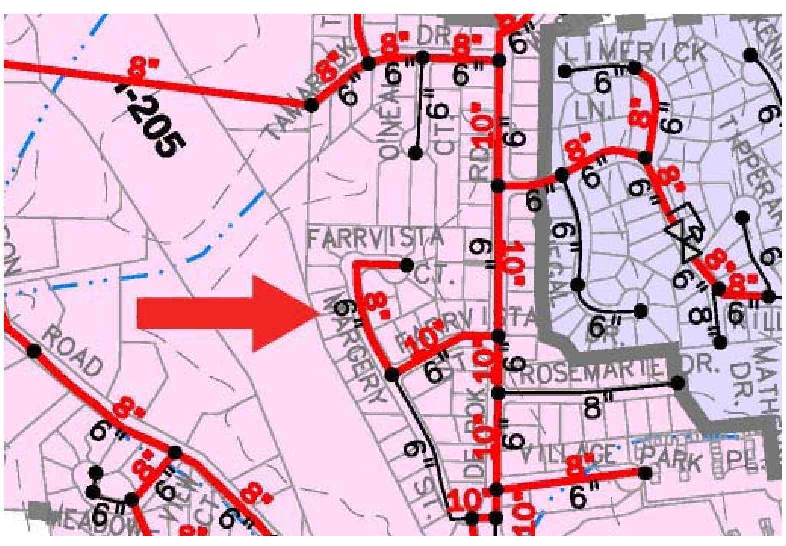
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125/$155

Estimated Project Cost: $138,330

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 25
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Tamarisk Dr.

Project Description: Installation of approximately 716 linear feet of 8-inch diameter ductile iron piping along Tamarisk Dr. in the Willamette pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

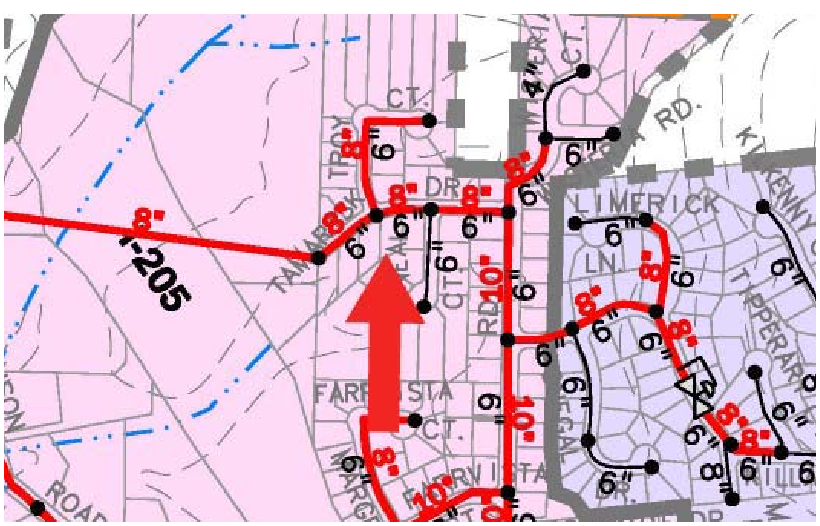
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $89,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 26
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Troy Ct.

Project Description: Installation of approximately 551 linear feet of 8-inch diameter ductile iron piping along Troy Ct. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

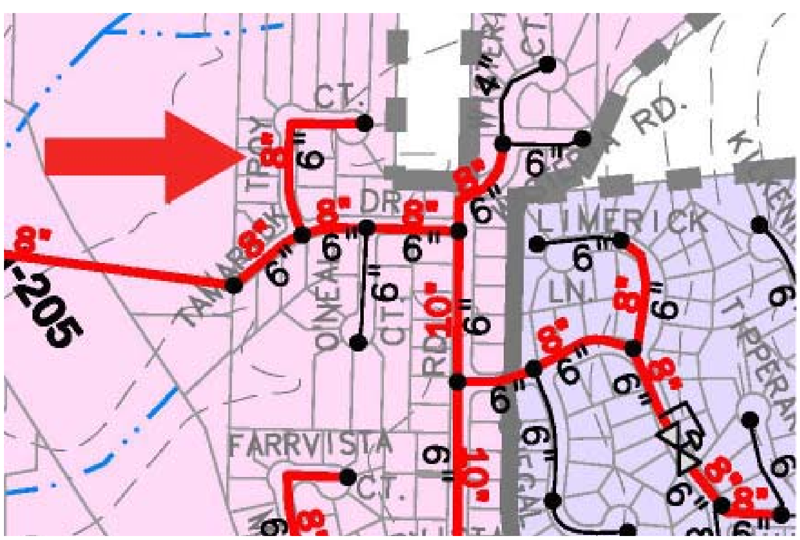
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $68,875

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 27
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Wisteria Ct.

Project Description: Installation of approximately 320 linear feet of 8-inch diameter ductile iron piping along Wisteria Ct. in the Willamette pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

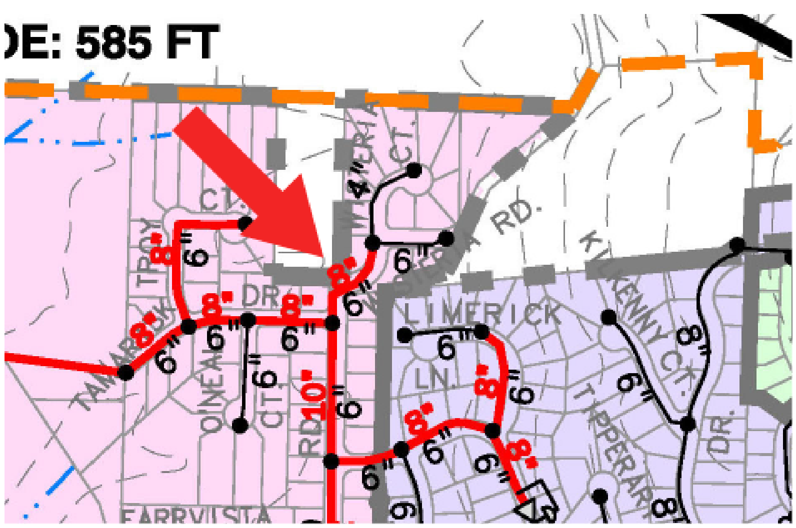
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $40,000

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 28
PRIORITY: 1
PROPOSED PROJECT: Pipeline Replacement

Location: Killarney Dr. from Debok Rd. to PRV, Killarney Dr. from PRV to Tipperary Ct.

Project Description: Installation of approximately 1,200 linear feet of 8-inch diameter and 354 linear feet of 8-inch diameter ductile iron piping along Killarney Dr. in the Bland pressure zone is expected to improve transmission capacity under existing and future peak demand conditions.

Existing Pipe Diameter:	6 in.	**Proposed Pipe Diameter:**	8 in.
Existing Pipe Material:	DI, CI	**Proposed Pipe Material:**	DI

Cost

Unit Cost: $125

Estimated Project Cost: $194,250

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 29
PRIORITY: 4
PROPOSED PROJECT: Proposed Pipeline

Location: Weatherhill Rd. from S. Salamo Rd. to S. Bland Circle and then south

Project Description: Installation of approximately 2,312 linear feet of 8-inch diameter ductile iron piping along Weatherhill Rd. in the Horton pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: -

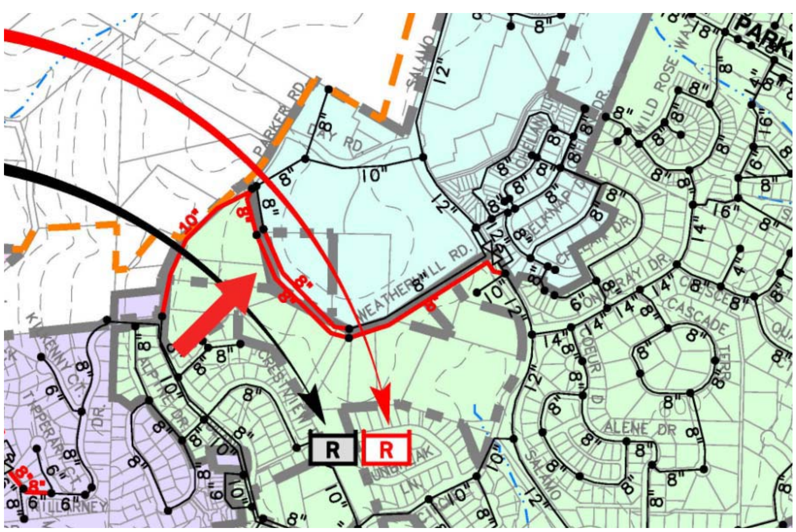
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $289,000

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 30
PRIORITY: 4
PROPOSED PROJECT: Proposed Pipeline

Location: Weatherhill Rd.

Project Description: Installation of approximately 861 linear feet of 8-inch diameter ductile iron piping along Weatherhill Rd. in the Rosemount pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: -

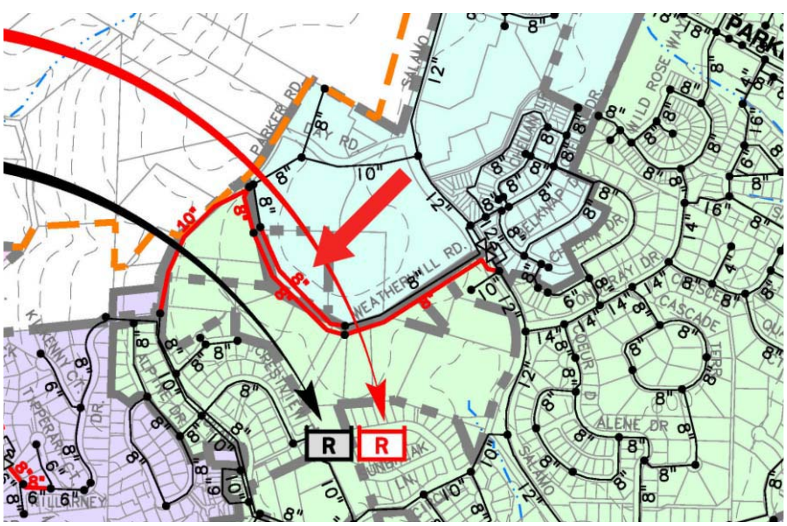
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $107,625

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 31
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Sussex St. south of Sunset Ave.

Project Description: Installation of approximately 248 linear feet of 8-inch diameter ductile iron piping along Sussex St. in the Horton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter:	4 in.	**Proposed Pipe Diameter:**	8 in.
Existing Pipe Material:	CI	**Proposed Pipe Material:**	DI

Cost

Unit Cost: $125

Estimated Project Cost: $31,000

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 32
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: From River View Ave. to Falls View Dr.

Project Description: Installation of approximately 213 linear feet of 8-inch diameter ductile iron piping along River View Ave. in the Horton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 4 in.

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: CI, ST

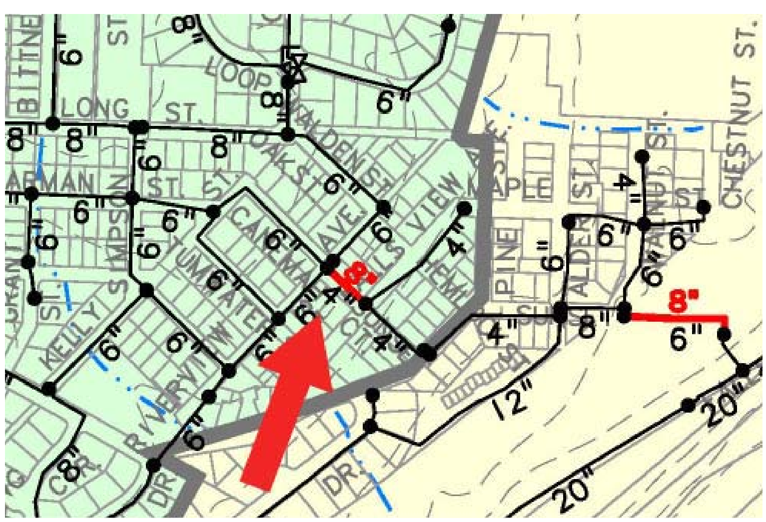
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $26,625

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 33 - THIS CIP NO. NOT USED
PRIORITY:
PROPOSED PROJECT:

Location:

Project Description:

Existing Pipe Diameter:

Proposed Pipe Diameter:

Existing Pipe Material:

Proposed Pipe Material:

Cost

Unit Cost:

Estimated Project Cost:

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 34
PRIORITY: 4
PROPOSED PROJECT: Proposed Pipeline

Location: I-205 crossing west of Tamarisk Dr.

Project Description: Installation of approximately 1,208 linear feet of 8-inch diameter ductile iron piping along I-205 in the Willamette pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: -

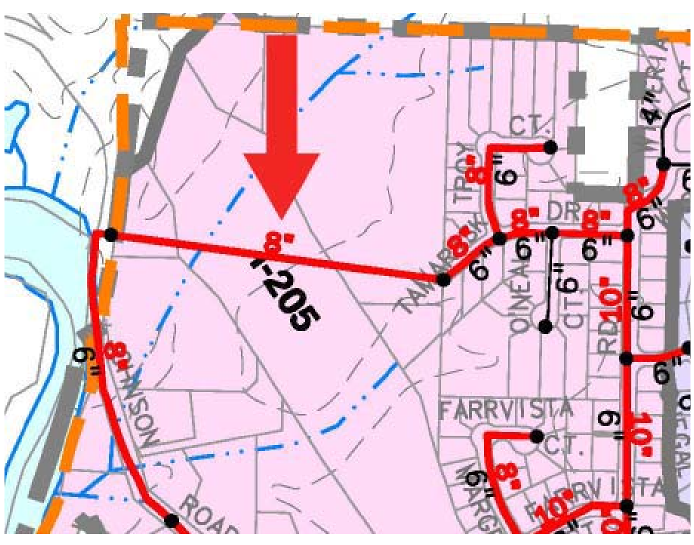
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $151,000

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 35
PRIORITY: 1
PROPOSED PROJECT: Pipeline Replacement

Location: Transmission to View Dr. Reservoir

Project Description: Installation of approximately 4,211 linear feet of 12-inch diameter ductile iron piping along Transmission to View Dr. in the Robinwood pressure zone is expected to improve transmission capacity under existing and future peak demand conditions.

Existing Pipe Diameter: 10 in. **Proposed Pipe Diameter:** 12 in.

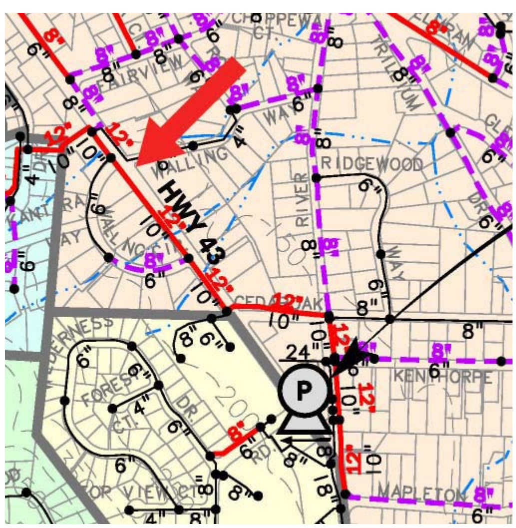
Existing Pipe Material: AC **Proposed Pipe Material:** DI

Cost

Unit Cost: $185

Estimated Project Cost: $779,035

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 36
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: River St. from Burns St. to Holly St.

Project Description: Installation of approximately 2,107 linear feet of 8-inch diameter ductile iron piping along River St. in the Bolton pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 4, 6 in. **Proposed Pipe Diameter:** 8 in.

Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $263,375

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 37
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Suncrest Ave. from Carriage Way to Valley View Dr.

Project Description: Installation of approximately 1,656 linear feet of 12-inch diameter ductile iron piping along Suncrest Ave. in the Rosemont pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 8 in. **Proposed Pipe Diameter:** 12 in.

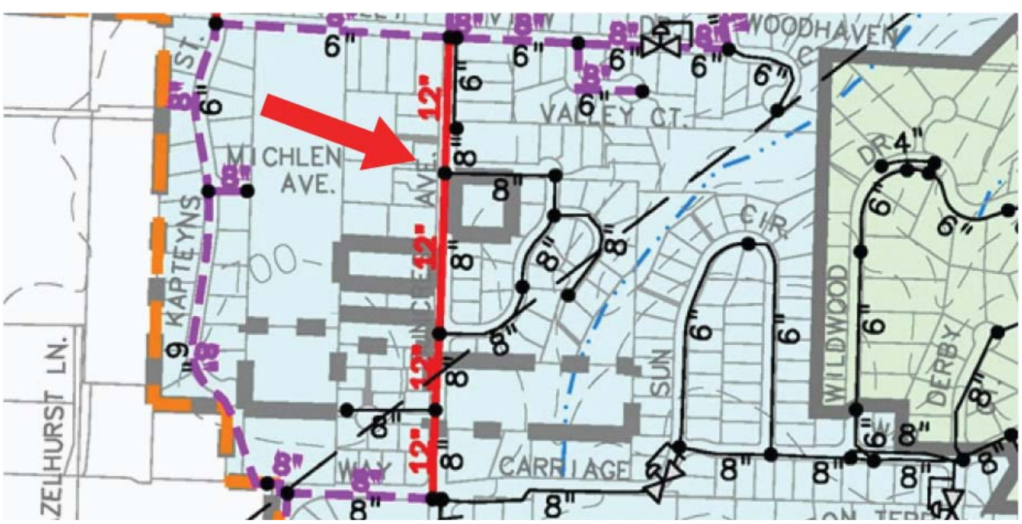
Existing Pipe Material: AC **Proposed Pipe Material:** DI

Cost

Unit Cost: $185

Estimated Project Cost: $306,360

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 38
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Burns St. from Hood St. to River St.

Project Description: Installation of approximately 1,228 linear feet of 8-inch diameter ductile iron piping along Burns St. in the Bolton pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

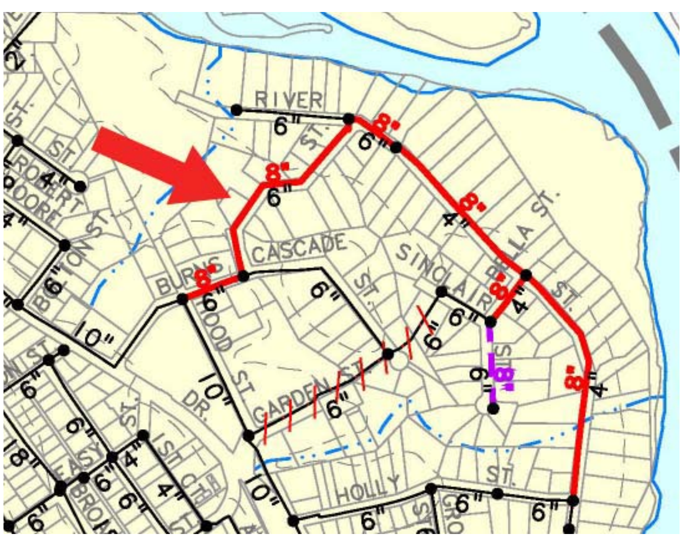
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $153,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 39
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Clark St. south of Skyline

Project Description: Installation of approximately 425 linear feet of 8-inch diameter ductile iron piping along Clark St. in the Horton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

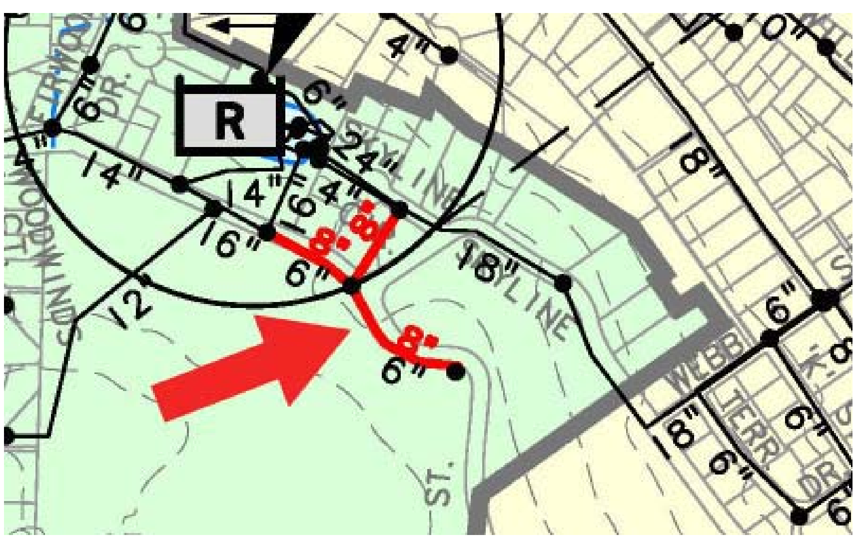
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $53,125

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 40
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Caufield St.

Project Description: Installation of approximately 711 linear feet of 8-inch diameter ductile iron piping along Caufield St. in the Bolton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $88,875

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 41
PRIORITY: 4
PROPOSED PROJECT: Pipeline Replacement

Location: Ridge Ln. area

Project Description: Installation of approximately 1,300 linear feet of 8-inch diameter ductile iron piping along Ridge Ln. in the Rosemont pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: 2 in. **Proposed Pipe Diameter:** 8 in.

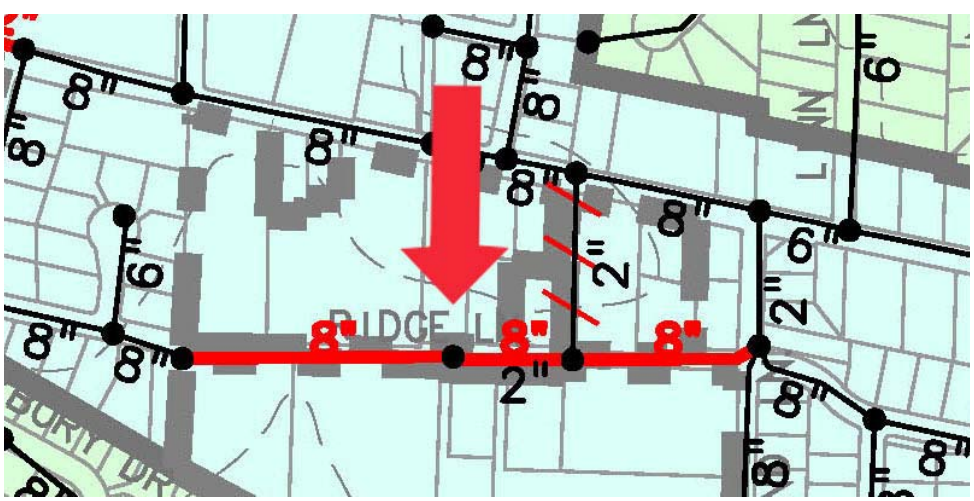
Existing Pipe Material: PVC **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $162,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 42
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: North of Linn Ln.

Project Description: Installation of approximately 369 linear feet of 8-inch diameter ductile iron piping along Linn Ln. in the Horton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

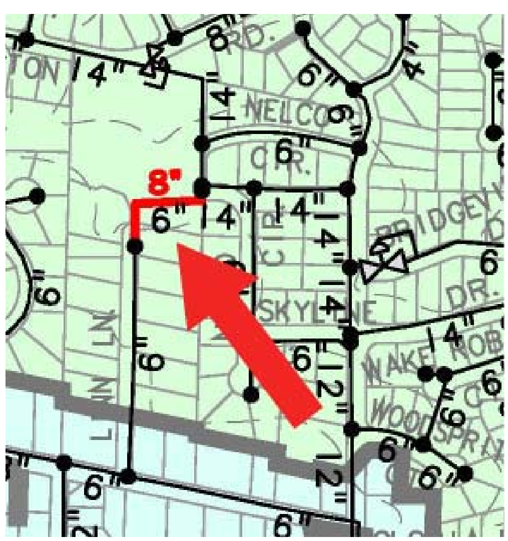
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $46,125

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 43
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Parkview Terrace and Rosepark Dr.

Project Description: Installation of approximately 765 linear feet of 8-inch diameter ductile iron piping along Parkview Terrace in the Horton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $95,625

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 44
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: S. Shannon Ln. north of Rosepark Dr.

Project Description: Installation of approximately 602 linear feet of 8-inch diameter ductile iron piping along S. Shannon Ln. in the Rosemont pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

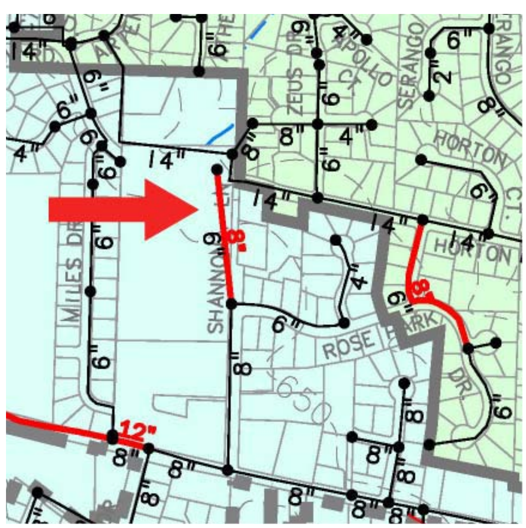
Existing Pipe Material: ST **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $75,250

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 45
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Rosemont Rd. from Salamo Rd. to Wild Rose Dr.

Project Description: Installation of approximately 1,843 linear feet of 12-inch diameter ductile iron piping along Rosemont Rd. in the Rosemont pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 8 in. **Proposed Pipe Diameter:** 12 in.

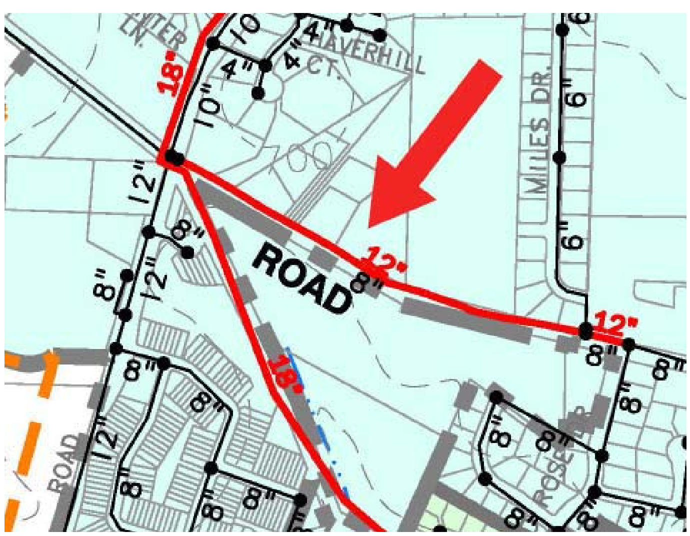
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $185

Estimated Project Cost: $340,955

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 46
PRIORITY: 1
PROPOSED PROJECT: Proposed Pipeline

Location: Parker Rd. to Horton Reservoir

Project Description: Installation of approximately 3,240 linear feet of 18-inch diameter ductile iron piping along Parker Rd. in the Rosemont pressure zone is expected to improve transmission capacity under existing and future peak demand conditions.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 18 in.

Existing Pipe Material: -

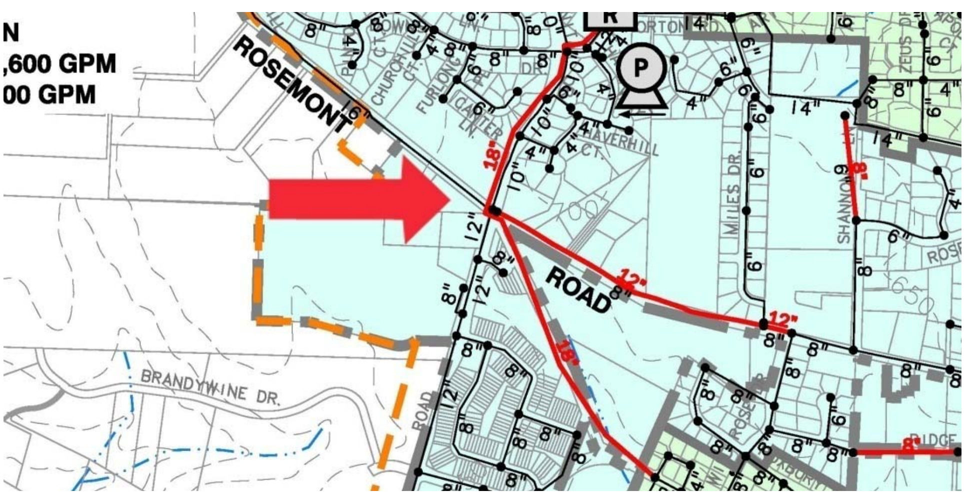
Proposed Pipe Material: DI

Cost

Unit Cost: $290

Estimated Project Cost: $939,600

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 47
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Apollo Rd. west of Athena Rd.

Project Description: Installation of approximately 385 linear feet of 8-inch diameter ductile iron piping along Apollo Rd. in the Horton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

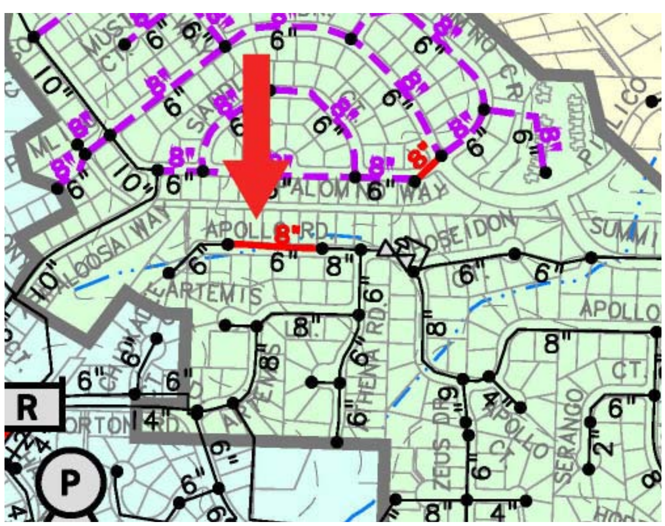
Existing Pipe Material: PVC **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $48,125

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 48
PRIORITY: 4
PROPOSED PROJECT: Pipeline Replacement

Location: Palomino Way from Saddle Ct. to Palomino Circle

Project Description: Installation of approximately 246 linear feet of 8-inch diameter ductile iron piping along Palomino Way in the Horton pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: -

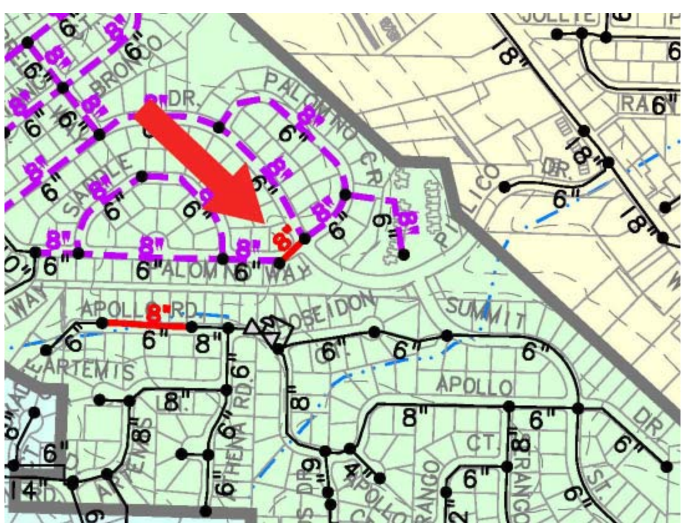
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $30,750

Project Area Map:



DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 49
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Mark Ln. from Willamette Dr. to Lowell Ave.

Project Description: Installation of approximately 759 linear feet of 8-inch diameter ductile iron piping along Mark Ln. in the Bolton pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

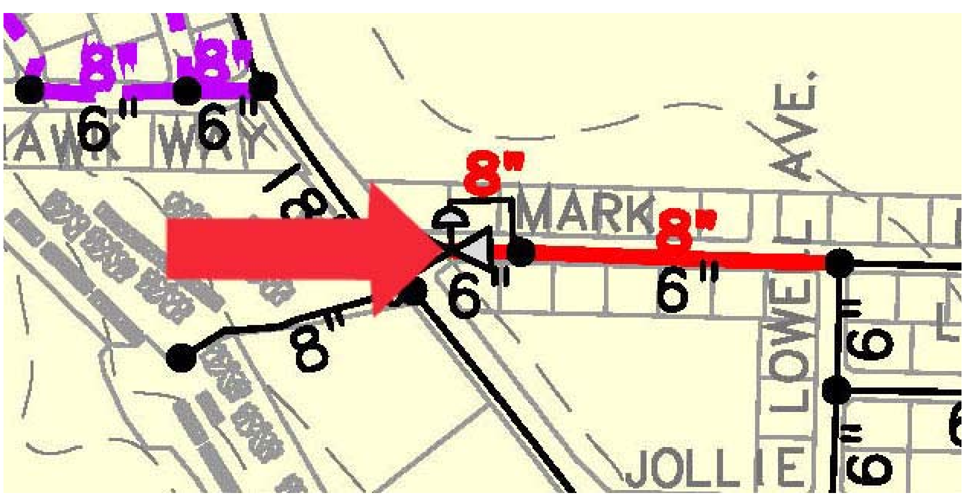
Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $94,875

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 50
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Magone Ln. west of Tulane St.

Project Description: Installation of approximately 293 linear feet of 8-inch diameter ductile iron piping along Magone Ln. in the Bolton pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 4 in.

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: DI

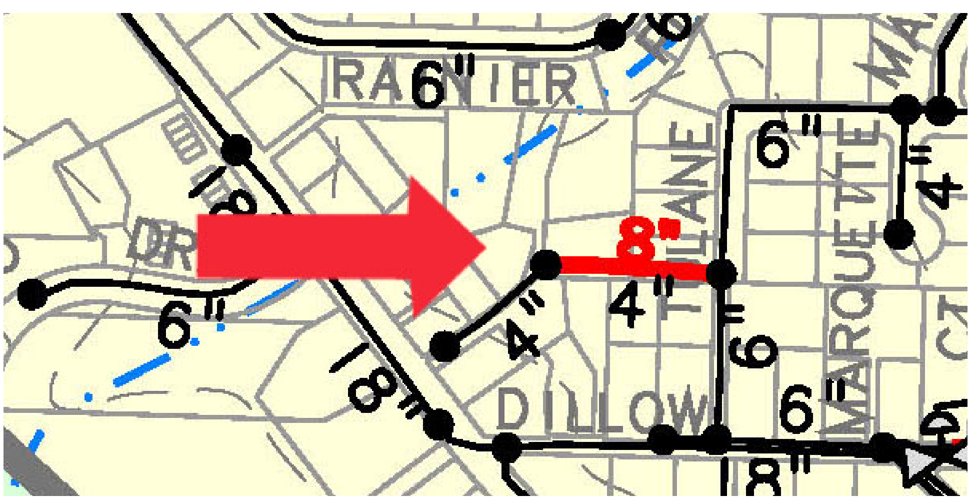
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $36,625

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 51
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Dillow Dr. and Larson Ave. area

Project Description: Installation of approximately 1,334 linear feet of 8-inch diameter and 901 linear feet of 10-inch diameter ductile iron piping along Dillow Dr. in the Bolton pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 4,6 in. **Proposed Pipe Diameter:** 8,10 in.

Existing Pipe Material: CI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125/$155

Estimated Project Cost: $306,405

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 52
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Hidden Springs Rd. southwest of Willamette Dr.

Project Description: Installation of approximately 319 linear feet of 8-inch diameter ductile iron piping along Hidden Springs Rd. in the Bolton pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

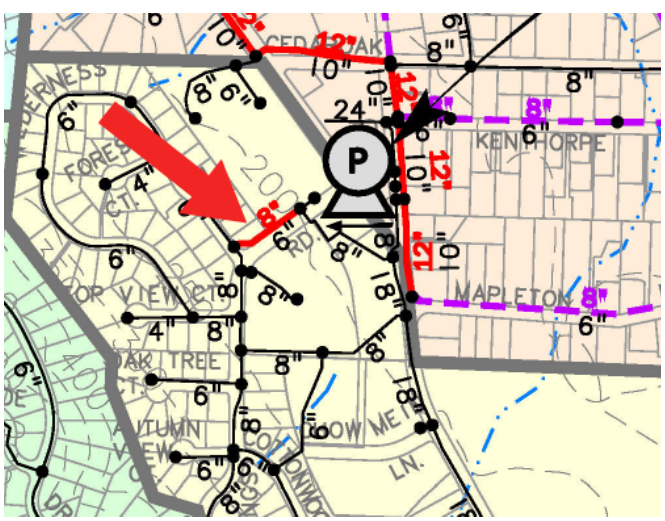
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $39,875

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 53
PRIORITY: 4
PROPOSED PROJECT: Proposed Pipeline

Location: Elmran Dr. from Cedaroak Dr. to Nixon Ave.

Project Description: Installation of approximately 988 linear feet of 8-inch diameter ductile iron piping along Elmran Dr. in the Robinwood pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: -

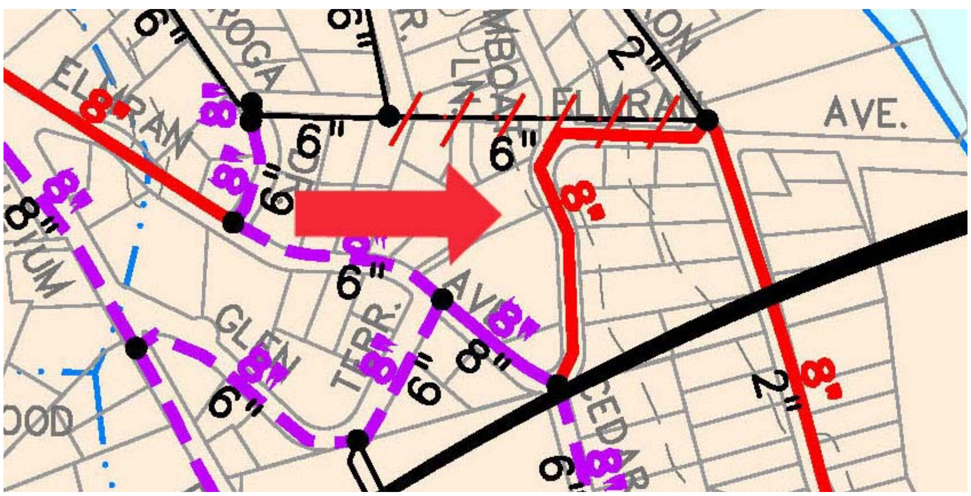
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $123,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 54
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Nixon Ave.

Project Description: Installation of approximately 2,536 linear feet of 8-inch diameter and 492 linear feet of 8-inch diameter ductile iron piping along Nixon Ave. in the Robinwood pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 2,6 in. **Proposed Pipe Diameter:** 8 in.

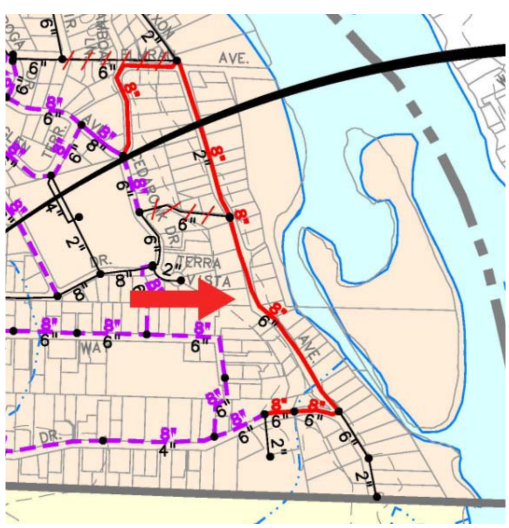
Existing Pipe Material: GLV, DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $378,500

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 55
PRIORITY: 4
PROPOSED PROJECT: Proposed Pipeline

Location: Elmran Dr. from Trillium Dr. to Calaroga Dr.

Project Description: Installation of approximately 860 linear feet of 8-inch diameter ductile iron piping along Elmran Dr. in the Robinwood pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: -

Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $107,500

Project Area Map:

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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 56
PRIORITY: 5
PROPOSED PROJECT: Pipeline Replacement

Location: Parkwood Way west of Calaroga Dr.

Project Description: Installation of approximately 255 linear feet of 8-inch diameter ductile iron piping along Parkwood Way in the Robinwood pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 2 in.

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: GLV

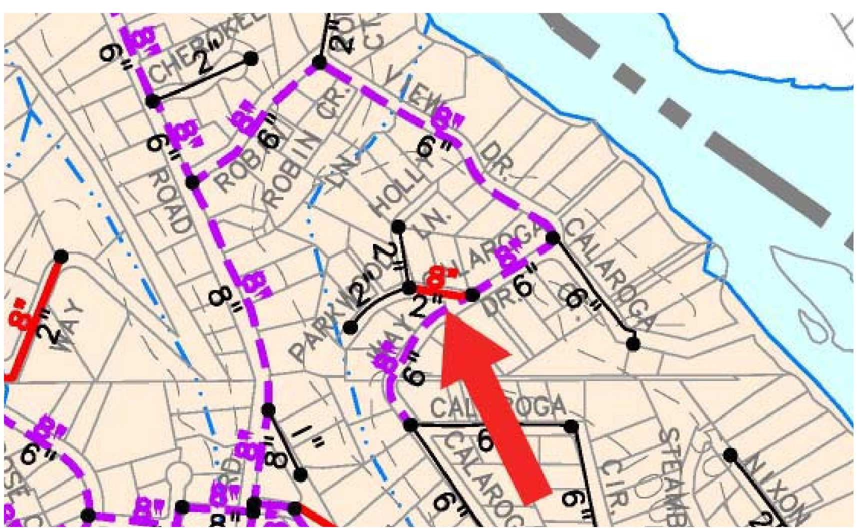
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $28,125

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 57
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: River Rd. south of Riverwood Pl.

Project Description: Installation of approximately 411 linear feet of 8-inch diameter ductile iron piping along River Rd. in the Robinwood pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

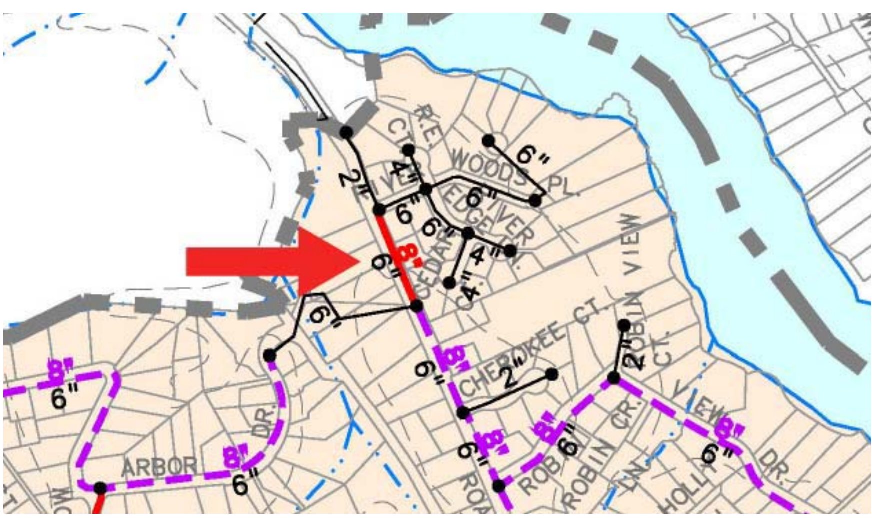
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $51,375

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 58 - THIS CIP NO. NOT USED
PRIORITY:
PROPOSED PROJECT:

Location:

Project Description:

Existing Pipe Diameter: **Proposed Pipe Diameter:**

Existing Pipe Material: **Proposed Pipe Material:**

Cost

Unit Cost:

Estimated Project Cost:

Project Area Map:

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Distribution/transmission Main Improvement

Project ID (CIP No.): 59
Priority: 5
Proposed Project: Pipeline Replacement

Location: Vista Ct.

Project Description: Installation of approximately 584 linear feet of 8-inch diameter ductile iron piping along Vista Ct. in the Robinwood pressure zone is expected to improve local hydraulic capacity in a dead-end main where looping is not feasible.

Existing Pipe Diameter: 6 in.

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: CI

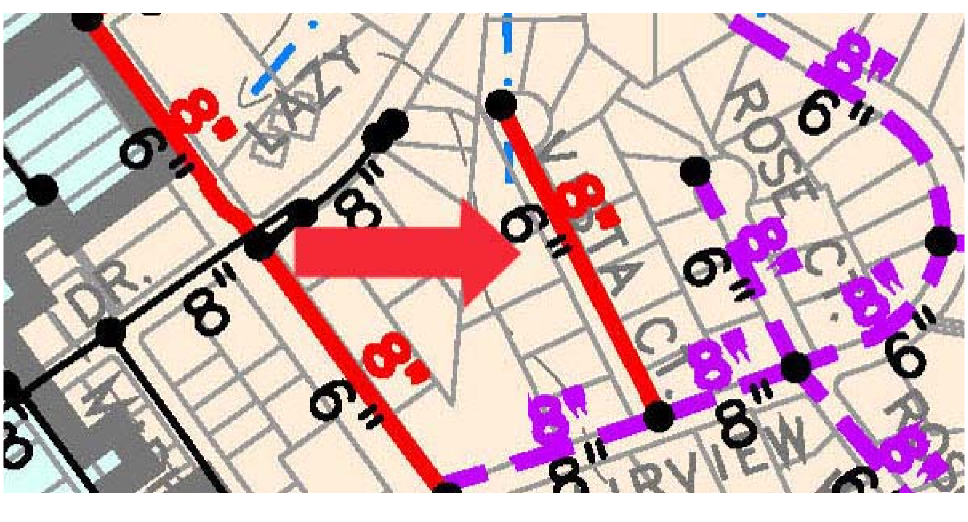
Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $73,000

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 60
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: Shady Hollow Way and Willamette Dr. to Fairview Way

Project Description: Installation of approximately 2,002 linear feet of 8-inch diameter ductile iron piping along Shady Hollow Way in the Robinwood pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 3, 6 in. **Proposed Pipe Diameter:** 8 in.

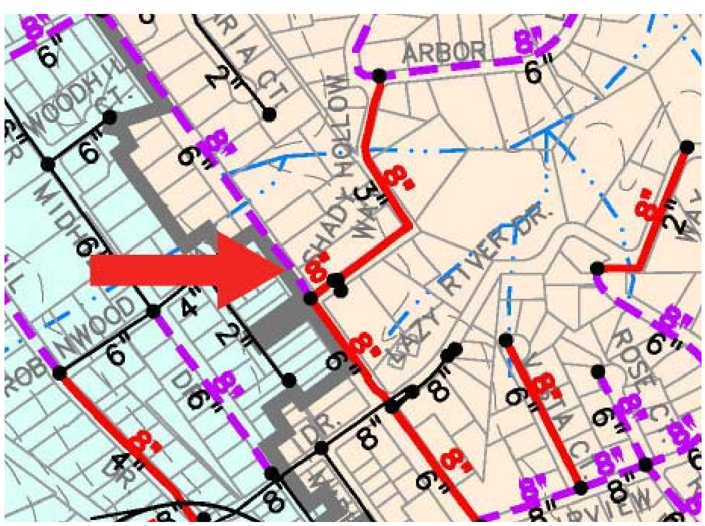
Existing Pipe Material: GLV, DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $250,250

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 61
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Upper Midhill Circle from Robinwood Way to Marylhurst Dr.

Project Description: Installation of approximately 795 linear feet of 8-inch diameter ductile iron piping along Upper Midhill Circle in the Rosemont pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 4 in.   **Proposed Pipe Diameter:** 8 in.

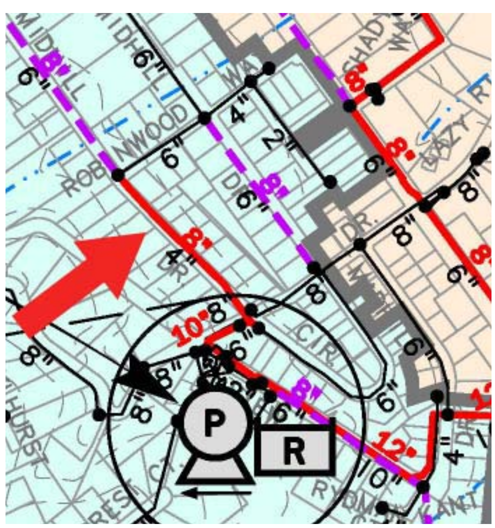
Existing Pipe Material: CI   **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $99,375

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 62
PRIORITY: 2
PROPOSED PROJECT: Pipeline Replacement

Location: View Drive Pump Station to Marylhust Dr.

Project Description: Installation of approximately 170 linear feet of 10-inch diameter ductile iron piping along View Drive Pump Station in the Rosemont pressure zone is expected to relieve existing hydraulic defeciences under current maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 8 in.

Proposed Pipe Diameter: 10 in.

Existing Pipe Material: AC

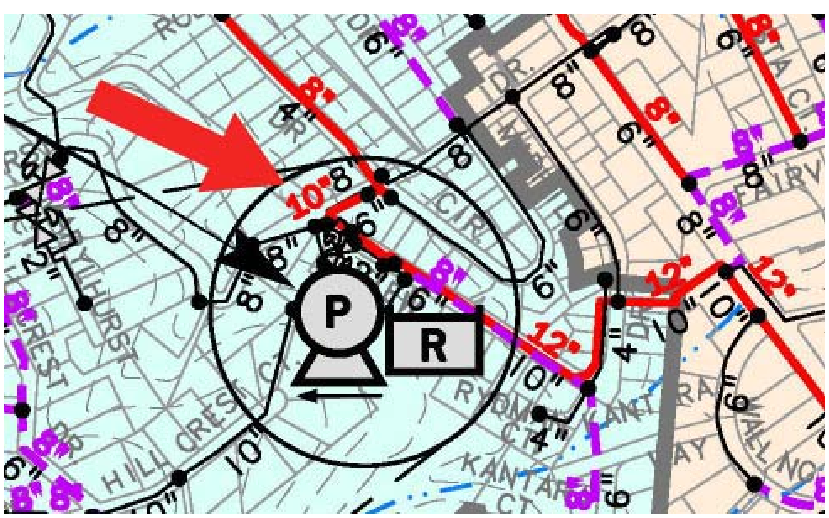
Proposed Pipe Material: DI

Cost

Unit Cost: $155

Estimated Project Cost: $26,350

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 63
PRIORITY: 3
PROPOSED PROJECT: Pipeline Replacement

Location: Arbor Dr. from Upper Midhill Dr. to Lower Midhill Dr.

Project Description: Installation of approximately 406 linear feet of 8-inch diameter ductile iron piping along Arbor Dr. in the Rosemont pressure zone is expected to relieve future hydraulic defeciences under saturation development maximum day demand conditions with fire flow conditions in the areas.

Existing Pipe Diameter: 6 in. **Proposed Pipe Diameter:** 8 in.

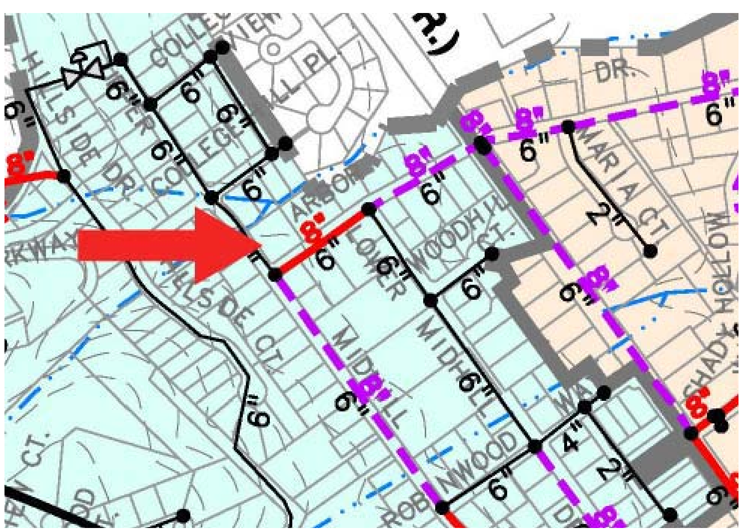
Existing Pipe Material: DI **Proposed Pipe Material:** DI

Cost

Unit Cost: $125

Estimated Project Cost: $50,750

Project Area Map:



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DISTRIBUTION/TRANSMISSION MAIN IMPROVEMENT

PROJECT ID (CIP NO.): 64
PRIORITY: 4
PROPOSED PROJECT: Proposed Pipeline

Location: Skye Pkwy and Hillside Dr. area

Project Description: Installation of approximately 680 linear feet of 8-inch diameter ductile iron piping along Skye Pkwy in the Rosemont pressure zone is expected to improve hydraulic capacity by increasing system looping.

Existing Pipe Diameter: -

Proposed Pipe Diameter: 8 in.

Existing Pipe Material: -

Proposed Pipe Material: DI

Cost

Unit Cost: $125

Estimated Project Cost: $85,000

Project Area Map: