City of Silverton, Oregon

storm water ▪ master plan

Adopted July 2, 2012 Ordinance No. 12-02

KELLER associates

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July 2, 2012

CITY OF SILVERTON

Storm Water Master Plan

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1.0 EXECUTIVE SUMMARY

1.0 INTRODUCTION

Effective management of storm water has become a matter of increasing concern and focus in recent years. Recognizing the existing challenges and emerging issues, the City of Silverton commissioned this storm water master plan to formally identify the challenges and to develop practical solutions.

1.1 PURPOSE AND NEED

This report presents findings and recommendations relating to the Silverton municipal storm water system. This study was commissioned by the City in an effort to determine the current state of the storm water system and to plan for future needs. The planning study is intended to build upon previous planning efforts. The primary objectives of this Storm Water Master Plan are to:

- Establish storm system design and planning criteria.
- Evaluate the existing storm system capacity using computer hydraulic modeling.
- Summarize existing system deficiencies and propose improvements to enhance system serviceability.
- Recommend improvements needed to service future growth.
- Develop a capital improvement plan and an appropriate system implementation strategy.

Figures and supporting data for the information presented in this report have been included in the appendices for reference.

1.2 ACKNOWLEDGEMENTS

Keller Associates gratefully recognizes all those who have provided their support and assistance in the completion of this study. Keller Associates has worked with a Technical Advisory Committee (TAC), which included key City staff, Silverton residents, and business/institution representatives, to understand the challenges currently facing the system and develop practical, cost-effective solutions. Members of the TAC include the following:

- Laurie Carter, Silverton City Council
- Gus Frederick, Silverton Planning Commission
- Mark Grenz, Home Builders Assoc.
- Peter Paradis, School District
- Jeff Lorenz, Silverton Hospital
- David Gortner, Silver Cliff Estates Resident
- Gerald Fisher, Silverton Public Works Director/City Engineer
- John Cramer, Silverton Senior Civil Engineer
- Steve Starner, Silverton Water Quality Division Manager

1.3 STUDY AREA

The City of Silverton is located in Marion County, Oregon approximately 15 miles northeast of Salem. The City consists of approximately 3.5 square miles of land. The study area includes additional land outside of Silverton's City limits and urban growth boundary, which contributes storm runoff flows to the City's storm water system. The study area, the City limits, and Silverton's urban growth boundary are illustrated in Figure 1 in Appendix A. Storm water from the study area generally drains into three different receiving streams: Silver Creek, Abiqua Creek, and Brush Creek.

The climate of the study area is characterized by mild, wet winters and warm, dry summers. According to the Western Regional Climate Center, Silverton experiences an average annual rainfall of 47 inches and average temperatures ranging from 60 °F to 45 °F during the summer and winter months, respectively.

The predominant soil types within the study area play an important role in watershed characterization and storm water runoff. The soil types in Silverton are classified as having moderate to slow infiltration rates and moderate to high runoff potential.

Another important watershed characteristic is land use because it affects the quality, quantity, and timing of the runoff from rainfall events over the drainage basin. Figure 1 in Appendix A also illustrates land use designations within the City.

1.4 DESIGN CRITERIA

The TAC was involved in developing and approving the design criteria for the master plan and public works storm water design standards. Keller Associates recommends that the storm drainage conveyance system be capable of passing runoff from the 25-yr storm event without flooding. For detention facilities, the post-development maximum runoff rate from the 50-yr storm event should not exceed the pre-development runoff from the 50-yr storm event. Recommendations for improving the City's storm water quality and construction design standards are further discussed in Section 3.

Several assumptions were made based on the design criteria in the creation of the storm water model which was used to evaluate the City's storm water system. The basic assumptions are:

- Catch basins capture all storm water.
- Pipes, ditches, and catch basins are clean.
- Detention facility discharges are clear of debris.

1.5 MODEL DEVELOPMENT

The storm water modeling software XP-SWMM v2011 was used to project storm water runoff from the study area using the NRCS Urban Hydrograph Method. Additionally, XP-SWMM was used to dynamically route the hydrologic model runoff through a hydraulic model representing the existing storm water network. The computer model was calibrated to storm water flow meter data collected at several locations throughout the City. Hydrologic and hydraulic model parameters and calibration are further discussed in Section 4.

1.6 EXISTING STORM DRAINAGE SYSTEM CONDITION AND EVALUATION

Silverton's existing storm drain system is illustrated in Figure 3 in Appendix A. The existing system is composed of roughly 26 miles of pipeline, 400 manholes, 900 catch basins, 38 detention pipes, 13 detention ponds, and 18 miles of open channels. Recommendations have been made for operation, maintenance, and replacement of this infrastructure in Section 5.

The storm drain system was delineated into five major drainage basins as shown in Figure 4 in Appendix A. These five major basins were further divided into sub-basins which are also shown in Figure 4 in Appendix A. The current storm water problem areas for each of the five major drainage basins are summarized in Figure 7 in Appendix A.

1.7 WATER QUALITY CONDITION AND EVALUATION

Storm water management has historically emphasized flood control. However, in recent years the focus has shifted to include water quality management. Three of the regulatory programs applicable to Silverton's storm water include the Underground Injection Control (UIC) program, the National Pollutant Discharge Elimination System (NPDES) program, and the Willamette Basin Total Maximum Daily Load (TMDL).

The UIC program relies on voluntary reporting and registration. Four known drywells within the City do not appear to be on DEQ's UIC database, and should be registered with DEQ or abandoned per DEQ requirements. The NPDES Phase II regulations on storm water do not apply to Silverton because the population is less than 10,000. However, the City has expressed the desire to be in a position to meet those requirements. Silverton is listed as a Designated Management Agency (DMA) in the Willamette Basin TMDL, and as such is required to prepare a TMDL Implementation Plan. The City of Silverton completed their TMDL Implementation Plan in 2011, which was subsequently approved by DEQ. The plan and approval letter can be found in Appendix D.

1.8 RECOMMENDED IMPROVEMENTS AND CAPITAL IMPROVEMENT PROGRAM

The capital improvement plan was developed and prioritized based on factors such as flooding frequency and potential or recurring damage to property. Currently, regulatory demands do not exist for any of these improvements to be made - however, the nature of the improvements, their related costs, and Silverton's continued development make it a prudent decision to begin implementing the master plan. Figure 8 in Appendix A illustrates all recommended prioritized improvements. These improvements are summarized in Table 1.1. Further detail regarding the capital improvement plan is provided in Section 8.

Table 1.1 – Capital Improvement Plan

Item #	Item Description	Opinion of Probable Cost*	Percent SDC Eligible	SDC Improvement Amount	City Amount
Priority 1 Improvements (by 2022)					
1	Utility and SDC Rate Study	$20,000	50%	$10,000	$10,000
1A	Olson's Ditch Improvements	$536,000	30%	$160,800	$375,200
1B	North Second Street and Mills Addition Improvements	$2,061,000	20%	$412,200	$1,648,800
1C	West Main, Welch, and Cherry Street Storm Water	$691,000	10%	$69,100	$621,900
1D	High Street to East Main Street Storm Water	$1,013,000	5%	$50,700	$962,300
1E	Jersey Street Storm Water	$453,000	5%	$22,700	$430,300
	Total Priority 1 Improvements	***$4,774,000***		**$725,500**	**$4,048,500**
	Priority 1 Annual Payment (20yr, 4%)	***$351,279***			***$297,896***
Priority 2 Improvements (2017 - 2027)					
2	Update Storm Water Master Plan	$150,000	50%	$75,000	$75,000
2A	Hwy 214 Detention Facility	$1,061,000	10%	$106,100	$954,900
2B	North James Street and Pine Street Storm Water	$238,000	0%	$0	$238,000
2C	Sheridan Street and Pine Street Storm Water	$288,000	10%	$28,800	$259,200
2D	Rock Street to South 3rd Street Connection	$218,000	10%	$21,800	$196,200
2E	McClaine Street Improvements	$236,000	5%	$11,800	$224,200
2F	Koons Street Improvements	$265,000	0%	$0	$265,000
2G	James Street Improvements	$185,000	5%	$9,300	$175,700
	Total Priority 2 Improvements	***$2,641,000***		**$252,800**	**$2,388,200**
	Priority 2 Annual Payment (20yr, 4%)	***$194,329***			***$175,728***
Priority 3 Improvements (2022 - 2032)					
3A	Oak Street Improvements	$197,000	35%	$69,000	$128,000
3B	Monson Road Improvements	$161,000	40%	$64,400	$96,600
3C	Grant Street Improvements	$128,000	10%	$12,800	$115,200
3D	West McClain Street Improvements	$94,000	0%	$0	$94,000
3E	Monitor Road Improvements	$61,000	55%	$33,600	$27,400
	Total Priority 3 Improvements	***$641,000***		**$179,800**	**$461,200**
	Priority 3 Annual Payment (20yr, 4%)	***$47,166***			***$33,936***
	TOTAL (rounded)	**$8,056,000**		**$1,158,100**	**$6,897,900**

* All costs in 2012 Dollars. Costs include engineering and contingencies.

1.9 STORM WATER FUNDING

In addition to capital improvements, a storm water system maintenance and replacement program is recommended. This consists of a plan to regularly maintain and replace all deteriorated components of the storm water system. The SDC fund and available funds from other sources will not be able to cover the entire City's storm water system costs; therefore, Keller Associates recommends the City create a storm water utility. Because the recommended budgets are substantially higher than current funding levels, some aspects (such as the replacement program) could be phased over time.

The annual costs for the priority improvements, system replacement program, and maintenance are summarized in Table 1.2. The costs represented in this table are based on a conceptual level opinion of probable cost. Additional details on the opinions of probable cost can be found in Section 8 and Appendix F.

The scope of this study did not include an evaluation of user rates or SDCs. However, Keller Associates did review the City's SDC methodology and made recommendations that will guide the City in moving forward. These recommendations are summarized in Section 8. Additionally, recommendations for procedures and potential methodology have been provided for how the City could develop a storm water utility fee. Keller

Associates recommends a more detailed rate study be completed in connection with implementation of a storm water utility and associated user rates and SDCs.

Table 1.2 – Annual Budget Levels

Task	Annual OPC*
Maintenance Contracted Out	
Contracted Maintenance	$108,100
City Seasonal Maintenance	$47,500
Total Rounded Cost	**$155,600**
City Perform Maintenance	
Additional City Staff	$117,500
Equipment and Supplies	$31,500
Total Rounded Cost	**$149,000**
Replacement Program & City Perform Maintenance	
Additional City Staff	$117,500
Equipment and Supplies	$31,500
System Replacement Program	$427,800
Total Rounded Cost	**$576,800**
CIP Priority 1 Improvements, Replacement Program, & City Perform Maintenance	
Additional City Staff	$117,500
Equipment and Supplies	$31,500
System Replacement Program	$427,800
CIP Priority 1 Improvements Annualized Cost**	$351,300
Total Rounded Cost	**$928,100**
All CIP Improvements, Replacement Program, & City Perform Maintenance	
Additional City Staff	$117,500
Equipment and Supplies	$31,500
System Replacement Program	$427,800
All CIP Improvements Annualized Cost**	$592,800
Total Rounded Cost	**$1,169,600**

*Opinion of probable cost
**CIP annualized costs assume no SDC contribution

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2.0 STUDY AREA

2.0 GENERAL

This section discusses the study area and its physical characteristics. Also discussed are pertinent land use and planning criteria, as well as population and demographics.

2.1 STUDY AREA

The study area is comprised of the areas within the City limits, the Urban Growth Boundary (UGB), and additional area outside of these two boundaries where storm water runoff drains into the City's storm system. The 2006 City limits of the City of Silverton encompass an area of approximately 2,215 acres. The City's UGB is made up of 2,665 acres of land. Adding regions outside of the City limits and the UGB brings the total study area to 3,305 acres. Figure 1 in Appendix A illustrates the City limits, the UGB, and the study area.

2.2 PHYSICAL ENVIRONMENT

This section provides a review of the physical environment of the study area including climate, soils, and topography.

2.2.1 Climate

Silverton lies within the Willamette Valley which has a relatively mild climate throughout the year, characterized by cool wet winters and warm dry summers. A summary of climate data for Silverton is shown in Table 2.1.

Table 2.1 – Climatological Data (1962-2011) - Silverton, Oregon

	Jan	Feb	Mar	Apr	May	June	July
Precipitation (in)	6.77	4.87	4.98	3.67	2.84	1.92	0.70
Snowfall (in)	1.0	0.8	0	0	0	0	0
Temperature (F)	39.9	43.1	46.4	49.8	55.7	61.1	66.5
	Aug	**Sep**	**Oct**	**Nov**	**Dec**	**Annual Average**	
Precipitation (in)	0.89	1.8	3.63	7.08	7.61	46.76	
Snowfall (in)	0	0	0	0.2	1.2	3.2	
Temperature (F)	66.8	62.4	53.5	45.3	39.8	52.5	

2.2.2 Soils

In general, soils within the Silverton area are either a silty clay loam or silt loam. Slopes vary from 0 to 50 percent. Soils data from the area was obtained from the NRCS website. A soils map and listing of soils within the Silverton area can be found in Appendix B.

2.2.3 Topography

Ground elevations in the study area range from a low of approximately 220 feet above mean sea level near the northwest boundary, to approximately 830 feet above mean sea level near the south eastern boundary of the study area. The majority of Silverton is steep and hilly both east and west of Silver Creek, with a flat narrow corridor along the northeast side of Silver Creek. The slopes in the City typically range between 10%-50%. The topography of the remainder of the City is flatter (0.50%-2% slopes) and generally slopes from southeast to northwest. The study area topography is shown in Figure 2 in Appendix A.

2.3 STORM WATER DRAINAGE SHEDS

Storm water from the study area generally drains into three different receiving streams: Silver Creek, Abiqua Creek, and Brush Creek. The storm systems that drain to each of these receiving streams is delineated in Figure 5 in Appendix A, and the approximate percentages of the study area draining to each are summarized in Table 2.2.

Table 2.2 – Percent of Study Area Draining to Receiving Streams

Silver Creek	Abiqua Creek	Brush Creek
60%	30%	10%

2.4 LAND USE

The City of Silverton includes lands designated as agricultural; area of mutual interest; public/semi public; commercial; railroad; industrial; Silver Creek; multi-family; mobile home park; and single family residential inside City limits. Existing and future land use assumed for the study area is also shown in Figure 1 in Appendix A. Land use assumptions for future development were developed in conjunction with the City planning and public works staff, and are consistent with assumptions documented in the recently completed Silverton Water Master Plan.

2.5 POPULATION PROJECTIONS

The population values presented in Table 2.3 summarize existing and future populations used for this planning effort. Population projections reflect the Marion County adopted forecasts based on the published values from the Portland State University (PSU) Population Research Center dated September 2008. These values are consistent with other planning documents, including the water, wastewater, and transportation master plans completed in recent years. In estimating the 2035 population, we assumed a growth rate of 1.5% (the growth rate assumed by PSU for the period from 2020 to 2030).

Table 2.3 – Existing & Future Populations

Year	Population
2009	9,600
2020	12,423
2030	14,418
2035	15,532

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3.0 STORM WATER SYSTEM DESIGN CRITERIA

3.0 GENERAL

Storm water system design criteria encompass the fundamental principles applied in evaluating the existing system and planning for future expansion of the system. The design criteria applied in this study come from sources such as neighboring communities, industry standards, and state and federal storm water regulations.

The aim of the design criteria is to accurately define the system demands in order to mitigate existing deficiencies and prevent future problems. Design criteria address design storm events, hydrologic methods, and hydraulic calculation methods. Storm water quality standards are addressed in Section 7 of this report.

As part of this master plan, the City's storm water policies, design standards, and construction standards were reviewed and several changes have been recommended. The City's existing storm water policies, design standards, and construction standards are included in Appendix E for reference.

3.1 DESIGN STORM

The design storm is the storm event for which the storm water facilities are designed. It essentially becomes the standard used to measure the functionality of the storm drain system. The design storm is a theoretical storm event with typical characteristics for storms in a given region.

One parameter of the design storm is the total depth of rainfall expected to occur over a given time period. Another parameter is the recurrence interval, or the average interval between successive events. For example, a 100-yr storm occurs an average of once every 100 years. The National Oceanic and Atmospheric Administration (NOAA) published isopluvial charts showing rainfall depths for a range of recurrence intervals for a storm duration of 24 hours over geographic areas. Table 3.1 contains the values for the City of Silverton as obtained from the NOAA isopluvial charts for the state of Oregon.

Table 3.1 – Storm Depths (24-hr duration)

Storm Event	Precipitation (in)*
2-year	2.4
5-year	2.9
10-year	3.3
25-year	3.8
50-year	4.3
100-year	4.4

*NOAA Atlas 2, Volume X

Another parameter of a design storm is how the given amount of precipitation is distributed over the duration of the storm (temporal distribution). A hyetograph illustrates the typical temporal distribution of a storm. The hyetograph shape is theoretical and is based on historical data collection and extrapolation. One important aspect to understand is that the distributions are for design storms, not necessarily actual storms. In other words, a real storm may not behave in this same fashion. The maximum

intensity may not be reached as uniformly as shown in the hyetographs. The Natural Resource Conservation Service (NRCS) has developed region-specific hyetographs for western Oregon. For Silverton, the NRCS recommends the use of a Type 1A distribution. The geographic boundaries for the NRCS rainfall distributions are presented in Chart 3.1. The 25-year storm hyetograph is illustrated in Chart 3.2.

Chart 3.1 – Geographic Boundaries for NRCS (SCS) Rainfall Distributions

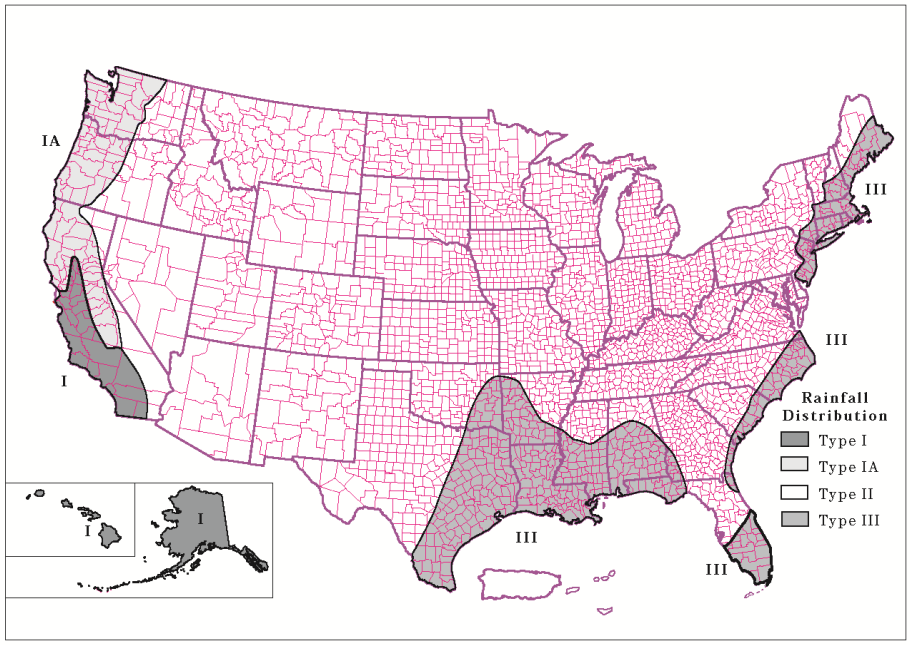
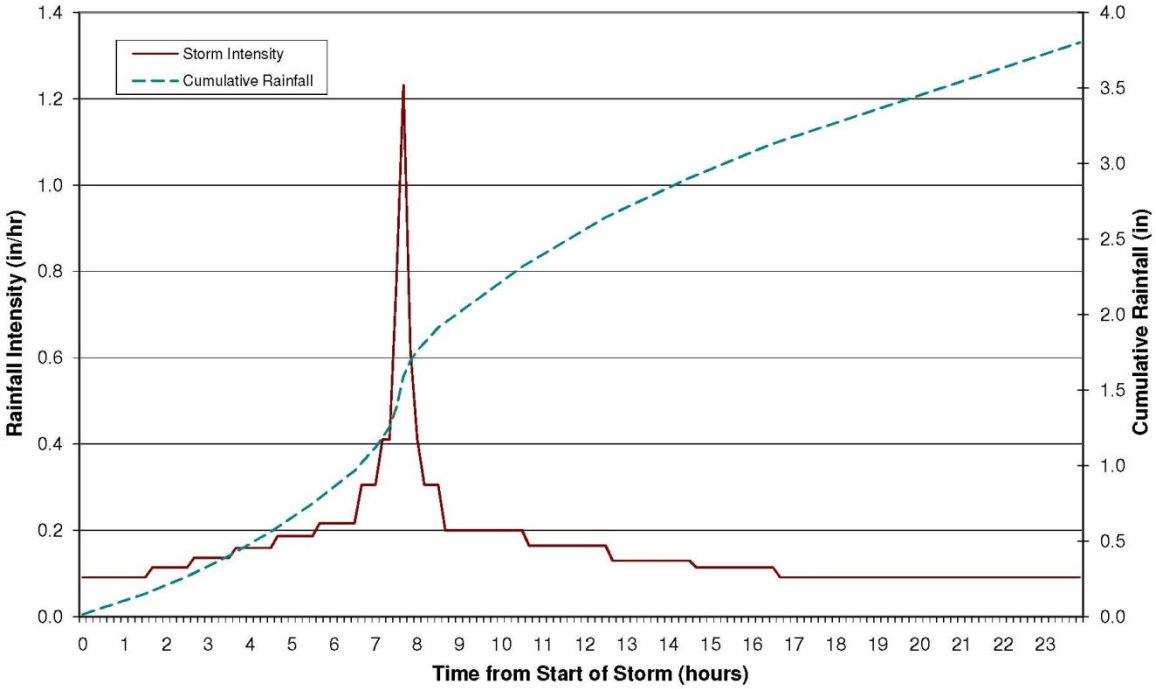


Chart 3.2 – Silverton 25-year Storm Hyetograph



Selection of a design storm is a matter that balances level of service with economic feasibility. Keller Associates recommends that the storm drainage conveyance system be capable of passing runoff from the 25-yr storm event without flooding. For detention facilities, the post-development maximum runoff rate from the 50-yr storm event should not exceed the pre-development runoff from the 50-yr storm event. In addition to the 50-yr storm, the detention facility should serve the same function for smaller storm events such as the 2-, 5-, 10- and 25-yr events. In short, this means that when development occurs, the peak runoff rate must be less than or equal to the pre-existing conditions. Detention facilities must have a means to safely bypass the 100-yr storm event without damage to property, endangering human life, or public health.

3.2 HYDROLOGIC METHODOLOGY

Hydrologic methodology refers to the method applied to define how an area or "basin" will react to the design storm. Some items of particular concern are how much of the rainfall over the basin will be converted to runoff, where that runoff will go, and how quickly it will get there.

There are several acceptable hydrologic methods for defining basin characteristics. In researching hydrological methodology, three design documents are widely used in the region. These documents are as follows:

- 2005 Oregon Department of Transportation (ODOT) Hydraulics Manual
- 2007 City of Portland Sewer and Drainage Facilities Design Manual
- 2007 Clean Water Services (CWS) Design and Construction Standards

The following is a list of acceptable hydrologic methods compiled from the above mentioned design manuals:

- Natural Resources Conservation Service (NRCS) TR-20
- Hydrologic Modeling System (HEC-HMS)
- NRCS Urban Hydrograph Method (TR-55/SCS)
- Santa Barbara Urban Hydrograph (SBUH) Method
- Rational Method
- Environmental Protection Agency (EPA) Storm Water Management Model (SWMM)
- Flood Insurance Studies (FIS)
- Statistical Analysis of Stream Gage Data and USGS Regression Equations

Each of these methods has varying applications. The FIS and regression equations are applicable for determining stream and river flow. The NRCS TR-20 is an older methodology predating TR-55. The Santa Barbara Urban Hydrograph Method uses the same process as the NRCS method to assign basin characteristics but formulates a unit hydrograph through a different process. The rational method is appropriate for estimating peak discharges for small urban basins up to about 200 acres. The HEC-HMS and EPA SWMM methodologies are not as widely used as the NRCS Urban Hydrograph Method for assigning basin characteristics. It should be noted that the list of methods provided above are not entirely independent of each other. For example the EPA SWMM methodology uses the same NRCS hyetographs used in the NRCS Urban Hydrograph Method to assign rainfall distribution throughout the design storm event.

For the applications and purpose of this master plan, Keller Associates recommends the NRCS Urban Hydrograph Method. The NRCS Urban Hydrograph Method fits the study area size and characteristics. It should also be noted that if only the NRCS method was utilized to model the system, spreadsheets would be required in lieu of a computer hydraulic model. The computer model that was used to apply the NRCS Urban Hydrograph Method is XP-SWMM. This computer model allows for choosing different methods to assign basin characteristics and then utilizes the SWMM algorithms or SWMM engine to model the pipelines and other various facilities in the system.

3.3 POLICY AND DESIGN STANDARDS

Practical and useful information can be found in the experiences of Silverton's neighboring communities and their standards. In an effort to glean some of this information, a storm water policy survey was conducted for this master plan. The results of this survey have been recorded and are summarized in Table 3.2.

The City's storm water policies, design standards, and construction standards provide guidance to developers building within Silverton's urban growth boundary. As Silverton continues to grow, these documents serve as the basis by which the future storm drainage system will be constructed. It is, therefore, imperative for these documents to be consistent with the City's goals for effective storm water management. The City's existing storm water policies, design standards, and construction standards are included in Appendix E for reference.

The following recommended revisions to the policies and design standards have been developed to meet the City's goal of being prepared to meet future storm water regulatory requirements, and target the specific needs of the City based in its geographic location and hydrologic conditions.

3.3.1 Storm Water Detention Facility Policy Recommendations

Storm water detention facilities should be included with each phase of development that has more than 10,000 square feet of planned impervious area, including streets, rooftops, driveways, patios, etc. All publicly owned storm water detention facilities, including storm water detention pipes, should be placed in a public right-of-way wherever possible or within a public easement with an access road per current City standard design requirements in order to maintain the facility. The City should have authority to maintain storm water detention facilities if privately-owned detention facilities are not maintained by their owners, at the owner expense.

3.3.2 Storm Water Quality Policy Recommendations

Storm water quality treatment is recommended as part of each phase of development. Catch basins and detention pipes offer minimal storm water quality treatment. Additional treatment devices are recommended to be set in place as part of each development. These water quality treatment devices could include vegetated swales, extended dry basins, proprietary treatment systems, or various low impact development (LID) approaches.

LID is an approach to land development (or re-development) that works with nature to manage storm water as close to its source as possible. LID employs principles such as preserving and recreating natural landscape features, and minimizing effective imperviousness to create functional and appealing site drainage that treat storm water as a resource rather than a waste product. As the City looks at updating their development standards, the City should consider LID standards that could reduce post-development runoff volumes.

3.3.3 Conveyance Systems Design Standards Recommendations

The City's existing storm water design standards and construction standards were last updated in 2007, and are included in Appendix E for reference. Several recommendations are offered to improve the City's design and construction standards.

As stated in Table 3.2, the minimum storm main line diameter should be 12 inches. A 10-inch diameter pipe is allowable for connections between catch basins and manholes. The minimum storm line diameter for residential properties should be 4 inches.

The standards should require that after all City-required testing of the storm system during construction is complete, sections failing to pass the required tests and inspections shall be located and repaired. Additionally, storm water utility trench backfill should be compacted to a minimum of 95% of the maximum dry density, as determined by the Modified Proctor test (ASTM D-1557 and AASHTO T-180). Keller Associates also recommends catch basins and ditch inlets have a minimum sump depth of 18", as well as be equipped with a "snout" on the outlet pipe for improved water quality. Finally, all storm drains should be designed and constructed to produce a mean velocity of not less than 2.5 feet per second, when flowing full, based on a Manning's pipe roughness coefficient "n" value of not less than 0.013, or the pipe manufacturer's recommendations, whichever is greater.

Table 3.2 summarizes additional recommended design standards that should be employed when evaluating storm water requirements for new developments.

Table 3.2 – Storm Drainage Design Criteria Comparison

Item	Silverton (Existing)	Silverton (Recommended)	Marion County	Salem	Stayton	Albany	Portland	Wilsonville
Storm Distribution	NS	NRCS 1A	NRCS 1A	NS	NRCS 1A	NRCS 1A	NRCS 1A	NRCS 1A
24 hr Storm Precipitation	NS	NOAA	NOAA	NS	NOAA	OSCS	PIA	NS
Model Approach	Rational Method	Variable	NRCS-TR55	Variable	Variable	NRCS-TR55	Variable	Variable
Minimum Tc	NS	5 min	10 min	NS	5 min	NS	5 min	5 min
PVC "n" value	NS	0.013	0.013	0.009 - 0.013	0.013	0.01	0.013	NS
Min. Pipe Diameter	NS	12"	10"	10"-12"	10"-12"	10"	12"	10"-12"
Design Storm: For Conveyance	5-yr	25 yr	10 yr	10 - 25 yr	25 - 50 yr	25 - 50 yr	25 yr	25 yr
Design Standards: For Detention Facilities on New Developments	25-yr	50 yr with overflow bypass to 100 yr	Difference between 5 yr & 10 yr with overflow bypass to 50 yr	50 yr	25 - 50 yr with overflow bypass to 100 yr	25 - 50 yr with overflow bypass to 100 yr	25 yr w/escape route up to 100 yr	25 yr with overflow bypass to 100 yr
Detention Facilities Allowed Inside Flood Plains?	NS	As Approved	As Approved	NS	As Approved	As Approved	No	Comply with FEMA
Infiltration Policy	NS	As Approved	Not Allowed	Allowable	Allowable	Allowable	Allowable	Allowable
Roof Drains to Gutter or Yard	NS	As Approved	Gutter	As Approved	NS	Gutter	Gutter	NS
Funding Source	Gas Taxes	Storm Water Utility Fee	Utility Fee & Construction Permit Fees	Sewer Utility Fee. Stormwater Utility Fee to begin 2013.	Combinations of contributions from General Fund, Wastewater Fund, Water Fund, Park Fund, & Street Fund	None. In emergencies, Sewer or Water fees are utilized.	Public Utility Fee & SDC Fee	Combinations of contributions from Utility Fee, SDC Fee, Development Plan Review & Inspection Fee

*Disconnection Incentives Provided through water/sewer billing

NRCS = Natural Resource Conservation Service
NOAA = National Oceanic & Atmospheric Adm.
SBUH = Santa Barbara Unit Hydrograph
OSCS = Oregon State Climate Service

Tc = Time of Concentration
n value = Manning's Roughness Coefficient
PIA = Portland International Airport Records
NS = None Specified

4.0 MODEL DEVELOPMENT

4.0 GENERAL

An accurate computer model of the storm water system serves as a planning tool and provides the basis for a solid storm water master plan. The model also provides insight into potential improvements to address existing deficiencies, and can be used to effectively plan for future development within the study area. The modeling software program XPSWMM v2011 was utilized to estimate storm water runoff from the study area.

A storm water model correlates interactions of natural events and natural systems, (hydrologic parameters) with manmade systems (hydraulic parameters). Because there are countless variables with broad ranges of values in each system, a well coordinated and strategic data collection effort is required, along with practical assumptions and good judgment for data that cannot be feasibly obtained. This section outlines the model construction and calibration process beginning with data collection on the existing systems, and how key assumptions were incorporated to construct the final calibrated model of Silverton's storm water system.

4.1 EXISTING SYSTEM OVERVIEW

Prior to this study much of the storm water system was unmapped. Because an accurate base map is necessary to evaluate the existing system and create a master plan, a significant effort was put into mapping the existing storm water system. Data on the existing system was obtained from a combination of record drawings, site visits, and field testing. The resulting storm water system base map is illustrated in Figure 3 in Appendix A.

4.2 MODEL PARAMETERS

The storm water model consists of two parts, a hydrologic model and a hydraulic model. The hydrologic model consists solely of drainage basins, or geographic areas that drain to a specific point. Each drainage basin is characterized by various input parameters. These input parameters essentially define the basin in terms of how much rainfall is converted to runoff, and when the runoff reaches the outlet point. The hydraulic model then routes the runoff through the storm drain network of open channels, detention ponds, and pipelines.

Each of the two parts of the storm water model requires a number of input parameters to sufficiently simulate the actual rainfall events and the resulting effects on storm water sewers. The runoff input parameters include basin area, time of concentration, composite curve number, initial abstraction, and evaporation. The parameters and input assumptions are explained in detail and their values summarized in Appendix C.

The area within the study area was delineated into five major drainage basins as shown in Figure 4 in Appendix A. These five major basins were further divided into minor basins which are also shown in Figure 4 in Appendix A. The basin parameters for each of the minor basins are summarized in Table 1 in Appendix C, along with descriptions of each parameter and how it is calculated.

The hydraulic parameters for the model are the parameters relating to how the runoff from the drainage basin is routed through the network of storm water lines, open channels, and detention facilities. These parameters are calculated from input data on pipe diameter, length, roughness, slope, outfall conditions, invert and ground elevations. Record drawings provided most of the necessary input data, and a roughness value of 0.014 was assumed. For unknown pipe inputs, values such as length and slopes were interpolated using known upstream, downstream, and ground elevation data.

The scope of this study is to identify deficiencies, and propose solutions to problems in major pipeline networks and adjacent portions of the system which were considered to play an important role in system functionality. Additional localized flooding challenges may need to be addressed as part of the City's ongoing storm water maintenance program or as updates to the list of capital improvement projects identified in this report. The modeled storm water lines are illustrated in Figure 6 in Appendix A.

4.3 MODEL CALIBRATION

This section covers the measures taken to calibrate the storm water model. Typically, calibration for a storm drain model involves more unknowns than for a water or wastewater model. There are a number of reasons for this.

First, the quantity of fluid going into a water or wastewater system is relatively well-defined with meters at pump stations, lift stations, and treatment plants. In contrast, influent into a storm system can be related to precipitation, groundwater and spring water discharge. Many soil, vegetation, climatic, and topographical factors control the relationship between these elements and inflow into a storm drain system.

Second, the quantity of fluid exiting a water and wastewater system is also relatively well-defined with meters on residential and commercial services for water systems and meters at wastewater treatment plants. In contrast, very few storm systems have flow locations that are measured on a regular basis.

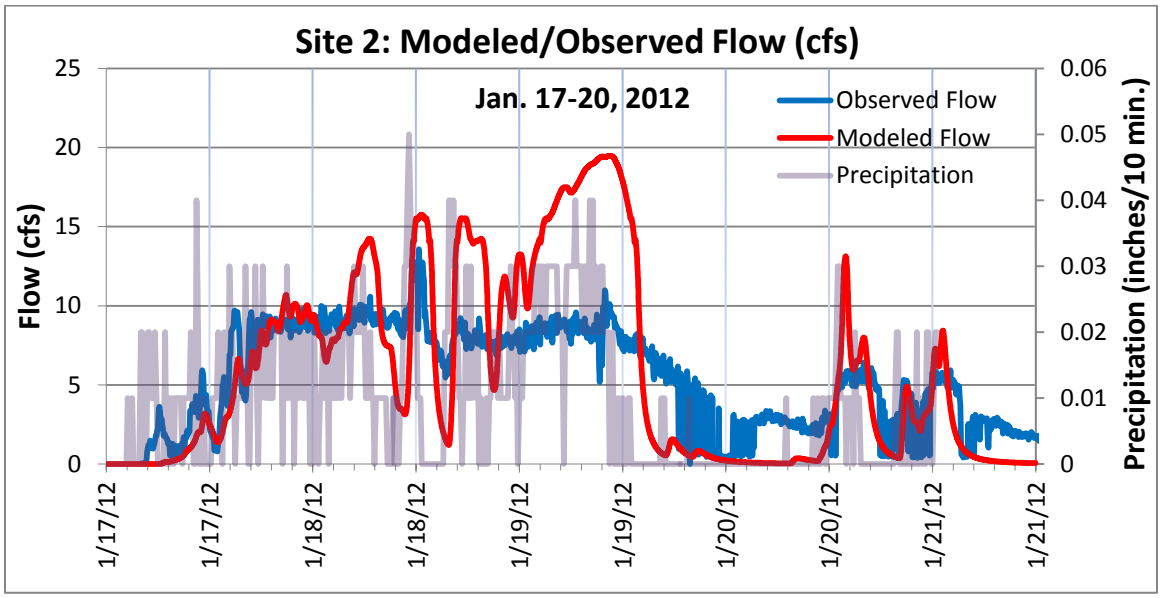
Thirdly, water and wastewater flows are much more regular and predictable. Storm drain flows are dependent on the weather, which is much less predictable. Given these considerations, methods that would provide a reasonable assurance that the model generally reflects field conditions were implemented.

The first method used to calibrate the model involved storm water flow monitoring at five sites throughout the storm water system. The monitoring was performed during winter months when larger storm events typically occur. The rainfall during these events was also recorded in 15-minute increments. The data collected for both pipe flow and rainfall was carefully reviewed for reliability, and only reliable data for each of the sites was used. For this study, two of the five monitoring sites received little or no storm water flow; therefore not enough information was available to be utilized for calibration. Conversely, the lack of storm water flow for the recorded rainfall events was used to verify that the computer model also reflects no storm water flow. Locations where storm water flow was monitored and metered are illustrated on Figure 7 in Appendix A.

The same amount and temporal distribution of rainfall for the recorded events was simulated over the applicable basins in the storm water model. The adjustable parameters such as runoff coefficients were used to calibrate the model to actual observed events. Although these parameters are adjustable, they were kept within the bounds of reasonability. Increasing runoff coefficients to an unlikely value to match an observed peak flow ignores other potential factors which could lead to an inaccurate model. To avoid this kind of error, the adjustable parameters were bound to reasonable ranges.

The initial calibration resulted in a very good correlation between modeled and observed flows as shown in Chart 4.1 Sample Calibration Results. The calibration results for the other sites along with a site map can be referenced in Appendix C.

Chart 4.1 – Sample Calibration Results



Following initial model calibration against observed results at known sites, typical storm events were imposed on the model. The modeled storm events resulted in flooding in specific areas throughout the City. The observed flooding points were reviewed by City staff. City staff indicated whether or not they would anticipate observed flooding during storm events in those areas predicted by the model. For areas inconsistent with what the staff had observed, field data was collected in order to validate the model or to correct inaccuracies. By design, the flow predictions err on the conservative side with higher peaks and higher volumes.

The final product of the calibration process is shown in Figure 7 in Appendix A. This figure illustrates areas of concern for the storm water system based on model results for the 2-, 5-, 10, and 25-year storm events. The details of the issues surrounding these areas are covered in Section 5. It should be noted that areas that flood for a smaller flood event will also flood for a larger flood event, and are not repeated in Figure 7 in Appendix A.

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5.0 EXISTING SYSTEM CONDITIONS

5.0 GENERAL

The City of Silverton storm drainage system generally consists of surface flow to catch basins, a subsurface network of pipes, detention facilities, and open channels. Frequent rains, combined with the natural drainage characteristics of Silverton, result in high runoff volumes which can tax the existing system. As a result, flooding and ponding are common occurrences. The majority of the runoff conveyed by the system drain directly into Silver Creek or ultimately drains to Abiqua Creek through various tributaries. The evaluation of the storm water system was conducted based upon the design criteria and model parameters established in previous sections.

5.1 DRAINAGE BASIN ASSESSMENTS

This section discusses the general conditions of the storm water system in the City's five major drainage basins. These assessments are based on input from City staff and computer modeling results of the design storm. Figure 4 in Appendix A outlines the major and minor drainage basins, and Figure 7 in Appendix A illustrates the problem areas.

A general city-wide problem reported by City staff is flooding in older portions of the City where either a limited or no storm collection system exists. Some roads within the City limits are not paved and do not have a storm collection system; therefore, ponding occurs in roads and residential yards. In many other locations, paved roads simply do not have a stormwater collection system; consequently, during heavy rainstorm events the roads flood.

Another common reported problem is some public storm lines and underground detention pipes have limited access for maintenance due to a lack of manholes, catch basins, or access roads, especially when located on private properties.

The scope of this study is to identify deficiencies and propose solution to problems in major pipeline networks. Additional localized flooding challenges may need to be addressed as part of the City's ongoing storm water maintenance program or as updates to the list of capital improvement projects identified in this report.

5.1.1 Southeast Silver Creek Basin

The Southeast Silver Creek basin occupies approximately 676 acres in and around the southeast corner of the City's urban growth boundary (UGB). This basin is mostly undeveloped and collects drainage from rural areas beyond the urban growth boundary. The typical undeveloped ground cover is agricultural crops and timber stands. The undeveloped portion of this basin outside the City's UGB has steep slopes, and drains to new residential developments.

All runoff from this basin discharges directly into Silver Creek via two large pipelines from the Ike Mooney detention facility. There are multiple detention facilities in this basin that were added with recent residential developments, including a lake and underground detention pipes. With the exception of upstream agricultural properties, the detention

facilities and channel improvements also improve the quality of the storm water runoff. The storm conveyance system in the basin appears to be adequate to convey the 25-yr design storm without flooding due to the recent storm water improvements completed.

5.1.2 Northeast Silver Creek Basin

The Northeast Silver Creek basin includes approximately 540 acres on the east side of Silver Creek, made up of mostly older parts of town. This basin is almost entirely developed as residential properties, with a portion of commercial properties in the downtown area. The east side of this drainage basin is a ridge with steep terrain sloping southwest towards a flat downtown area that extends parallel to Silver Creek. This basin has numerous outfalls directly into Silver Creek, largely undetained and untreated since the majority of the basin consists of older portions of town.

A few of the drainage problems in this basin include flooding at the following locations, which are also illustrated in Figure 7 in Appendix A:

- Mill Street between B Street and Oak Street
- North 3rd and Main Street
- South 3rd and Jersey Street
- Abiqua Heights detention facility
- Terminus of Adams Avenue
- Silverton High School

City staff has also reported several storm water problems at the following locations, which are illustrated in Figure 7 in Appendix A:

- North 3rd Street between B Street and Oak Street
- East Main Street between South 3rd and Rock Street
- The hillside west of Reserve Street and Rock Street
- The hillside above the terminus of Koons Street
- Koons Street from Water Street to the terminus of Koons Street
- South 2nd and Drake Street
- Pine Street from Sheridan Street to Brown Street

Where pipelines exist, most of the flooding is caused by inadequate conveyance capacity, but in some cases flooding results from maintenance issues such as clogging of catch basins or pipelines. Segments of the existing system have shallow slope and minimal ground cover. Some of the old sections of town flood, due to either a limited storm water collection system or a complete absence of a storm water collection system. Storm water runoff or springs along hillsides cause problems to residences downstream of the runoff or spring.

5.1.3 Webb Lake Basin

The Webb Lake basin is located in the northeast corner of the City's UGB, and includes approximately 648 acres. The southern half of the basin is fairly steep, and drains towards the north. The basin land use consists of approximately 40% residential, 40% agricultural, and 20% industrial property (half of which is currently developed). The

majority of the basin drains to Webb Lake, either via Olson's Ditch or ditches along Monitor Road, which combine in the wetlands prior to reaching Webb Lake. Webb Lake then discharges at the north end of the basin into a small tributary of Abiqua Creek.

A few of the drainage problems in this basin include flooding at the following locations, which are also illustrated in Figure 7 in Appendix A:

- Olson's Ditch near the discharge of Silver Cliff Estates' detention pond
- Silver Cliff Estates detention pond
- South side of Oak Street between Norway Street and Steelhammer Road
- North of Monitor Road and Oak Street intersection
- Thyme Loop,
- North 2nd and Lincoln Street

One of the major reported problem areas in this basin is Olson's Ditch, which is eroding alongside the Silver Cliff Estates mobile home park. The erosion is due to a combination of fast-moving storm water and large volumes of water discharged upstream of the ditch a few times a day from the City's water treatment plant (plant backwash). In addition, the open channel between Olson's Ditch and Webb Lake has decreased flow capacity due to sediment build-up over time due to a lack of maintenance.

The northwest part of the basin is relatively flat and consists primarily of unmaintained ditches that poorly drain the residential neighborhoods. City staff report flooding problems along North 2nd Street between Lincoln Street and Whittier Street, as well as Lincoln Street, Jefferson Street, Washington Street, and Whittier Street.

City staff also report flooding of catch basins and manholes along the south side of Oak St just east of Iowa Street.

Most new developments in this basin have detention facilities, most of which drain through the open channels and receive natural water quality treatment prior to leaving the City. However, the channels and culverts that were constructed through the wetlands with the Industrial Park improvements near Eska Way have become heavily sedimented and are limited in flow capacity. The two culverts crossing Eska Way are more than half full of sediment due to a lack of maintenance and nearly flat grades.

5.1.4 North Central Basin

The North Central basin primarily consists of developed residential, commercial, and industrial properties. It is located in the north central area of the City's UGB, and covers approximately 223 acres. This basin is relatively flat and drains to the northwest, discharging near the intersection of James and Jefferson Street into a small channel that ultimately reaches Abiqua Creek. This basin extends into the Northeast Silver Creek basin and drains a portion of the downtown area.

A few of the drainage problems in this basin include flooding at the following locations, which are also illustrated in Figure 7 in Appendix A:

- North James Street between Western Avenue and Florida Drive
- Ditch inlet between the railroad tracks and a school sports field

- Lone Oaks Loop

City staff report flooding also occurs just south of the North James Street and Jefferson Street intersection, where a house at 550 North James Street is located relatively low and rests partly above a storm pipeline. Because the majority of the basin is made up of older parts of town, not much detention or storm water treatment occurs, apart from the treatment received by the natural swale at the downstream end of the basin.

The storm water conveyance system along Grant Street near Western Avenue consists of some pipe sections and undersized roadside ditches. City staff report this as a problem area.

5.1.5 West Silver Creek Basin

The West Silver Creek basin includes approximately 315 acres consisting of a mixture of residential, commercial, and industrial developed land. It is located west of Silver Creek and within the City's UGB. The basin slopes towards the north and northeast toward Silver Creek. This basin discharges flows directly into Silver Creek via a handful of outfalls.

Some of the drainage problem areas in this basin are located at the following locations, which are also illustrated in Figure 7 in Appendix A:

- Roadside ditch along Monson Road
- Open channel south of City Public Works maintenance shops
- Near the McClaine Street entrance to the Safeway shopping complex
- Silverton Plaza parking lot

Again, older areas of the City in this basin either have a very limited storm system or none at all. City staff report a problem area near Silverton Hospital, where steep slopes cause storm water to run off in high volumes down steep roads without storm collection systems and flood neighborhood yards. Also, the City Public Works maintenance shops report storm water ponding due to a plugged up dry well into which their facility drains.

A large problem area reported in this basin is Silver Creek overtopping its banks between C Street and James Street on the west side of the creek. The creek jumps its banks at this location every one or two years during large storm events. A senior assisted living facility and an apartment complex are most affected, as they are located on the bank of the creek. According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), this area is zoned a "Floodway Area" (see Appendix B for FEMA map and profile of Silver Creek). The FEMA flood profile along this stretch of Silver Creek shows the 10-yr flood elevation between 226' and 229' (NGVD 1929 datum). According to Silverton's new topographic map based on LIDAR information, the bank elevations in this area are between 226.5' and 230.5' (converted to NGVD 1929 datum).

Currently, to keep Silver Creek from jumping its bank at this location, the City aids the private property owners in constructing an emergency temporary sand berm along the creek bank in front of the senior assisted living facility and apartment complex. Due to

the fact that the point at which Silver Creek overtops the bank occurs on private property, the City is not proposing a solution to permanently correct the problem.

5.1.6 Other Areas

The previously mentioned drainage basins collect storm water runoff which flows through modeled pipelines and channels within the study area. The other areas within the study area make up approximately 903 acres, and are mostly undeveloped with minimal storm water conveyance features, which were not modeled as part of this study effort. The area in the southwest portion of the study area largely consists of the Oregon Gardens, agricultural farmlands, and large residential properties in mostly steep terrain. The region at the north side of the study area is generally flat, and is made up of agricultural farmland. Some ditches along Hobart Road are nearly flat and require some maintenance to improve flow capacity.

5.2 DETENTION FACILITY CONDITION EVALUATION

The City has many stormwater detention facilities to detain peak runoff rates, some of which also provide water quality treatment. Some detention facilities are in the form of aboveground basins such as ponds or lakes, and many are underground detention pipes. The detention ponds/lakes within the City have been observed in the field, evaluated, and their condition summarized in the following table. An inventory of detention pipes within the City is also summarized in this section. Locations of detention ponds/lakes and detention pipes are shown in Figure 3 in Appendix A. Maintenance recommendations for existing detention ponds/lakes and detention pipes have been provided, based on observations made in the field, to help improve the functions of the detention facilities. A brief evaluation of each detention pond/lake has been provided as well as specific recommendations. Detention capacities are not addressed in this section of the report.

Table 5.1 – Detention Pond/Lake Evaluation Summary

Detention Pond/Lake	Condition	Maintained By
Webb Lake	Good	HOA. Outlet structure maintained by City Public Works.
Silver Cliff	Poor	HOA
Silverton Towne II Apartments	Fair	HOA
Silverton High School	Poor	High School
Oak Knoll	Good	HOA
Abiqua Heights	Good	HOA. Inlet and outlet structures maintained by City Public Works.
Pioneer Lake	Good	HOA. Outlet structure maintained by City Public Works.
Ike Mooney Road	Poor	HOA. Outlet structure maintained by City Public Works.
Eureka Avenue	Fair	HOA. Outlet structure maintained by City Public Works.
Lewis Street	Good	City Public Works
East Main Street	Poor	City Public Works
Community Center	Fair	City Public Works
Roth's	Poor	HOA

5.2.1 Webb Lake

Webb Lake is the largest detention facility and year-round lake in the City at approximately 11 acres in surface area. It is located on the north side of town in the Webb Lake Estates subdivision. The detention facility is in good condition overall, with the exception of a few items. A large log is floating in the lake, which could become lodged against the weir intake screen or become wedged in the weir, possibly causing the water level to rise in the lake. It is recommended to remove the large log from the lake.

5.2.2 Silver Cliff

The detention pond located in the Silver Cliff Estates subdivision is approximately 12,000 square feet in surface area. The detention pond is in poor condition for several reasons. The pond is overgrown with tall grass and blackberry bushes on the west side where the outlet structure is located. The pond drains into Olson's Ditch via a pipe which is halfway submerged by sediment at the discharge end. The detention pond appears to have spilled over the emergency overflow spillway onto Sage Street, as mud and sediment is visible on the retaining wall next to the overflow. It is recommended to remove the invasive blackberry bushes, frequently mow the grass, and remove sediment buildup in Olson's Ditch where the pond discharges.

5.2.3 Silverton Towne II Apartments

The two detention ponds located in the Silverton Towne II Apartment complex are approximately 5,000 square feet in total surface area. The detention ponds are in fair

condition with some minor maintenance issues. Sediment has built up in the pond bottoms over time, and is submerging at least one of the inlet pipes. Sediment buildup also causes stormwater to flow directly in and out of the pond without much residence time; therefore, little water quality treatment occurs. The detention pond outlet structure has large rocks and sediment in the sump. The grass is mowed short, but a small group of cattails exists in one of the ponds. It is recommended to remove excess sediment from the pond bottoms, as well as removing sediment and rocks from the outlet structure.

5.2.4 Silverton High School

The detention pond located near the entrance to the Silverton High School on Krominga Drive is approximately 20,000 square feet in total surface area. The detention pond is in poor condition due to several factors. The entire pond is overgrown with invasive cattails, which crowd out most other vegetation and block access to the pond inlet and outlet structures. Several large trees and many small trees are growing in the pond bottom. Tall grass, as well as some blackberry bushes, are found on the pond slopes. It is recommended to remove the cattails and trees, which will allow sediment buildup to be removed from the pond bottom.

5.2.5 Oak Knoll

The Oak Knoll subdivision has two detention ponds in series, with a total surface area of approximately 7,000 square feet. These ponds are filled with water year-round. The detention ponds are in good condition due to regular maintenance. A variety of vegetation exists in the ponds, including floating lilly pads and grasses. The outlet structures are screened and free of any obstructions.

5.2.6 Abiqua Heights

The two detentions ponds in the Abiqua Heights subdivision are in series, and have a total surface area of approximately 35,000 square feet. The vegetation in and around the pond is well-maintained with a variety of sedges and small clumps of cattails. The condition of the detention ponds is good, with the exception of a minor item. The pond outlet structure is leaking in the concrete section joints and around the inlet drain pipe. The leaks in the outlet structure should be sealed.

5.2.7 Pioneer Lake

Pioneer Lake is a detention facility and a year-round lake, with approximately 2 acres surface area. The lake is located in the Pioneer Village subdivision, and is in good condition with a few exceptions. The outlet structures are partially blocked with tall grasses and blackberry bushes. Regular maintenance of the lake is recommended, which includes mowing grass on the pond slopes and removing invasive blackberry bushes.

5.2.8 Ike Mooney Road

The detention pond near the intersection of Ike Mooney Road and Sun Valley Avenue in the Pioneer Village subdivision is approximately 8,000 square feet in surface area. The detention facility is in poor condition due to a lack of maintenance. The vegetation consists of tall grass, cattails, and small trees growing in the pond. The outlet structure

has grass growing inside which is partially blocking the orifices. Sediment has built up in the pond bottom, as well as in the outlet structure. It is recommended to regularly mow the grass, remove the invasive cattails, remove the trees, and remove sediment buildup from the detention facility.

5.2.9 Eureka Avenue

The Eureka Avenue detention pond is located between Eureka Avenue and Edgewood Drive, with approximately 1,000 square feet in surface area. The detention pond is in fair condition. The pond is covered with fairly short grass and very small amounts of invasive blackberry bushes. The pond inlet pipe is halfway submerged in sediment and debris. It is recommended to remove the blackberry bushes and sediment buildup in the pond bottom.

5.2.10 Lewis St

The detention facility located on the corner of Lewis Street and 1st Street is approximately 1,500 square feet in surface area. The detention pond/swale is in good condition. The grass is mowed short, and the pond bottom does not appear to have much debris/sediment buildup. The outlet structure sumps should be emptied of sediment and debris.

5.2.11 East Main St

The East Main detention pond is located south of the intersection of East Main and East Park Street. The pond has approximately 7,000 square feet of surface area and is in poor condition. The pond is heavily overgrown with tall grass and blackberry bushes, which surround the outlet structure. The pond bottom has a large amount of sediment buildup, causing stormwater to flow down a narrow muddy channel directly to the outlet structure. A fence exists around the deep and steep pond, which is good for safety reasons. It is recommended to regularly mow the grass and remove the invasive blackberry bushes. The sediment buildup should also be removed from the pond bottom and sump of the outlet structure.

5.2.12 Community Center

The detention facility located at the City's Community Center parking lot consists of a detention pond and swale. The total surface area of the detention facility is approximately 1,500 square feet, and the facility is in fair condition. The swale is built up with sediment, which is blocking stormwater runoff from entering the swale at the curb cuts. The pond inlet and outlet pipes are not visible, and may be covered up with small stones. It is recommended to remove sediment buildup in the swale, and to uncover the pond inlet and outlet pipes.

5.2.13 Roth's

The detention pond located north of the Roth's grocery store near the intersection of North Second Street and Bow Tie Lane is approximately 1,500 square feet in surface area. The detention pond is in poor condition. The pond does not have any vegetative cover, and river rock is mounded near the pond bottom. The detention pond does not

appear to have been detaining stormwater for quite some time, as there is no evidence of water flowing into or out of the pond. One ditch inlet structure exists in the pond, which appears to be both the inlet into the pond and the outlet. It is recommended to verify that the on-site flow control manhole is operating as designed, which should backup storm water into the pond. Vegetation should also be established in the pond.

5.2.14 Detention Pipes

In addition to detention ponds/lakes, the City has many underground stormwater detention pipes. An inventory of all known detention pipes in the City is provided in the following table. The majority of detention pipes have been installed since the early 1990's. The City's current policy only allows underground stormwater detention, unless approved by the City's public works director.

Table 5.2 – Detention Pipe Inventory

Diameter (Inches)	Pipe Material	Length (Feet)	Location	City Project #
48	Concrete	24	Welch Street/Silverton Hospital Clinic	456
48	Aluminum CMP	352	Bryant Court & Todd Court	525
36	HDPE	15	930 Oak Street/Assisted Living Facility	562
48	CMP	69	930 Oak Street/Assisted Living Facility	562
48	HDPE	80	930 Oak Street/Assisted Living Facility	562
42	Aluminum CMP	110	605 Welch Street/Dr. Peters Clinic	572
54	CMP	46	Norway Street & Liberty Street	584
24	HPDE	78	240 Phelps Street&Welch Street Parking Lot	606
30	HDPE	102	1201 S. Water Street/Private Drive	616
48	HDPE	397	Crestview Drive & Breyonna Way	629
48	HDPE	296	April Lane & Pine Street	631
24	HDPE	29	April Lane & Pine Street	631
30	HPDE	161	551 North Water Street/US Post Office	645
54	CMP	247	Breyonna Way & Cambridge Avenue	665
48	HDPE	78	Bee Lane	702
60	HDPE	97	Bee Lane	702
36	CMP	207	701 McClaine Street/Silverton Plaza	705
48	HDPE	420	Lavender Street & Sage Street	718
48	HDPE	172	Ryan Drive & Ike Mooney Road	723
48	HDPE	255	Jodi Drive & Ike Mooney Road	723
36	HDPE	316	Walnut Way & Ike Mooney Road	731
57	Aluminum CMP	347	Meadow Avenue & Pioneer Drive	744
21	Concrete	119	1000 N 1st Street/Traeger Industries	750
24	Concrete	180	1000 N 1st Street/Traeger Industries	750
30	Ductile Iron	182	1000 N 1st Street/Traeger Industries	750
48	HDPE	221	Fossholm Street & Short Street	752
48	HDPE	150	Wilson Street & Short Street	752
36	CMP	61	Private Alley & McClaine Street	752
72	Aluminum CMP	137	Chikamin Loop & Skookum Drive	753
72	Aluminum CMP	52	Shelokum Drive & Skookum Drive	753
60	HDPE	154	Ike Mooney Road & Travis Drive	755
24	HDPE	192	Ike Mooney Road & Vintage Lane	759
24	PVC D3034	300	James St & Silver Avenue	761
18	HDPE	837	Commerce Court & Eska Way	764
36	HDPE	138	Fairview Street & W. Center Street	765
24	HDPE	320	Thyme Loop & Sage Street	769
36	HDPE	357	Crestview Drive & Hillsdale Lane	771
54	HDPE	499	831 Railway Street/Self Storage	774

HDPE = High Density Polyethylene
CMP = Corrugated Metal Pipe
PVC = Polyvinyl Chloride

5.3 OPERATION, MAINTENANCE, AND REPLACEMENT

Proper maintenance enables the storm water system to function as designed; however, it requires dedication of significant resources. This section covers recommendations for the operation, maintenance, and replacement programs for the storm water system.

5.3.1 Detention Facilities

The City does not have an official maintenance policy for detention ponds/lakes and detention pipes. According to City staff, the level of maintenance on detention ponds and detention pipes is minimal. The City cuts downs tall grass in public detention ponds once or twice a year and typically does not remove clippings. Otherwise, overdue maintenance is provided to detention ponds and detention pipes when a problem is reported.

When detention facilities maintained by others are not maintained and experience reported problems, the City typically responds to correct the issue. If the City has maintenance agreements with private entities such as Home Owners Associations (HOAs), these agreements should be enforced as needed. Currently, an ordinance enforcing maintenance of detention facilities does not exist.
Following are maintenance recommendations for detention ponds/lakes and detention pipes, vaults, or tanks.

Table 5.3 – Maintenance Recommendations for Detention Ponds/Lakes

What To Look For	What To Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
➢ Clogged inlets or outlets	➢ Remove sediment and debris from ditch inlets, catch basins, curb inlets, and pipes to maintain at least 75% conveyance capacity at all times.
➢ Cracked drain pipes or grates	➢ Repair/seal cracks. Replace when repair is insufficient.
Vegetation shall cover 90% of the facility.	
➢ Invasive vegetation such as Himalayan Blackberry or Cattail	➢ Attempt to control even if complete eradication is not feasible.
➢ Dead or strained vegetation	➢ Replant per original planting plan, or substitute with similar vegetation. ➢ Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
➢ Tall grass and vegetation	➢ Cut back grass and prune overgrowth 1-2 times a year. Remove clippings.
➢ Weeds	➢ Manually remove weeds. Remove all plant debris.
➢ Trees	➢Remove trees that interfere with access for maintenance (slope mowing, silt removal, vactoring, or equipment movements).
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 48 hours.	
➢ Sediment accumulation in pond bottom exceeds 6 inches or affects inlet/outlet	➢ Remove sediment to designed pond shape and depth. Replace vegetation.
➢ Gullies	➢ Fill, lightly compact, and install plant vegetation to disperse flow.
➢ Erosion	➢ Replace splash blocks or inlet gravel/rock.
➢ Slope slippage	➢ Stabilize 3:1 slopes/banks with appropriate vegetation.
➢ Ponding	➢ Rake, till, or amend to restore infiltration rate.

Maintenance Schedule:

Summer: Make any structural repairs. Improve filter medium as needed. Clear drain. Irrigate as needed.

Fall: Replant exposed soil and replace dead plants. Remove sediment and plant debris.

Winter: Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.

Spring: Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch.

All seasons: Weed as necessary.

Table 5.4 – Maintenance Recommendations for Detention Pipes, Vaults, and Tanks

What To Look For	What To Do
Structural Components, including inlets, outlets, pipes, vaults, and/or tanks.	
➢ Clogged inlets or outlets or diminished pipe, vault or tank capacity	➢ Annually vactor oil & sediment or when sediment fills 25% of pipe depth and when oil is 2-inches deep.
➢ Cracked drain pipe or manhole	➢ Fill or replace when cracks are greater than 1/4".
Vegetation, including surface cover and nearby plantings.	
➢ Large shrubs and trees	➢ Remove as needed to prevent large root systems from damaging subsurface structural components.

Maintenance Schedule:

Summer: Make necessary structural repairs. Remove oil and sediment.

Winter: Monitor flow-through rates. Remove oil.

5.3.2 Pipelines

It is necessary to provide regular TV inspection to determine pipeline conditions, and then clean and repair the pipelines as needed. Sediment build-up in the pipelines reduces their capacity, and increases the potential for flooding. Sediment build-up also results in higher pollutant concentrations flushed out during large storm events. Other problems that could reduce the conveyance capacity of the storm water lines are broken or cracked pipelines, offset joints, root intrusion, and other blockage. A regular cleaning and TV program for the storm water pipelines will enable the City to identify and prioritize the pipelines in need of maintenance.

Records and notes of conditions and corrective actions should be kept. The records will aid the City in tracking maintenance problem areas. These areas can then be evaluated for potential source elimination. It is recommended that all the storm water pipelines be cleaned every 3 years, or more regularly if TV records justify a higher cleaning frequency. Annual cleaning is recommended for lines with significant root intrusion or sediment buildup.

5.3.3 Catch Basins

Some of the catch basins, particularly in the older parts of town, are damaged and need to be replaced. New catch basins may also need to be added where drainage and slopes are not adequate. At a minimum, catch basins need to be cleaned when sediment or debris reaches the bottom of the outlet pipe.

Records and notes of conditions and corrective actions should be kept. According to a study titled Evaluation of Catch Basin Performance for Urban Stormwater Pollution Control (Aronson et al, 1983. EPA-600/2-83-043), it is recommended that all catch basins be cleaned at least annually. A catch basin's effectiveness increases with more frequent cleanings.

Catch basin cleaning can be coordinated with line cleaning and TV inspection. If lines are cleaned and inspected every three years, approximately 1/3 of the lines and catch

basins will be cleaned yearly. This leaves 2/3 of the catch basins to be cleaned independently of the storm lines.

5.3.4 Open Channels

If open channels have a vegetative cover, mowing and other maintenance will be required during growing seasons. Sediment build-up results in higher pollutant concentrations flushed out during large storm events. When sediment accrual exceeds six inches, the channel should be dredged in order to maintain conveyance capacity and avoid overtopping of channels during large storm events.

5.3.5 Street Sweeping

The City of Silverton operates a street sweeping program for City streets. The program consists of sweeping with a City-owned sweeper operated by City maintenance staff, and storing the collected debris at the maintenance yard where it is collected, screened, tested, and disposed of by hauling to the dump. As part of this study, an evaluation was made of the current procedures for storing, screening, testing, and disposing of the street sweeping debris for regulatory compliance and consistency with other street sweeping programs in the region.

The current street sweeping frequency is consistent with other entities in the region and is reportedly sufficient for Silverton. No change in frequency is necessary at this time. However, periodic monitoring of debris accumulation should be performed to ascertain if certain areas need to be swept more or less frequently.

It is recommended that the City establish a street sweeping debris (road waste) management plan. The City's street sweeping debris management plan should include the following facilities:

- Stockpile bay consisting of a concrete pad and surrounding ecology blocks.
- Cover over stockpile bay.
- Drainage for concrete pad and drainage of surrounding area away from bay.
- Sand/grease separator for stockpile bay drainage.
- Discharge from sand/grease separator to City sanitary sewer system.

It is recommended that the City's street sweeping debris management plan include the following procedures:

- Testing of stockpile per requirements of receiving landfill.
- Haul to lined solid waste landfill that is permitted by DEQ.

These improvements should be phased in as maintenance facility budget is made available. The transportation of the debris to a lined solid waste landfill permitted by the DEQ should be incorporated as a standard practice immediately.

An analysis of the underground injection well is also recommended. This well should either be registered with the DEQ's UIC database or abandoned per DEQ standards. The analysis of the underground injection well should also include implementing BMPs

for the maintenance yard site drainage to assure proper treatment and disposal of storm water drainage.

For an in-depth look at street sweeping and comparisons to surrounding communities, a technical memorandum on street sweeping is included in Appendix D for reference.

5.3.6 Replacement Program

As broken or offset pipe sections are identified through TV monitoring and flow monitoring, Keller Associates recommends that these areas be documented and included in a replacement program. Pipeline and manhole replacement and rehabilitation needs will only increase as the storm water conveyance system ages.

5.4 CITY LIABILITIES

If the City's storm drainage system was to flood and cause bodily harm or damage to property, the City could possibly be held liable. Locations for flooding occurring during storm events up to the 25-year storm event and reported problem areas are shown in Figure 7 in Appendix A. Many more areas within the City would flood during the 50- and 100-year storm events, since most of the existing storm water system was designed to convey runoff flows from the 25-year storm event. Large detention facilities such as ponds and lakes should have an overflow path defined such that when the facility floods, no bodily harm and minimal property damage is incurred.

5.4.1 Drainage Law

Oregon drainage law, which originates from common law or case law, has developed without legislative action, and it is embodied in the decisions of the courts. Therefore, there is no Oregon Revised Statute to cite pertaining to Oregon drainage law.

Oregon has adopted the civil law doctrine of drainage. Under this doctrine, adjoining landowners are entitled to have the normal course of natural drainage maintained. The lower owner must accept water which naturally comes to his land from above, but he is entitled not to have the normal drainage changed or substantially increased. The lower landowner may not obstruct the runoff from the upper land, if the upper landowner is properly discharging the water. The full interpretation of the Oregon drainage law by the State of Oregon and Marion County can be found in Appendix B.

6.0 SUMMARY OF ALTERNATIVE IMPROVEMENTS

6.0 GENERAL

Problem areas or challenges discussed in Section 5 are summarized in Figure 7 in Appendix A. This section summarizes improvement alternatives intended to solve the problem areas, and is organized by drainage basin. Each alternative's benefits and drawbacks have been reviewed with City staff and the Technical Review Committee (TAC) prior to finalizing the recommended improvements. Since the Southeast Silver Creek Drainage basin does not have any problem areas, and it is not included in this section.

6.1 NORTHEAST SILVER CREEK DRAINAGE BASIN

As shown in Figure 5 in Appendix A, storm water from most of the downtown area north of Koons Street to B Street and west of 3rd Street discharges directly into Silver Creek with minimal water quality mitigation or detention. During a 25-year storm event, flooding occurs in this area due to an undersized and non-existent storm water conveyance pipe network. Outlined below are two alternatives that were considered to address storm water flooding in this area. A hydraulic model was constructed to simulate these alternatives. Other problem areas within this basin would be improved via upsizing existing pipelines or constructing new storm pipelines in areas currently without a storm water collection system.

The **first alternative** is to upsize the existing pipelines or add parallel pipelines to provide adequate conveyance capacity in order to eliminate flooding. Additionally, each discharge into Silver Creek would be equipped with water quality mitigation measures.

The **second alternative** is to construct new storm water pipelines along Jersey Street and High Street or Park Street, that would intercept storm water that currently discharges into Silver Creek near the C Street Bridge, as well as intercept storm water that has historically discharged into the tributary of Abiqua Creek as shown on Figure 5 in Appendix A. The new storm water pipelines would serve as trunklines in areas of downtown that currently do not have a storm water collection system. These new storm pipelines would also help alleviate flooding in the North Central drainage basin by intercepting a portion of its drainage basin which currently extends into the Northeast Silver Creek drainage basin.

<u>Recommendation:</u> Based on the information presented above, Keller Associates recommends that the City pursue the **second alternative** as the best solution to the drainage problems in this area. The second alternative requires less pipeline length, while serving a larger area than the first alternative and is therefore less expensive. The City should begin negotiations with property owners to secure easements for the new discharge into Silver Creek near High Street.

6.2 WEBB LAKE DRAINAGE BASIN

Currently, storm water runoff south of Oak Street and west of Iowa Stret within this drainage basin discharges into Olson's Ditch. During large storm events, the banks of Olson's Ditch erode and flooding occurs upstream and downstream of the Silver Cliff

Estates detention pond discharge (See Figure 7 in Appendix A for problem area locations). Outlined below are two alternatives that were considered to address erosion problems and flooding in this area. Other problem areas within this basin would be improved via upsizing existing pipelines or constructing new storm pipelines in areas currently without a storm water collection system.

The **first alternative** is to hard pipe Olson's Ditch from Oak Street down to near the outfall of the Silver Cliff Estates detention pond. As seen by the higher velocities, an energy dissipater would be required at the end of the new pipeline to lower the energy of the water. This alternative would eliminate erosion due to ditch flow along the Silver Cliff Estates western property line, as well as mitigate flooding upstream and downstream of the Silver Cliff Estates detention pond discharge. Additionally, the discharge into the wetlands would be equipped with water quality mitigation measures. A hydraulic model was constructed to simulate this alternative.

The **second alternative** is to construct a new detention facility at the upstream end of Olson's Ditch and decrease the velocities in the ditch with stepped weirs, in order to decrease erosion of the ditch banks.

Recommendation: Based on the information presented above, Keller Associates recommends that the City pursue the **first alternative** as the best solution to the drainage problems in this area. The first alternative is the less expensive of the two options, and would require less maintenance than the second alternative.

6.3 NORTH CENTRAL DRAINAGE BASIN

The North Central drainage basin discharges into a tributary of Abiqua Creek. Most of the area in the drainage basin is already developed. Portions of the conveyance system in this drainage basin are currently undersized, as evidenced by flooding shown in Figure 7 in Appendix A. A major problem area where flooding occurs is located between the Union Pacific railroad and a school sports field, which floods downstream properties along North James Street. Outlined below are two alternatives that were considered to address storm water flooding in this area. A hydraulic model was constructed to simulate these alternatives. Other problem areas within this basin would be improved via upsizing existing pipelines or constructing new storm pipelines in areas currently without a storm water collection system.

The **first alternative** is to construct a new regional detention facility upstream of the flooding areas between Highway 214 and the Union Pacific railroad, east of the school sports fields. At this location a large depression exists that naturally detains storm water. During large storm events, this area would provide temporary storage volume until the large storm event passes, and then storm water in this area would flow back into the conveyance system and into the tributary of Abiqua Creek. Based on the model results, the detention facility would provide enough reduction in peak flows to eliminate flooding and the need to upsize or add parallel pipelines downstream of the detention facility.

If property acquisition is not feasible at the above mentioned location, a possible alternative location for a smaller regional detention facility would be near the discharge of this drainage basin at 550 North James Street. If this location is chosen, the storm

conveyance system would need to be upsized with either larger pipes or the addition of parallel pipelines between the Union Pacific railroad to this detention facility to convey the peak 25-year storm event.

The **second alternative** is to upsize the entire conveyance system with either larger pipes or by adding parallel pipelines between the Union Pacific railroad down to North James Street to convey the peak 25-year storm event. This improvement would increase the peak 25-year storm water runoff flow from 25-40 cfs to approximately 53 cfs at the discharge end of the pipe crossing North James Street. The large increase of flow into a relatively small channel downstream of the improvements may cause flooding, which has several buildings in close proximity to the channel. Due to this reason, this alternative was not considered acceptable and was not pursued further.

Recommendation: Based on the information presented above, Keller Associates recommends that the City pursue the **first alternative** as the best solution to the drainage problems in this area. While the second alternative is less expensive, the large increase of quantity of storm water inflow into the tributary of Abiqua Creek may cause flooding problems downstream of the improvements. Consequently, the second alternative is not recommended. The proposed location of this facility is shown on Figure 8 in Appendix A. The detention pond should be designed in such a manner as to provide both water quality treatment and detention. Furthermore, property and/or easements should be pursued for the detention facility site.

6.4 WEST SILVER CREEK DRAINAGE BASIN

As shown in Figure 5 in Appendix A, storm water from this basin drains into Silver Creek with minimal water quality mitigation or detention. During a 25-year storm event, flooding occurs in front of the City Public Works maintenance shops and along Monson Road due to an undersized storm water conveyance network. Outlined below are two alternatives that were considered to address storm water flooding in these areas. Other problem areas within this basin would be improved via upsizing existing pipelines or constructing new storm pipelines in areas currently without a storm water collection system.

The **first alternative** is to construct a new regional detention facility upstream of the flooding areas between Highway 213 and the Union Pacific railroad, south of the City Public Works maintenance shops. There is a large open field consisting of a few trees and lawn at this location. During large storm events, this area would provide temporary storage volume until the large storm event passes, and then storm water in this area would flow back into the conveyance system and on to Silver Creek.

The **second alternative** is to upsize the existing lines, add parallel pipelines, deepen/widen existing channels, and/or construct new pipelines to provide adequate conveyance capacity in order to eliminate flooding. Additionally, each discharge into Silver Creek would be equipped with water quality mitigation measures. A hydraulic model was constructed to simulate this alternative.

Recommendation: Based on the information presented above, Keller Associates recommends that the City pursue the **second alternative** as the best solution to the drainage problems in this area. The second alternative is also the less expensive of the two options.

6.5 GENERAL DETENTION ALTERNATIVES

The three general types of detention alternatives are regional detention, local detention, and onsite detention. A regional detention facility would detain runoff from several minor basins, while a local detention facility detains runoff from one minor basin, and onsite detention would be designed to detain runoff from a single development within a minor basin. These three types can be effective individually or in a variety of combinations, depending on the major and minor basin characteristics.

The City currently has a policy of requiring onsite detention for development of property, which is recommended as a continued practice. The runoff from these developments could either discharge directly to the receiving waters or continue through the storm system to a local or regional detention facility. This policy assists in reducing pollutants through the use of water quality Best Management Practices (BMPs), and further mitigates flooding impacts.

6.6 OTHER PROBLEM AREAS

Keller Associates has reviewed all problem areas with the Technical Advisory Committee (TAC). Several problem areas shown in Figure 7 in Appendix A were deemed low risk problems and improvements were not proposed due to a variety of reasons. All these problem areas would pose a very low threat to property damage if flooded. Most of these problem areas would flood in a roadway and flow downstream to the next available catch basin or conveyance system that has capacity.

7.0 WATER QUALITY

7.0 GENERAL

Storm water management has historically emphasized flood control. However, in recent years the focus has shifted to include water quality management. Storm water quality in Oregon is regulated by three main programs. This section summarizes these programs and Silverton's current position with regard to each of them. In addition spill prevention and pollution control recommendations have been provided, along with wetland mitigation measures downstream of Olson's ditch. This storm water master plan provides the framework for the City to be prepared to meet all regulatory requirements.

7.1 REGULATORY PROGRAMS

7.1.1 UIC Program

The Underground Injection Control (UIC) Program was enacted in 1974 for management of fluid injection underground, in order to protect groundwater aquifers from contamination. The primary goal of the UIC Program is to preserve groundwater for beneficial uses such as drinking water. The Oregon Department of Environmental Quality (DEQ) has been delegated primacy to administer the UIC program for Oregon.

The DEQ administers the UIC program under Oregon Administrative Rule (OAR) 340-044. According to this rule, underground injection activities must be authorized through DEQ, either by registering the injection system and meeting general regulatory requirements ("rule authorized") or by obtaining a permit.

A strict definition of a UIC is "any system, structure, or activity that is created to emplace fluid directly into the subsurface." A few examples of storm water UICs are drywells, trench drains, sumps, perforated piping, floor drains, and drill holes. Single residential roof or footing drains that receive only storm water are exempt from UIC requirements.

The DEQ has developed guidance documents and forms to facilitate compliance with the UIC program. A document titled UIC Program Information has been prepared as part of this master plan to provide guidance for the City relating to underground injection systems, and it is included found in Appendix D.

The DEQ database records show the City of Silverton owns two UIC wells, which are both registered and rule-authorized with DEQ. Private and public entities also own UIC wells within the City. DEQ's database lists 21 other UIC wells owned by private or public entities, of which 10 UIC wells are registered and rule-authorized, while the remainder are under review by DEQ. Given the general ground water and soil characteristics in Silverton, it is recommended that underground injection be used only if all other storm water discharge options have been ruled out and if conditions are conducive to a UIC well.

Four other known drywells exist in the City, which do not appear to be on DEQ's UIC database. One drywell is located at the City Public Works Maintenance Shops. Another drywell is located in a parking lot north of Silverton Hospital near the southeast corner of the Welch and Phelps St. intersection. Two drywells are located in front of the Eugene

Field Elementary School on the east side of N. Water St. These four drywells and any other known drywells should be registered with DEQ or abandoned per DEQ requirements.

7.1.2 National Pollutant Discharge Elimination System (NPDES) Program- Phase II

Point source discharges to waters of the U.S., including storm water, are regulated through NPDES permits issued by the U.S. Environmental Protection Agency (EPA) or by authorized states. In Oregon, NPDES permits are issued and implemented by the DEQ. The Water Pollution Control Act (Oregon Revised Statute 468B) is the primary Oregon State law protecting water quality.

The DEQ combines the federal NPDES regulations with pertinent state regulations and issues combined permits that regulate discharges to waters of the U.S. and waters of the state. These permits are designed to meet NPDES permit requirements and state law under the Oregon Water Pollution Control Act. Waters of the state include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, and the Pacific Ocean within the territorial limits of the State of Oregon. In general, the waters of the state include all bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except private waters which do not combine with surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.

The storm water portion of the federal NPDES regulations has been implemented in two phases. Phase I addressed storm water discharges by large and medium municipal separate storm sewer systems (MS4s) and certain industrial activities, including construction sites disturbing more than 5 acres (The term “separate” means that wastewater such as sanitary sewage is not combined with storm water runoff). The Phase I storm water regulations were published in 1990. Phase II addressed MS4s in smaller municipalities and construction sites disturbing between 1 and 5 acres; those regulations were adopted in 1999. Municipalities with a population of 10,000 or more in are candidate Phase II communities. Silverton is not currently designated as a Phase II community.

The DEQ requires Phase II municipalities to adopt ordinances and implement minimum measures and BMPs equivalent to those in the federal guidance and in DEQ’s Internal Management Directive—Phase II MS4 General Permit: Storm Water Management Program Plan Framework (June 2003). Under the Phase II rules, municipalities may be subject not only to the requirements of MS4 owners and operators, but also to two other components of the federal NPDES storm water program, also delegated to DEQ for implementation:

- The Industrial Storm Water General Permit as an operator of regulated industrial activity.

- The Construction Storm Water General Permit as an operator of regulated construction activity disturbing more than 1 acre of land.

Each of the three components of the NPDES storm water program (municipal, industrial and construction) has its own requirements and permits.

Although Silverton is not currently required to meet NPDES Phase II requirements, the City has expressed the desire to be in a position to meet these requirements. As part of this master plan to provide the framework necessary for the City to meet Phase II requirements when required, recommendations have been made and implemented into the City's recently approved Total Maximum Daily Loads Implementation Plan. A matrix within the TMDL Implementation plan recommends a staged sequential plan, including strategies to address public involvement/education, removal of illicit discharges, and construction erosion control management. Performance benchmarks and reporting procedures are also listed for each strategy tackling a certain pollutant source. This document can be found in Appendix D.

Keller Associates recommends adoption of the Clean Water Services Erosion Prevention and Sediment Control Planning and Design Manual, current edition.

Once the City of Silverton is designated as a NPDES Phase II community, the City will be required to develop a storm water management program to meet the six minimum control measures indentified in the NPDES Phase II program. This strategy outlines the actions the City will need to take over a five-year period once it becomes a Phase II municipality in order to comply with the NPDES program. More details, including specific actions, responsible personnel, and time and costs should be developed from this strategy. The six minimum control measures are as follows:

- Public Education and Outreach
- Public Participation/Involvement
- Illicit Discharge Detection and Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

Public Education and Outreach – The City could develop and implement a storm water education and outreach strategy that examines target audiences. The City could also develop and distribute a brochure or equivalent program to inform the general public about storm water issues and of the hazards associated with illicit discharges and improper disposal of waste. Another activity the City could plan and implement is storm drain stenciling "Do Not Dump – Drains to Stream" or an equivalent message on storm drain inlet draining to the system.

Public Participation/Involvement – The City could hold public meetings and solicit public review of the storm water management plan. News releases for local newspapers could be developed in order to solicit interest to cover the new storm water program as a feature story. Another activity the City could perform is holding meetings with a stakeholder advisory group for storm water issues.

Illicit Discharge Detection and Elimination – The City could create a storm water system map showing all know storm drain outfalls to water bodies. An ordinance could be developed prohibiting illicit discharges and illegal dumping, and authorizing enforcement actions, including on private property. The City could also build an illicit discharge detection plan. Another activity the City could perform is to visually inspect for illicit discharges during dry weather at all known outfalls that discharge to surface waters.

Construction Site Runoff Control – The City should require (through an ordinance), erosion and sediment controls in compliance with an adopted storm water management manual or other guidance document for construction operators disturbing more than one acre. Training could be provided or coordinated with existing training efforts to educate plan reviewers and field inspectors in erosion and sediment control BMPs and requirements. Another activity the City could perform is review of storm water site plans prior to construction to ensure that they include erosion and sediment controls and post-construction control measures.

Post Construction Runoff Control – For construction of private developments, the City could require (through an ordinance), the installation and proper maintenance of post-construction runoff controls in compliance with an adopted storm water management manual or standards or other guidance document. A plan could be created to address post-construction storm water runoff during the plan review, construction inspection, and post-construction maintenance inspection process. The City could also provide training or coordinate training efforts to educate construction plan reviewers and field inspectors on post-construction design standards, runoff control BMPs, and maintenance standards.

Pollution Prevention/Good Housekeeping – The City could create and implement a municipal operation and maintenance (O&M) plan for general "good housekeeping" measures maintaining City facilities. The O&M plan could be a documentation of existing activities together with suggested modifications to reduce pollutants. The O&M plan could implement park and open space maintenance pollution prevention/good housekeeping practices. It could also implement publicly-owned vehicle and equipment washing pollution prevention/good housekeeping practices. Another activity the City could perform is requiring City construction projects to follow the same storm water requirements as private developments.

7.1.3 Total Maximum Daily Load Program

The Federal Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be established when a water body does not meet water quality standards. The majority of Silverton's runoff discharges to the Silver Creek and eventually to the Pudding and Molalla Rivers, which have been listed as water quality impaired under the Molalla-Pudding Subbasin and Willamette Basin TMDL. The DEQ adopted a TMDL for the Willamette Basin in September 2006 and the Molalla-Pudding Subbasin in 2008. Silverton was identified as a "designated management agency" (DMA) in the Molalla-Pudding Subbasin TMDL. A designated management agency is held responsible for managing water quality within their jurisdiction. As such, Silverton was required to develop a TMDL Implementation Plan to address TMDL allocations within their jurisdiction. Silverton submitted their TMDL Implementation Plan in 2008, and it was subsequently approved by DEQ. The Implementation Plan and DEQ approval letter is in Appendix D.

The pollutants of concern in the Molalla-Pudding Subbasin TMDL are temperature, bacteria, DDT, dieldrin, chlordane, iron, and nitrate. The pollutants of concern in the Willamette Basin TMDL are temperature, bacteria, and mercury. The required elements for TMDL implementation plans are defined in OAR 340-042-0080(3). In summary, the requirements are:

- Develop and implement best management practices (BMPs) or other management strategies to achieve TMDL load allocations.

- Develop a timeline for implementation and a schedule for completing measurable milestones.

- Develop a monitoring plan to determine whether:

  - BMPs are being implemented
  - Individual BMPs are effective
  - TMDL load allocations are being met
  - Water quality criteria are being met

- Provide evidence of compliance with applicable statewide land use requirements.

- DMAs also will have to include a storm water management component in their TMDL Implementation Plans.

- DMAs with a population between 10,000 and 50,000 will have to address the six minimum control measures identified in the NPDES Phase II program.

- DMAs with a population less than 10,000 are expected to give considerations to any of the measures that are relevant.

7.2 SPILL PREVENTION AND POLLUTION CONTROL

Storm water runoff from the City enters the storm water system, which in turn flows into nearby streams or creeks. Part of the City's drinking water is pumped from Silver Creek near the downtown public swimming pool. Approximately 13 storm water outfalls exist upstream of the City drinking water intake, as shown on Figure 3 in Appendix A. The drainage basin within the study area upstream of the Silver Creek drinking water intake is shown in Chart 7.1. The majority of the area upstream of the water intake within the study area is developed as residential housing, with some agricultural and commercial uses. With the majority of the basin area being residential housing, the most likely pollutant to the storm water system would be illegal or illicit connections to the storm water system.

Chart 7.1 – Drainage Basin Upstream of Silver Creek Intake

Illicit discharges are generally any discharge into a storm drain system that is not composed entirely of stormwater. Illicit discharges are a problem because, unlike wastewater which flows to a wastewater treatment plant, storm water generally flows to waterways without any additional treatment. Illicit discharges often include pathogens, nutrients, surfactants, and various toxic pollutants. Once the City becomes obligated to meet Phase II NPDES requirements, illicit discharges will be one of the six control measures the City will need to address. The City can take the following steps to prevent and/or control spills or illicit discharges into the public storm water system:

- Create brochures with information about illicit discharges for general public.
- Develop and enforce an ordinance prohibiting illicit discharges and/or connections to the storm system and authorizing enforcement action, including discharges on private property.
- Develop an illicit discharge detection plan with at least the following components:
  - Identification of priority areas for assessment
  - Field assessment activities
  - Routine schedule for system inspection
  - Characterization of any discharges found
  - Procedures to trace an illicit discharge
  - Procedures to remove an illicit discharge

- Visually inspect for illicit discharges during dry weather at all known outfalls that discharge to surface waters.

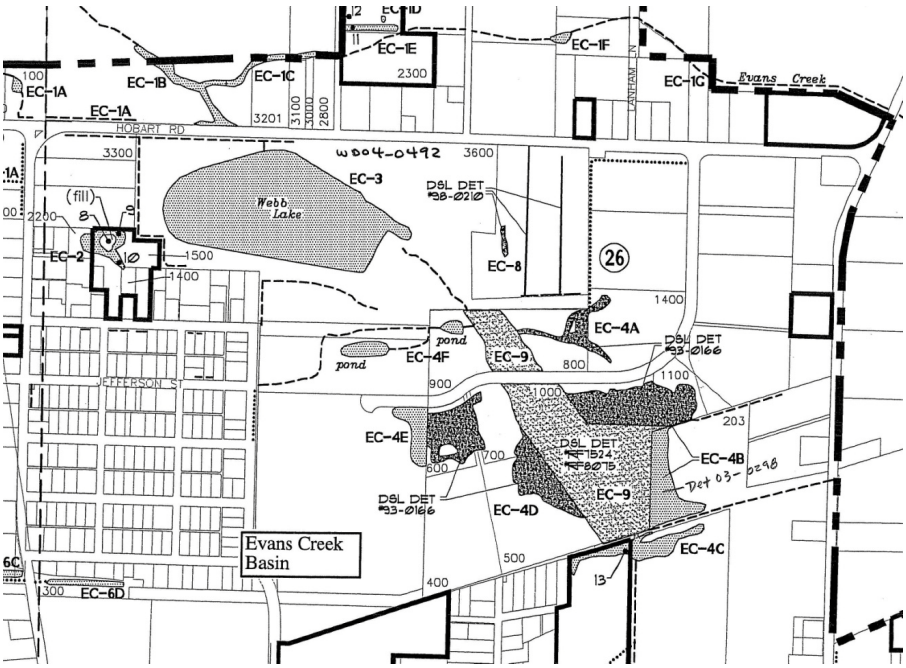
- Develop and implement a spill response plan, including different types of spills, who should be contacted and what the municipality will do in response.

- Train relevant City staff on proper response to spills and illicit discharges.

7.3 WETLAND MITIGATION

The City has an approved mapped wetland inventory completed by the Oregon Department of State Lands (DSL). Mapped wetlands for the whole City can be found in Appendix D. The majority of the City's inventoried wetlands are located on the north side of town, south of Webb Lake and north of Olson's ditch (See Chart 7.2). This large wetland area is mostly zoned for industrial use. If this industrial area was to be developed, it would require the wetlands be at least partially filled in.

Chart 7.2 – DSL Inventoried Wetlands in Northeast Silverton



Oregon´s Removal-Fill Law (ORS 196.795-990) requires people who plan to remove or fill material in waters of the state to obtain a permit from the Oregon Department of State Lands (DSL). The following conditions require permits or general authorizations:

- Projects requiring the removal or fill of 50 cubic yards or more of material in waters of the state.

- The removal or fill of any material regardless of the number of cubic yards affected in a stream designated as essential salmon habitat.

- The removal or fill of any material from the bed and banks of scenic waterways regardless of the number of cubic yards affected.

Many projects that require a DSL removal-fill permit also will require a federal permit from the U.S. Army Corps of Engineers (Corps). DSL and the Corps use a joint permit application form, so only one application needs to be filled out to obtain both permits. Each agency reviews the application and issues separate permits that may have different requirements. Either agency may require a permit when the other does not.

When applying for a removal-fill permit to impact waters of the state, the applicant is required to mitigate the impacts. Mitigation is a process to reduce the effects of the proposed project, and includes avoidance and minimization.

As part of the application process, applicants must first consider, in the following order: 1) avoiding the impact altogether; 2) minimizing the impact; 3) rectifying the impact at project completion; and 4) compensating for the unavoidable losses.

Examples of the type of analysis that must be documented in the permit application are: how might the footprint of the impact be modified; how might the proposed development area be moved to avoid or minimize wetland or waterway impacts; or how might the temporary impacts be repaired. If permanent impacts are unavoidable, permittees must compensate (mitigate) for the ecological functions and societal benefits (values) that will be permanently lost.

The success of a mitigation project depends upon multiple factors including appropriate siting, a sound project design and monitoring plan, and the site's potential to be self-sustaining. Compensatory mitigation will normally require the assistance of trained professionals to assure that projects are successful and that plans and reports contain sufficient detail to satisfy DSL requirements.

There are four general steps in compensatory mitigation:

Step 1: Evaluate project impacts on acreage/linear feet, and functions and values.
Step 2: Select the mitigation opportunity(ies) that will best offset those impacts.
Step 3: Develop a mitigation plan as part of the permit application to DSL.
Step 4: Construct and monitor the mitigation project as required by the permit conditions.

Additional information facts regarding compensatory mitigation for wetland impacts can be found in Appendix D.

8.0 CAPITAL IMPROVEMENT PLAN

8.0 GENERAL

This section summarizes recommended capital improvements, with an associated planning level opinion of probable cost. Recommended improvements are illustrated on Figure 8 in Appendix A, and details on each improvement are presented in Appendix F. This section also summarizes annual operation, maintenance, and replacement costs for the storm water system.

8.1 CAPITAL IMPROVEMENT PLAN

The opinions of probable cost for the capital improvement plan are prioritized based on their urgency to mitigate existing deficiencies. Figure 7 in Appendix A illustrates the problem areas identified in the computer model when running the 2-, 5-, 10-, and 25-year storm events, as well as other reported problems. *Opinions of probable cost are in 2012 dollars for improvements necessary to correct flooding for the 25-year storm event.* Additional details of the opinions of probable cost presented below for each project can be found in Appendix F. All improvements are illustrated in Figure 8 in Appendix A, and are color-coded by priority.

8.1.1 Priority 1

Priority 1 improvements were considered most urgent, and include improvements that correct flooding problems that pose significant and immediate threat to property. The following project identifiers and recommended actions summarize the priority 1 improvements.

1A – Olson's Ditch Improvements: Construct a pipeline to replace Olson's Ditch from Oak Street to near the outfall of the Silver Cliff Estates detention pond. An energy dissipater may be required at the end of the new pipeline to lower the energy of the water. The existing drainage channel that will receive the discharge needs to be deepened and widened. These improvements will eliminate erosion due to ditch flow along the Silver Cliff Estates western property line, as well as mitigate flooding upstream and downstream of the Silver Cliff Estates detention pond. Additionally, the discharge into the wetlands should be equipped with water quality mitigation measures.

1B – North Second Street and Mills Addition Improvements: Increase the conveyance capacity of the North Second Street and upstream conveyance system by upsizing sections of pipeline and constructing new storm pipeline in areas currently without a storm water collection system.

1C – West Main, Welch, and Cherry Street Storm Water: Construct new storm pipelines along West Main Street, Welch Street, and Cherry Street. This area currently does not have a storm water collection system. Additionally, the discharge into Silver Creek should be equipped with water quality mitigation measures.

1D – High Street to East Main Street Storm Water: Construct new storm pipelines along either High Street or Park Street, North 3rd Avenue, and East Main Street. This area currently does not have a storm water collection system, with the exception of a

stretch of pipeline along East Main Street. This improvement will alleviate flooding along Mill Street by taking some of the flow from Oak Street via a flow split in a manhole. Prior to discharge into Silver Creek, the pipeline should be equipped with water quality mitigation measures. The City should begin negotiations with property owners to secure easements for the new discharge into Silver Creek near High Street.

1E – Jersey Street Storm Water: Construct a new storm pipeline along Jersey Street that will intercept storm water that currently discharges into Silver Creek near the C Street Bridge. The new pipeline will also alleviate flooding in Mill Street, and drain areas of downtown that currently do not have a storm water collection system. Additionally, the outfall into Silver Creek should be equipped with water quality mitigation measures.

8.1.2 Priority 2 Improvements

Priority 2 improvements correct problems that pose a smaller and less immediate threat to property. The following project identifiers and recommended actions summarize the priority 2 improvements.

2A – Hwy 214 Detention Facility: Construct a regional detention facility upstream of the flooding areas between Highway 214 and the Union Pacific railroad, east of the school sports fields. This detention facility should provide a minimum of 9.5 ac-ft of storage volume and be designed to also provide water quality treatment for the drainage basin. This facility will provide detention for the majority of the storm water collection system for the North Central Basin. A 30" bore for a new 24" pipeline will be required to cross the railroad tracks. This new 24" pipeline will take the place of the existing wooden culverts. The rim elevation for the manhole downstream of the new railroad crossing should be equal to or greater than the finish grade of the railroad. This required rim elevation will keep the manhole from surcharging above the rim elevation and flooding the area. This improvement includes the purchase of approximately 2.4 acres. This property is currently listed for sale at $600,000.

2B – North James Street and Pine Street Storm Water: Construct new storm pipelines along North James Street and Pine Street. This area currently does not have a storm water collection system. Additionally, the discharge into Silver Creek should be equipped with water quality mitigation measures.

2C – Sheridan Street and Pine Street Storm Water: Construct new storm pipelines along Pine Street and upsize an existing pipeline along Sheridan Street. This section of Pine Street currently does not have a storm water collection system. Prior to discharge into Silver Creek, the pipeline should be equipped with water quality mitigation measures.

2D – Rock Street to South 3rd Street Connection: Construct new storm pipeline from Rock Street down the hillside to South 3rd Street. This improvement will redirect concentrated storm water runoff that is currently discharging into residential backyards. The City should begin negotiations with property owners to secure easements for the new pipeline.

2E – McClaine Street Improvements: Construct new storm pipelines along McClaine Street and connect to existing storm at South James Street. This area currently does not have a storm water collection system.

2F – Koons Street Improvements: Increase the conveyance capacity in Koons Street by upsizing sections of pipeline. Additionally, the outfall into Silver Creek should be equipped with water quality mitigation measures.

2G – James Street Improvements: Increase the conveyance capacity in North James Street by upsizing sections of bottlenecked pipe and installing a parallel pipeline.

8.1.3 Priority 3 Improvements

Priority 3 improvements correct problems that pose a lower threat to property and are generally intended to correct problems that occur only during larger storm events. The following project identifiers and recommended actions summarize the priority 3 improvements.

3A – Oak Street Improvements: Increase the conveyance capacity on the south side of Oak Street by upsizing a section of undersized pipeline.

3B – Monson Road Improvements: Increase the conveyance capacity of the conveyance system along Monson Road by re-grading the roadside ditch to provide positive downward slope to Silver Creek and upsizing existing pipes. Prior to discharge into Silver Creek, the pipeline should be equipped with water quality mitigation measures.

3C – Grant Street Improvements: Increase the conveyance capacity in Grant Street by upsizing sections of pipeline and converting roadside ditches to pipelines.

3D – West McClaine Street Improvements: Increase the conveyance capacity on the south side of McClaine Street by upsizing a section of undersized pipeline.

3E – Monitor Road Improvements: Increase the conveyance capacity on the west side of Monitor Road by upsizing a section of undersized pipeline.

8.1.4 Improvements Summary

A summary of the recommended improvements organized by priority is presented in the following table. A graphical illustration of each improvement is provided on Figure 8 in Appendix A, and each improvement has been labeled with the priority number presented in Table 8.1. Additionally, a summary sheet for each improvement is presented in Appendix F. The annualized cost presented in Table 8.1 represents a 20-year loan at 4% interest to pay for all the respective priority improvements regardless of jurisdiction. This cost is provided as a reference on which to base an annualized budget for saving for future improvements or paying towards a loan.

Table 8.1 – Capital Improvement Plan

Item #	Item Description	Opinion of Probable Cost*	Percent SDC Eligible	SDC Improvement Amount	City Amount
Priority 1 Improvements (by 2022)					
1	Utility and SDC Rate Study	$20,000	50%	$10,000	$10,000
1A	Olson's Ditch Improvements	$536,000	30%	$160,800	$375,200
1B	North Second Street and Mills Addition Improvements	$2,061,000	20%	$412,200	$1,648,800
1C	West Main, Welch, and Cherry Street Storm Water	$691,000	10%	$69,100	$621,900
1D	High Street to East Main Street Storm Water	$1,013,000	5%	$50,700	$962,300
1E	Jersey Street Storm Water	$453,000	5%	$22,700	$430,300
	Total Priority 1 Improvements	***$4,774,000***		**$725,500**	**$4,048,500**
	Priority 1 Annual Payment (20yr, 4%)	***$351,279***			***$297,896***
Priority 2 Improvements (2017 - 2027)					
2	Update Storm Water Master Plan	$150,000	50%	$75,000	$75,000
2A	Hwy 214 Detention Facility	$1,061,000	10%	$106,100	$954,900
2B	North James Street and Pine Street Storm Water	$238,000	0%	$0	$238,000
2C	Sheridan Street and Pine Street Storm Water	$288,000	10%	$28,800	$259,200
2D	Rock Street to South 3rd Street Connection	$218,000	10%	$21,800	$196,200
2E	McClaine Street Improvements	$236,000	5%	$11,800	$224,200
2F	Koons Street Improvements	$265,000	0%	$0	$265,000
2G	James Street Improvements	$185,000	5%	$9,300	$175,700
	Total Priority 2 Improvements	***$2,641,000***		**$252,800**	**$2,388,200**
	Priority 2 Annual Payment (20yr, 4%)	***$194,329***			***$175,728***
Priority 3 Improvements (2022 - 2032)					
3A	Oak Street Improvements	$197,000	35%	$69,000	$128,000
3B	Monson Road Improvements	$161,000	40%	$64,400	$96,600
3C	Grant Street Improvements	$128,000	10%	$12,800	$115,200
3D	West McClain Street Improvements	$94,000	0%	$0	$94,000
3E	Monitor Road Improvements	$61,000	55%	$33,600	$27,400
	Total Priority 3 Improvements	***$641,000***		**$179,800**	**$461,200**
	Priority 3 Annual Payment (20yr, 4%)	***$47,166***			***$33,936***
	TOTAL (rounded)	**$8,056,000**		**$1,158,100**	**$6,897,900**

* All costs in 2012 Dollars. Costs include engineering and contingencies.

8.2 STORM WATER SYSTEM MAINTENANCE AND REPLACEMENT PROGRAM

The storm water conveyance system requires regular maintenance to ensure that pipelines, catch basins, and detention sites facilitate flows during the design storm event. Additionally, storm water facilities continue to age and will eventually need to be rehabilitated or replaced. This section summarizes recommended maintenance and replacement activities and budgets.

8.2.1 Storm Water System Maintenance Program

The City currently does not maintain the storm water system due to insufficient funds for proper equipment and the necessary staffing to perform the maintenance. The City has two options for implementing the storm water system maintenance program: contract out maintenance services, or perform maintenance with the purchase of equipment and additional staff. The equipment and supply costs for the City to perform maintenance of the storm water system have been summarized in Table 8.2. In addition to equipment and supply costs, the City will need additional staff to perform the maintenance, which is summarized in Table 8.5. Keller Associates recommends that the storm water system be regularly maintained.

The City currently does not have a cleaning and inspection rig (vactor truck). According to a recent survey of suppliers, new fully equipped vactor trucks cost approximately

$300,000. Assuming the cost is split between the storm water and wastewater budgets, the annualized capital cost of the vactor truck for the storm systems portion would be about $14,500 per year based on a 15-year equipment life and 5% interest rate.

An additional reason why the City should consider purchasing their own equipment would be to give the City the flexibility to clean and TV monitor without scheduling it with a third party. City staff could respond more quickly to debris blockages that may cause flooding or ponding during storm events.

Table 8.2 – Summary of Annual Equipment and Supply Maintenance Costs

Equipment and Supplies	Rounded Annual OPC*
Vactor Truck ($300k/15yrs)	$14,500
Decanting Facility($100k/20yrs)	$8,000
Tractor ($23K/15yrs)	$2,200
Flail Mower ($10K/5yrs)	$2,300
Chemical Sprays	$2,500
Equipment fuel	$1,000
Equipment maintenance	$1,000
Rounded Total	**$31,500**

*Opinion of Probable Cost assumes 5% interest on annual payments

If the City chose to contract out the maintenance of storm pipes, catch basins, and detention pipes in place of purchasing equipment and adding staff, this option is described below. If these services were hired out, the City would still need to hire seasonal laborers for the maintenance of detention ponds and open channels.

The maintenance program is based on the total amount of City-owned existing storm water infrastructure. The City currently owns and maintains approximately 26 miles of storm lines (8" and larger only), 900 catch basins, and 38 detention pipes. Based on a 3-year pipeline cleaning and TV inspection cycle, approximately 8.6 miles of pipeline would need to be cleaned annually. The typical contracted cleaning and TV inspection costs are about $1.75/ft assuming the lines are regularly maintained. Poorly maintained lines can cost up to $5/ft. Catch basin cleaning should be based on a 3-year cycle, which would require approximately 300 catch basins to be cleaned annually. Detention pipes should be cleaned annually as well.

Assuming an average pipe maintenance cost of $1.75/ft, a catch basin cleaning cost of $30 each, and a detention pipe cleaning cost of $500 each, the City would need an annual budget of about $108,100 for these contracted services. Table 8.3 summarizes the annual contracted maintenance program targets and the associated costs.

Table 8.3 – Summary of Annual Contracted Maintenance Costs

Facilities	Units*	Unit Cost	Total OPC**
Lineal Feet of Strom Pipe Cleaning & TV Inspection	45,760	$1.75/ft	$80,080
Number of Catch Basin Cleaning	300	$30 EA	$9,000
Number of Detention Pipe Cleaning	38	$500 EA	$19,000
Rounded Total Annual Contracted Maintenance Cost			**$108,100**

*Approximate number of units
**Opinion of probable cost

Due to the greater cost of contracting out maintenance services, Keller Associates recommends the City consider purchasing equipment and hiring additional personnel dedicated to the storm water system.

8.2.2 Storm Water System Replacement Program

In addition to regular maintenance, Keller Associates recommends that an annual pipeline replacement program be established. Storm water infrastructure replacement and rehabilitation needs will increase as the storm water conveyance system ages.

The replacement program is based on the total amount of existing City storm water infrastructure and its estimated useful life. The City facilities include approximately 26 miles of storm lines (8" and larger only), 400 manholes, 900 catch basins, and 7,800 feet of detention pipes. Assuming an average of a 50-year remaining useful life, the replacement program should target approximately 2,745 feet of pipe, 18 catch basins, 8 manholes, and 156 feet of detention pipe per year. Assuming an average pipe replacement cost of $100/ft, a catch basin cost of $2,300 each, a manhole cost of $3,750 each, and an average detention pipe cost of $525/ft, the City would need an annual replacement budget of about $427,800. Table 8.4 summarizes the annual replacement program targets and the associated costs.

Table 8.4 – Summary of Annual Replacement Costs

Facilities	Units*	Unit Cost	Total OPC**
Lineal Feet of Storm Lines	2,745	$100/ft	$274,500
Number of Catch Basins	18	$2,300 EA	$41,400
Number of Manholes	8	$3,750 EA	$30,000
Linear Feet of Detention Pipe	156	$525/ft	$81,900
Rounded Total Annual Replacement Cost			**$427,800**

*Approximate number of units
**Opinion of probable cost

8.2.3 Staffing

Two staffing options exist for maintenance of the City's storm water system. If the City chooses to contract out maintenance services for pipes, catch basins, and detention pipes, the staffing recommendation in this option is two seasonal employees working approximately 6 months per year to handle the cleaning, mowing, and spraying of the detention ponds and open channels. There will also need to be a storm water manager spending 25% of the time to manage the seasonal workers, coordinate work with the contractor, and complete the reporting and tracking requirements of the TMDL implementation plan.

If the City purchases the cleaning and inspection equipment, the staffing recommendation for this option is to hire a two-man crew in addition to the existing storm water staff. This two-man crew would spend 50% of their time on the storm water system, and 50% of their time on the wastewater system. Table 8.5 summarizes the two staffing options.

Table 8.5 – Staffing Recommendations

Options	Staffing	OPC*	Comments
OPTION 1: Contract Services	2 PTE**	$30,000	Two seasonal workers for 6 months of the year @ $15/hr.
	0.25 FTE***	$17,500	One storm water manager spending 25% time on the storm system @ $70k/yr.
	0.25 FTE	**$47,500**	**Total City Seasonal Maintenance (Contractor performing maintenance of pipeline, catch basin, and detention pipes)**
	2.0 PTE		
OPTION 2: Complete Services with City Staff	2 PTE	$30,000	Two seasonal workers for 6 months of the year @ $15/hr.
	0.25 FTE	$17,500	One storm water manager spending 25% time on the storm system @ $70k/yr.
	1 FTE	$70,000	Storm cleaning and maintenance (part of a 2 man crew spending 50% time on the storm water system) @ $70k/yr.
	1.25 FTE	**$117,500**	**Total Additional City Staff (City performing maintenance of pipeline, catch basin, and detention pipes)**
	2.0 PTE		

*Opinion of probable cost
**Part Time Employee
***Full Time Employee

8.2.4 Annual Cost Summary

The costs presented in previous subsections are summarized in Table 8.6. The costs are largely based on quantities, and will therefore need to be updated as the system grows and as unit costs change. Budgeting updates should be performed at least annually to ensure the storm water master plan implementation is on track. It should also be noted that the recommended budgets are substantially higher than current funding levels, and some improvements such as the replacement programs could be phased in over time to reduce impacts of a larger initial rate.

Table 8.6 – Annual Budget Levels

Task	Annual OPC*
Maintenance Contracted Out – Option 1	
Contracted Maintenance	$108,100
City Seasonal Maintenance	$47,500
Total Rounded Cost	**$155,600**
City Perform Maintenance – Option 2	
Additional City Staff	$117,500
Equipment and Supplies	$31,500
Total Rounded Cost	**$149,000**
Replacement Program & City Perform Maintenance	
City Perform Maintenance	$149,000
System Replacement Program	$427,800
Total Rounded Cost	**$576,800**
CIP Priority 1 Improvements, Replacement Program, & City Perform Maintenance	
City Perform Maintenance	$149,000
System Replacement Program	$427,800
CIP Priority 1 Improvements Annualized Cost**	$351,300
Total Rounded Cost	**$928,100**
All CIP Improvements, Replacement Program, & City Perform Maintenance	
City Perform Maintenance	$149,000
System Replacement Program	$427,800
All CIP Improvements Annualized Cost**	$592,800
Total Rounded Cost	**$1,169,600**

*Opinion of probable cost
**CIP annualized costs assume no SDC contribution

8.3 STORM WATER SYSTEM FUNDING

The City of Silverton currently pays for storm water operations and maintenance from a combination of gas tax funds, SDC funds, and contributions from private developers. The City's current storm water budget consists of approximately $10,000 annually from gas tax funds and $550,000 of SDC funds. In the upcoming fiscal year, the gas tax funds will no longer be available for the storm water system. The City's annual storm water budget should cover the phased costs for funding the operation and maintenance program, replacement program, and capital improvements.

Keller Associates has reviewed the City's current SDC methodology and has recommended several changes, which are summarized in this section. Recommendations for procedures and potential methodology have been provided for how the City could develop a storm water utility fee. In addition, existing and potential funding/financing sources have been identified for maintaining the existing storm water system and constructing future improvements.

8.3.1 System Development Charges

The City of Silverton establishes storm water System Development Charges (SDC) per Resolutions NO. 05-04, 05-27, and 09-32. Currently, the improvement SDC for single-family residences in the City is based on 2,072 square feet of impervious surface area for an average single-family residence. The current SDC amount for single-family residences is $2,072 per living unit. Multi-family residences, commercial, and industrial developments with an impervious area smaller than 5,000 square feet in size are currently charged $1.00 per square foot of impervious area. All larger developments that do not incorporate full detention of storm water runoff are currently charged $1.00 per square foot of impervious area. The current SDC amounts incorporate inflation as of April 2012. All developments larger than 5,000 square feet that detain storm water per City standards receive up to 60% credit. Currently, the City does not have a reimbursement fee portion in their SDCs.

Keller Associates recommends the SDC methodology be slightly revised to comply with Oregon Revised Statutes (ORS) 223.297 to 223.314. In order for the SDC methodology to be equitable to all users, those who contribute runoff to the storm water system should proportionately contribute to the costs of providing services. The improvement SDC amount for non-single-family residential developments should be based on their measured impervious area divided by 2,072 square feet, which is then multiplied by the single-family living unit SDC amount. The SDC improvement fee should be recalculated based on the CIP and the percentage SDC eligible for each capital improvement.

Also, the current SDC credit for storm water detention should be eliminated. No credits should be considered unless developers are required as a condition of development approval to make improvements to one or more of the identified public facilities in the CIP. A credit would be available where those improvements are either not on the development site or are required to be constructed at a greater capacity than is actually needed to serve the development itself. Storm water detention should be required per City policies and design standards.

A reimbursement fee is recommended to be added to the City's SDC, which is currently made up of only the improvement fee based on future growth. The reimbursement fee should be developed to recover a portion of the cost of existing facilities for which there is excess capacity to serve new development.

The improvement SDC amount is based on the cost of capital improvements that expand a storm water system's capacity or increase its level of performance to accommodate growth and development. In Table 8.1 each capital improvement project is allocated a percentage of the total cost that is eligible for funding by collected SDC funds. Each capital improvement project that will service undeveloped areas was reviewed. The SDC improvement amount is based on percentage of undeveloped area within the capital improvement's drainage basin.

8.3.2 Storm Water Utility Fee

The SDC fund will not be able to cover the entire City's storm water system costs; therefore Keller Associates recommends the City create a storm water utility fee. The remaining costs not covered by SDCs should be paid by all of the City's residents and businesses through a storm water utility fee. Similar to the recommended SDC

methodology, the utility fee for storm water management should be charged proportionately based on the measured impervious surface of a development. This approach is now regarded by most administrators and the courts as an appropriate method for financing storm water programs.

An in-depth financial analysis should be performed during the overall process of creating a storm water utility fee. The first step would be to develop an initial annual budget for a new storm water utility that would receive funds and at least pay the storm water system operation and maintenance costs. Then a near term (3-5 yr) forecast and financial plan should be developed that would ramp up user fees for the phasing in of the replacement program and capital improvement plan. Some initial decisions will need to be made regarding needed capital improvements and how to fund them. Usually an enterprise fund needs a 5-year history before it can issue revenue bonds in the municipal bond market.

The next step in developing a storm water utility is to create a storm water utility rate for all users of the system based on the methodology recommended above. Typically a flat fee is established for single-family residence. For non-single family developments (multi-family, commercial, industrial, institutional, etc.) the amount of existing impervious surface area for each development will need to be determined in order to calculate a utility fee. After this is complete, a cost of service study and rate design should be conducted. Finally, the City will need to draft an enabling ordinance and implementing resolution for the utility rates. Once completed, the City's utility billing program will need to be updated to accept storm water rates and to add those charges to each customer's utility bill.

8.3.3 Other Potential Storm Water Funding Sources

Outside of funds gathered by the City through the recommended SDCs and storm water utility fees, there are other sources of funding from private and government programs which may be available to aid the City in the implementation of this master plan.

With the aid of the Boise State University Environmental Finance Center, numerous sources of potential funding have been identified as having specific application to Silverton's storm water system financing. It is recommended that the City review the application requirements for each of these sources and apply for as many as possible. These potential sources are listed in Appendix G.

Appendix A

figures ▪ master plan

Figure 1 – Study Area and Land Use
Figure 2 – Topography
Figure 3 – Existing Strom System
Figure 4 – Drainage Basins
Figure 5 – Existing Drainage Areas
Figure 6 – Modeled Lines
Figure 7 – Problem Areas
Figure 8 – Prioritized Improvements

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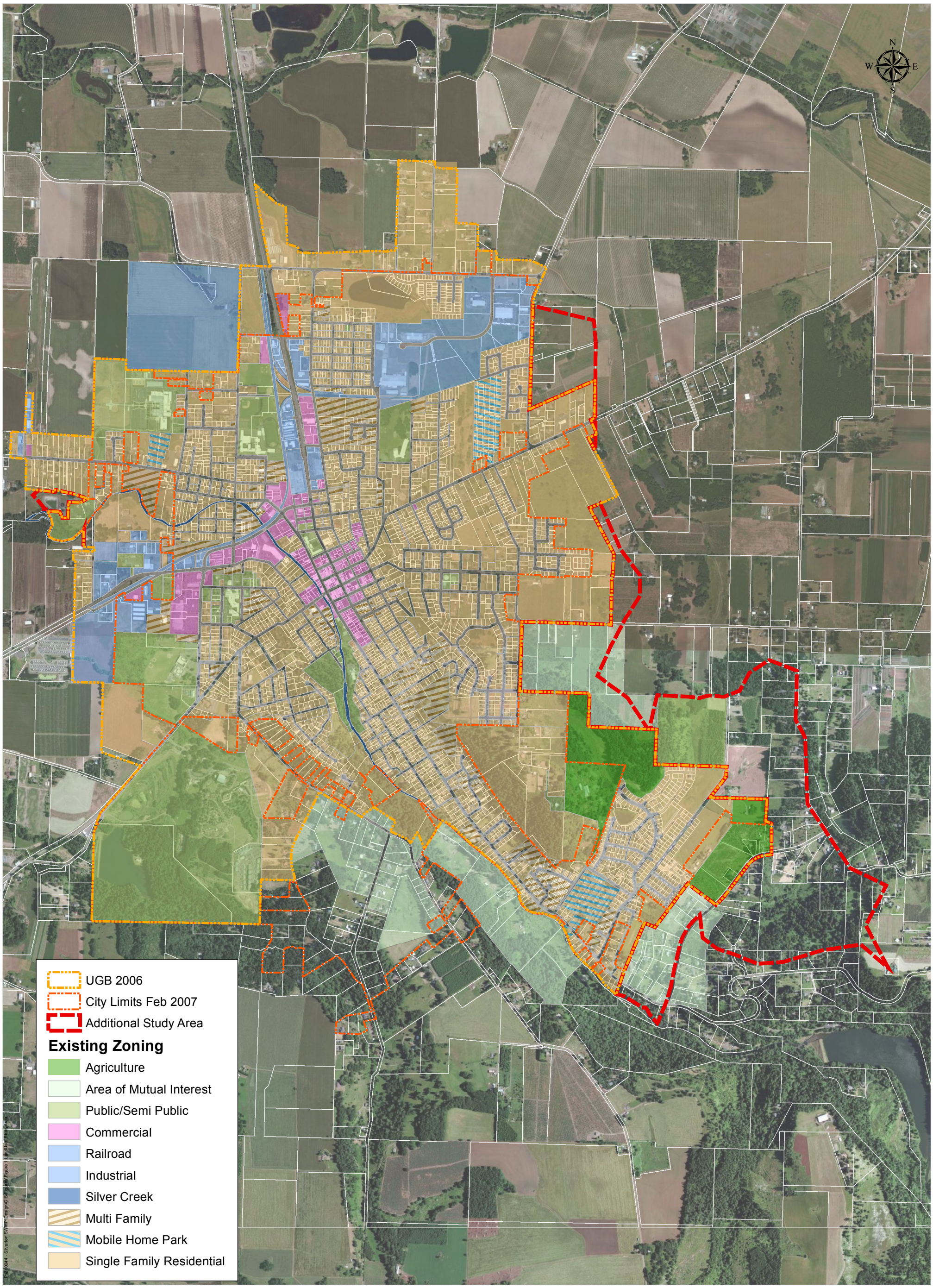


Figure:	Title:		Prepared for:	
1	Study Area and Land Use	STORM WATER MASTER PLAN 2012	CITY OF SILVERTON, OREGON	CITY OF SILVERTON · EST 1854 · OREGON'S GARDEN CITY KELLER associates

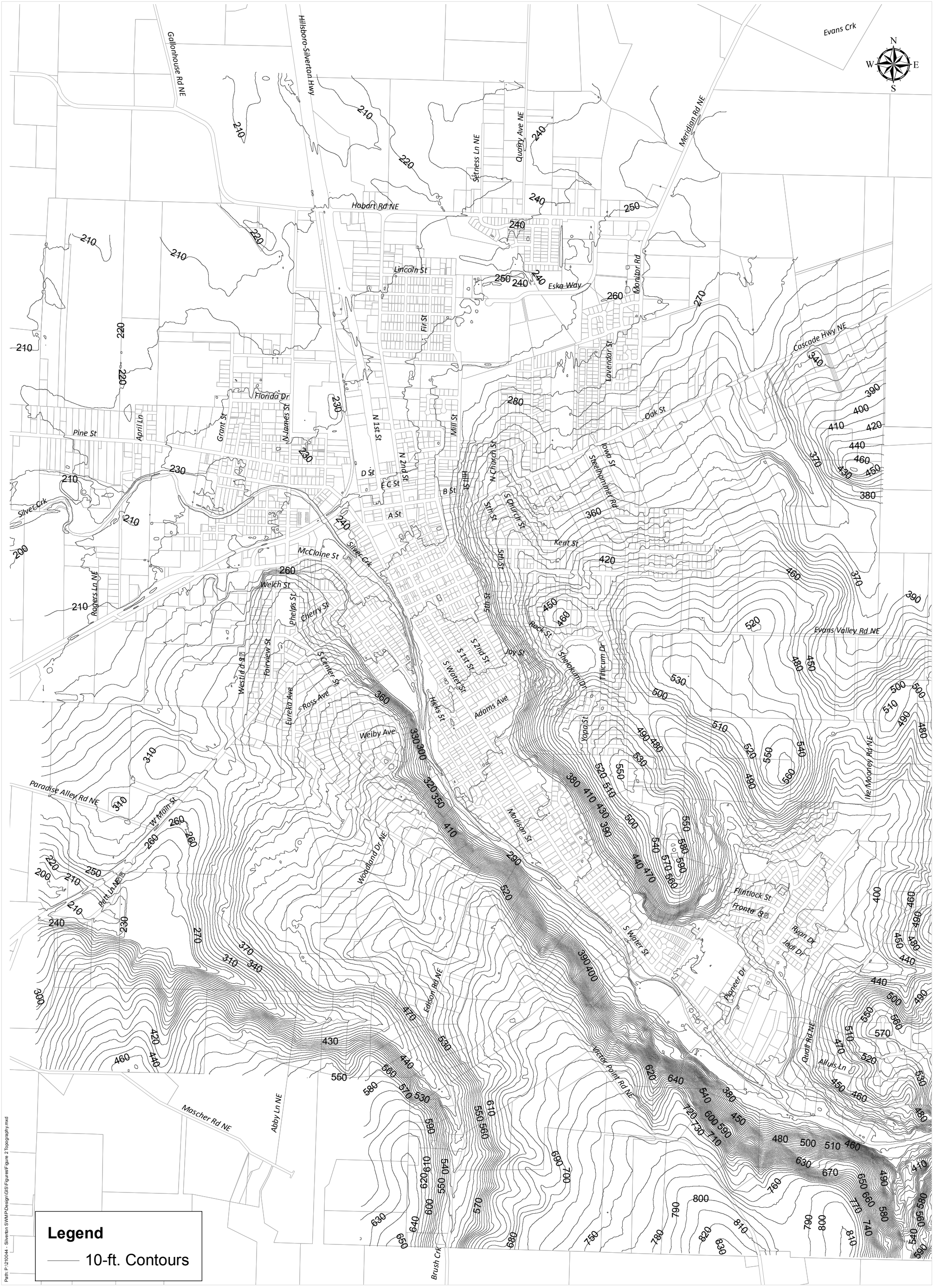


Figure:	Title:		Prepared for:	
2	Topography	STORM WATER MASTER PLAN 2012	CITY OF SILVERTON, OREGON	CITY OF SILVERTON · EST 1854 · OREGON'S GARDEN CITY KELLER associates

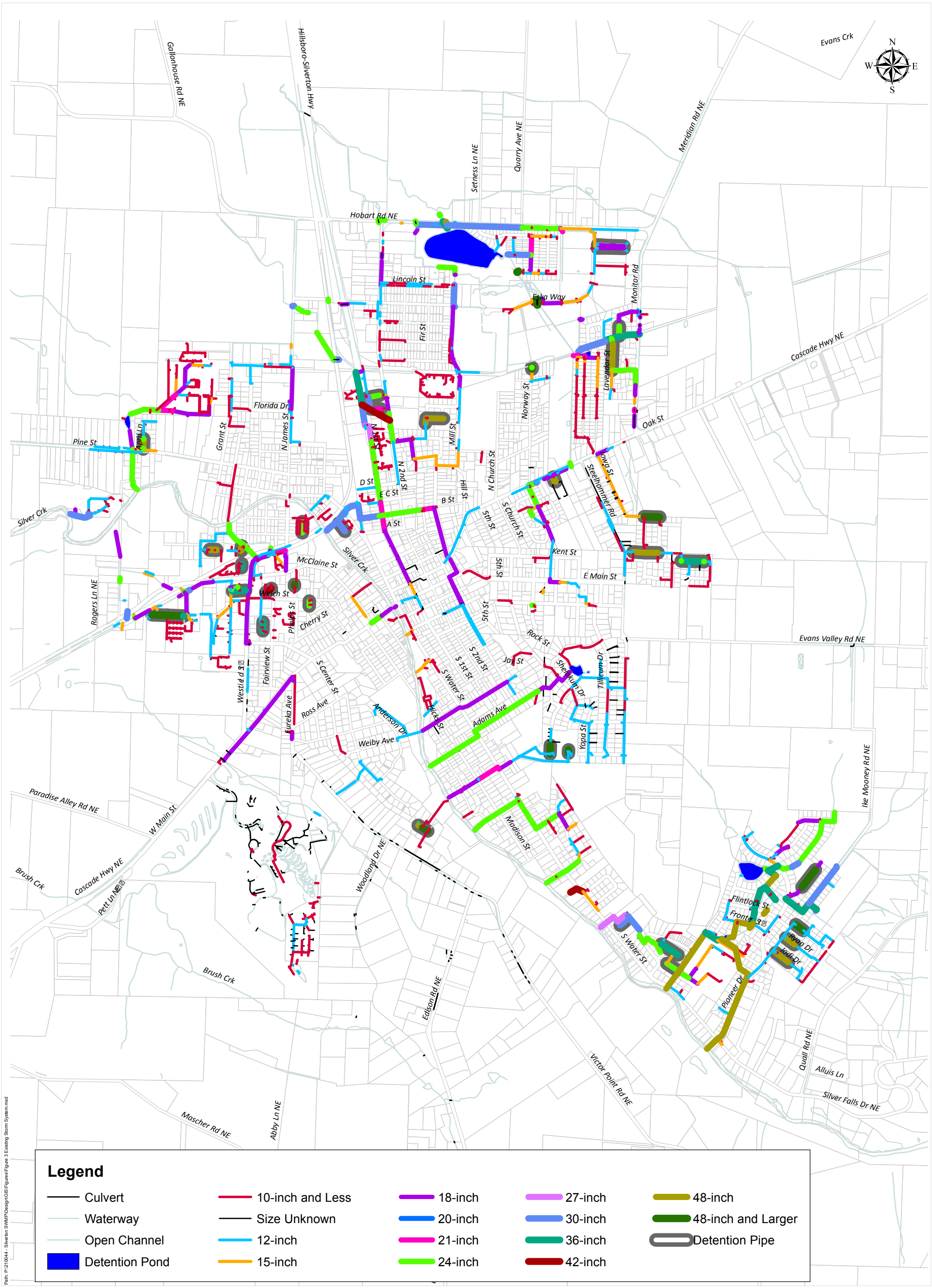
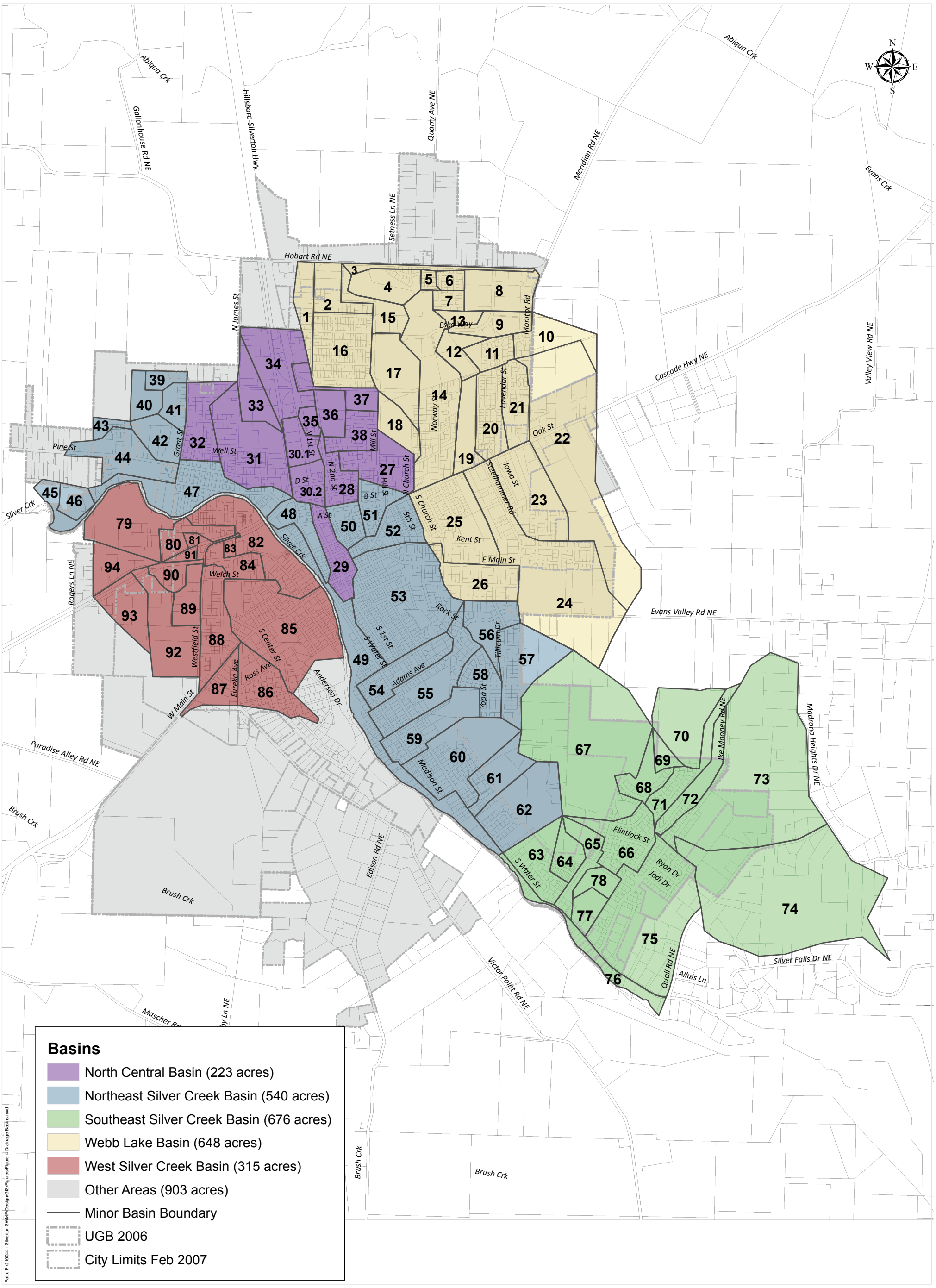


Figure:	Title:		Prepared for:	
3	Existing Storm System	STORM WATER MASTER PLAN 2012	CITY OF SILVERTON, OREGON	CITY OF SILVERTON · EST 1854 · OREGON'S GARDEN CITY KELLER associates



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4	Major and Minor Drainage Basins	STORM WATER MASTER PLAN 2012	CITY OF SILVERTON, OREGON	KELLER associates

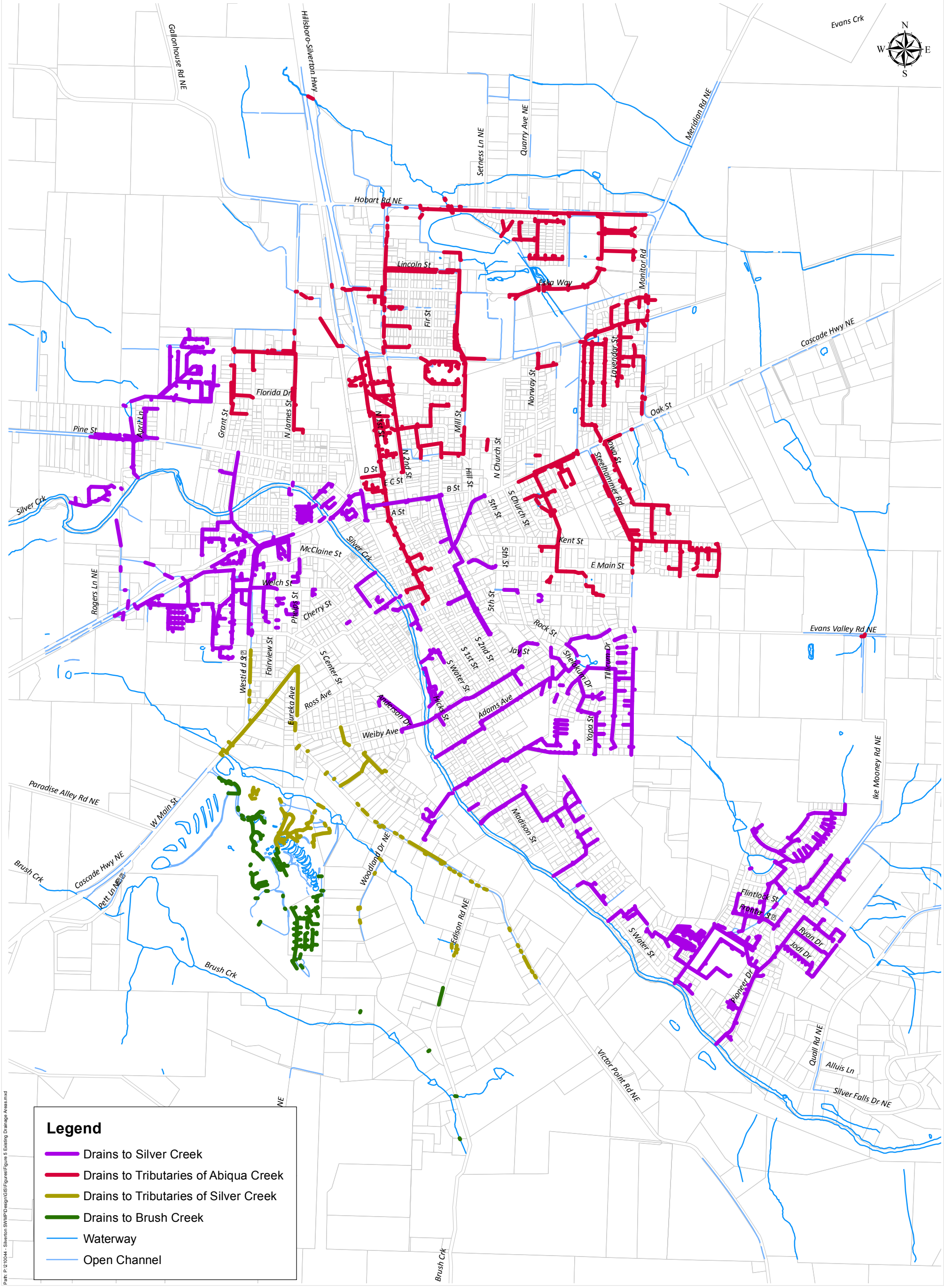

Figure:	Title:		Prepared for:	
5	Existing Drainage Areas	STORM WATER MASTER PLAN 2012	CITY OF SILVERTON, OREGON	CITY OF SILVERTON · EST 1854 · OREGON'S GARDEN CITY KELLER associates

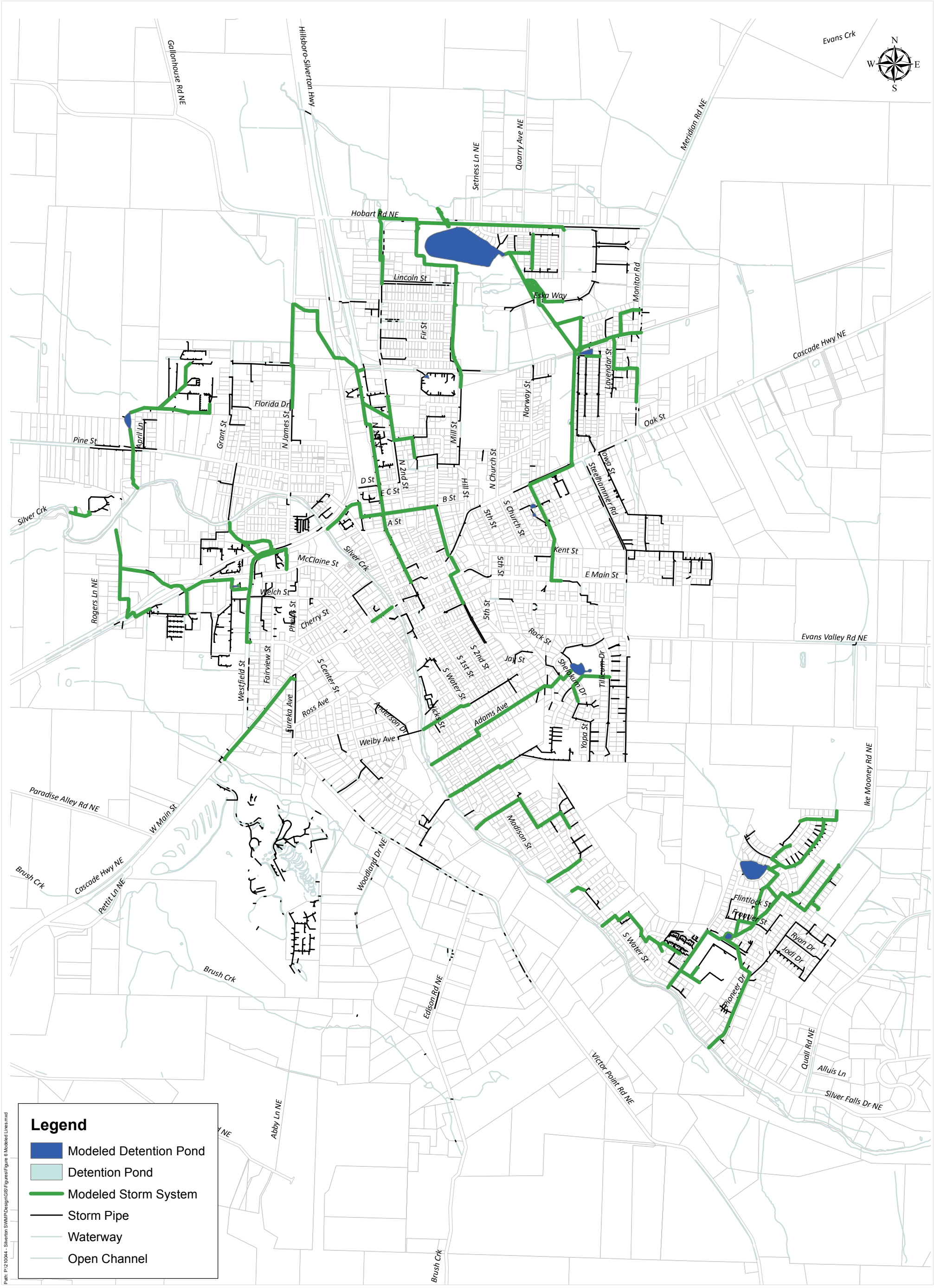

Figure:	Title:	STORM WATER MASTER PLAN 2012	Prepared for: CITY OF SILVERTON, OREGON	
6	Modeled Lines			CITY OF SILVERTON · EST 1854 · OREGON'S GARDEN CITY KELLER associates

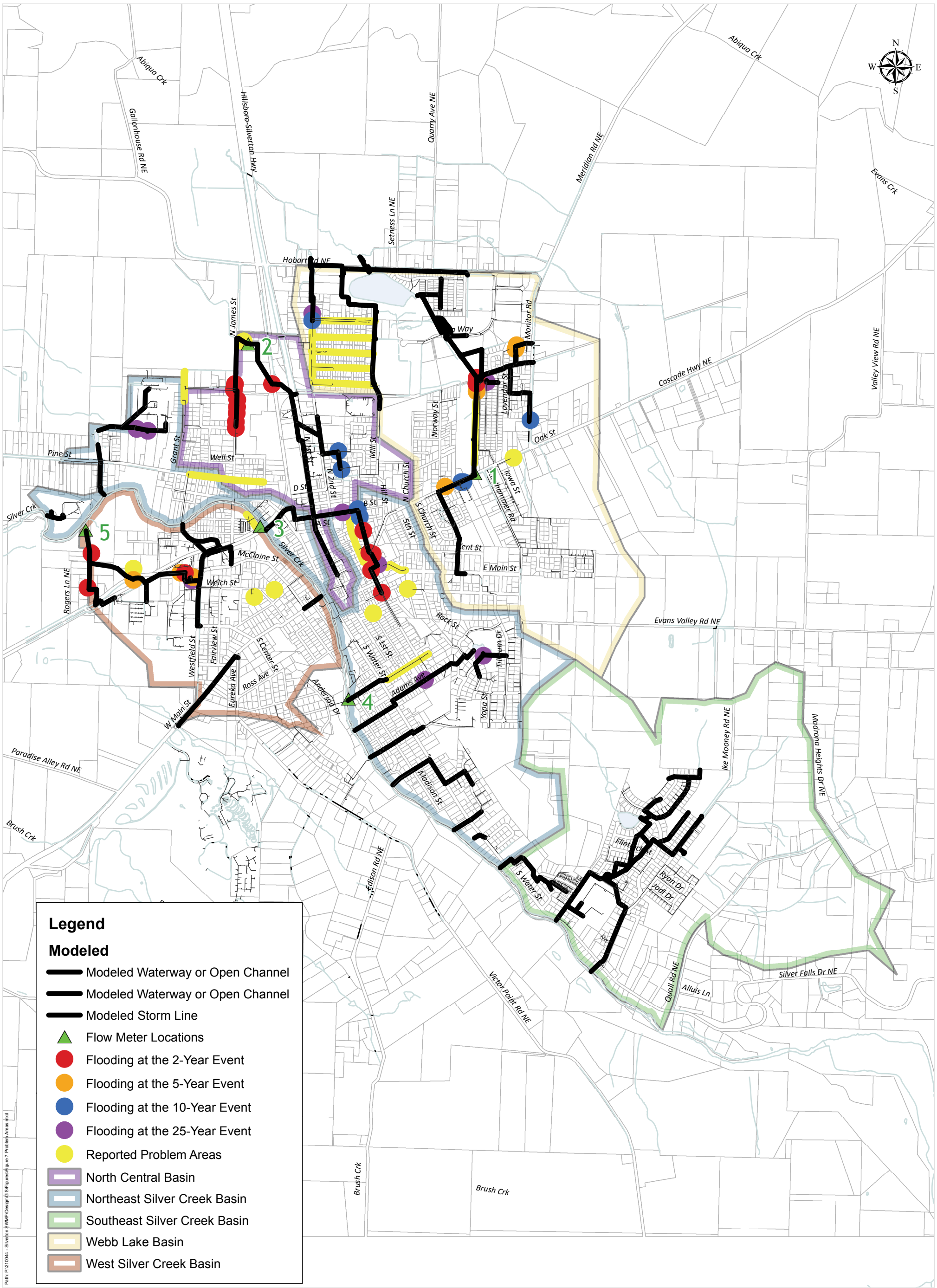

Figure:	Title:		Prepared for:	
7	Problem Areas	STORM WATER MASTER PLAN 2012	CITY OF SILVERTON, OREGON	CITY OF SILVERTON · EST 1854 · OREGON'S GARDEN CITY KELLER associates

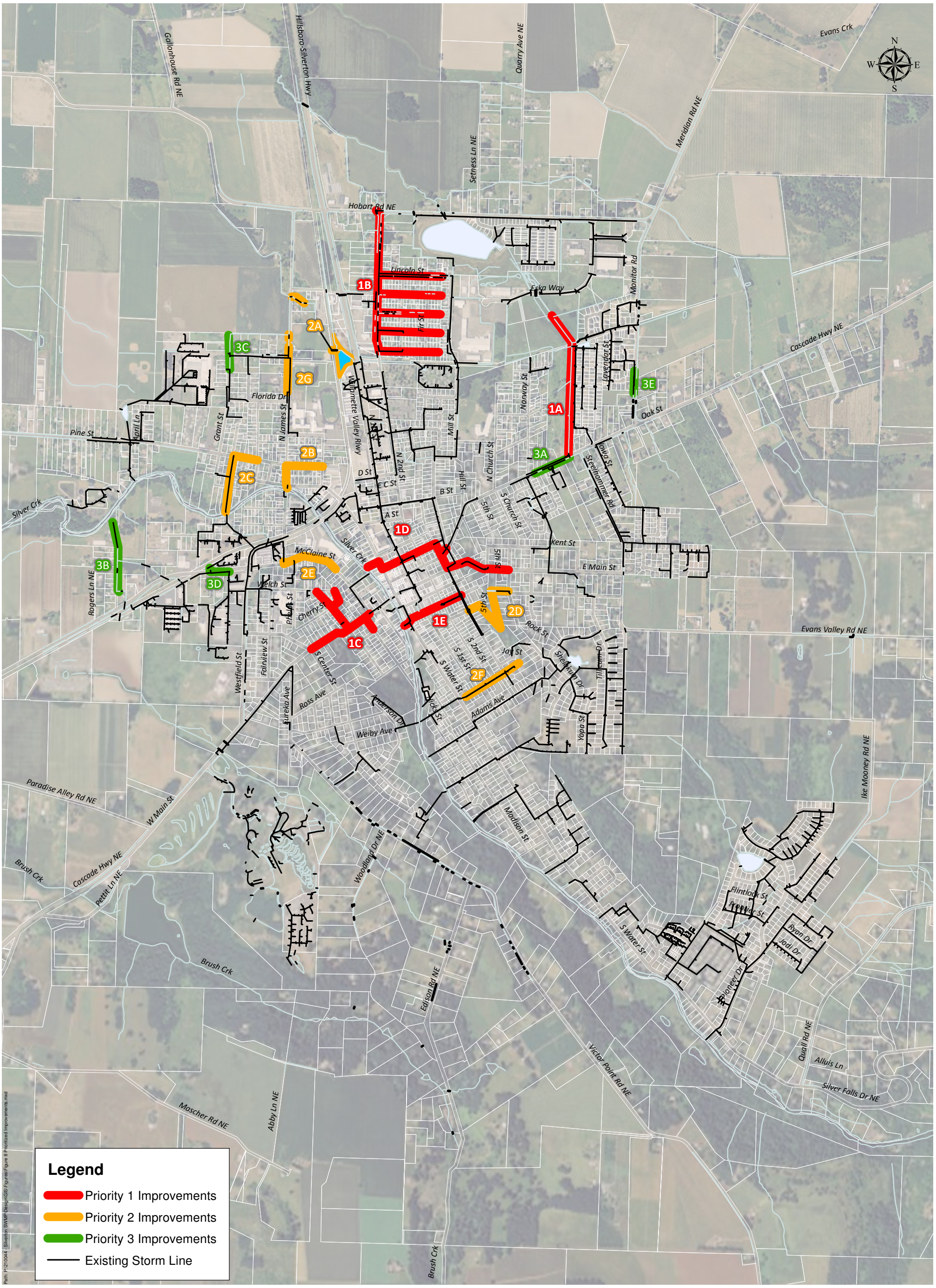

Figure:	Title:		Prepared for:	
8	Prioritized Improvements	STORM WATER MASTER PLAN 2012	CITY OF SILVERTON, OREGON	CITY OF SILVERTON EST 1854 OREGON'S GARDEN CITY / KELLER associates

Appendix B

study area data ▪ master plan

B.1 – Soil Types and Description
B.2 – Silver Creek FEMA Information
B.3 – Oregon Drainage Law – ODOT Interpretation
B.4 – Oregon Drainage Law – Marion County Interpretation

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Appendix B

study area data ▪ master plan

KELLER associates

B.1 Soil Types and Description

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United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Marion County Area, Oregon

Silverton SWMP Study Area

February 6, 2012

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://soils.usda.gov/sqi/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://soils.usda.gov/contact/state_offices/).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Soil Data Mart Web site or the NRCS Web Soil Survey. The Soil Data Mart is the data storage site for the official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

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Custom Soil Resource Report
Soil Map

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Units

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Gully

Short Steep Slope

Other

Political Features

Cities

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

MAP INFORMATION

Map Scale: 1:28,200 if printed on B size (11" × 17") sheet.

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Marion County Area, Oregon
Survey Area Data: Version 8, Feb 9, 2010

Date(s) aerial images were photographed: 8/4/2005; 8/3/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Marion County Area, Oregon (OR643)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AbA	Abiqua silty clay loam, 0 to 3 percent slopes	154.3	4.7%
AbB	Abiqua silty clay loam, 3 to 5 percent slopes	0.5	0.0%
Am	Amity silt loam	315.3	9.5%
Ca	Camas gravelly sandy loam	6.8	0.2%
Ck	Clackamas gravelly loam	63.8	1.9%
Cm	Cloquato silt loam	16.3	0.5%
Co	Concord silt loam	176.0	5.3%
Cu	Courtney gravelly silty clay loam	19.8	0.6%
Da	Dayton silt loam	70.4	2.1%
MaA	McAlpin silty clay loam, 0 to 3 percent slopes	126.9	3.8%
Mb	McBee silty clay loam	18.3	0.6%
NeB	Nekia silty clay loam, 2 to 7 percent slopes	382.9	11.6%
NeC	Nekia silty clay loam, 7 to 12 percent slopes	314.6	9.5%
NeD	Nekia silty clay loam, 12 to 20 percent slopes	109.3	3.3%
NeE	Nekia silty clay loam, 20 to 30 percent slopes	119.5	3.6%
NeF	Nekia silty clay loam, 30 to 50 percent slopes	69.9	2.1%
NkC	Nekia stony silty clay loam, 2 to 12 percent slopes	18.5	0.6%
NsE	Nekia very stony silty clay loam, 2 to 30 percent slopes	84.3	2.5%
NsF	Nekia very stony silty clay loam, 30 to 50 percent slopes	238.0	7.2%
Nu	Newberg fine sandy loam	12.9	0.4%
Nw	Newberg silt loam	8.5	0.3%
Sa	Salem gravelly silt loam	192.8	5.8%
SuC	Silverton silt loam, 2 to 12 percent slopes	210.1	6.3%
SuD	Silverton silt loam, 12 to 20 percent slopes	14.9	0.4%
SvB	Stayton silt loam, 0 to 7 percent slopes	143.7	4.3%
Te	Terrace escarpments	17.7	0.5%
W	Water	33.4	1.0%
Wa	Waldo silty clay loam	7.6	0.2%
Wc	Wapato silty clay loam	40.8	1.2%
WtE	Witzel very stony silt loam, 3 to 40 percent slopes	137.8	4.2%
WuA	Woodburn silt loam, 0 to 3 percent slopes	141.5	4.3%
WuC	Woodburn silt loam, 3 to 12 percent slopes	47.7	1.4%
Totals for Area of Interest		**3,314.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly

indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Marion County Area, Oregon

AbA—Abiqua silty clay loam, 0 to 3 percent slopes

Map Unit Setting

Elevation: 250 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Abiqua and similar soils: 85 percent
Minor components: 5 percent

Description of Abiqua

Setting

Landform: Hills
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): 1
Land capability (nonirrigated): 1

Typical profile

0 to 21 inches: Silty clay loam
21 to 54 inches: Silty clay
54 to 72 inches: Silty clay loam

Minor Components

Waldo

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

AbB—Abiqua silty clay loam, 3 to 5 percent slopes

Map Unit Setting

Elevation: 250 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Abiqua and similar soils: 100 percent

Description of Abiqua

Setting

Landform: Hills
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 2e

Typical profile

0 to 21 inches: Silty clay loam
21 to 54 inches: Silty clay
54 to 72 inches: Silty clay loam

Am—Amity silt loam

Map Unit Setting

Elevation: 120 to 350 feet
Mean annual precipitation: 40 to 45 inches

Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition
Amity and similar soils: 85 percent
Minor components: 5 percent

Description of Amity

Setting
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, convex
Across-slope shape: Linear
Parent material: Mixed silty alluvium

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 12.0 inches)

Interpretive groups
Land capability classification (irrigated): 2w
Land capability (nonirrigated): 2w

Typical profile
0 to 24 inches: Silt loam
24 to 37 inches: Silty clay loam
37 to 60 inches: Silt loam

Minor Components

Concord
Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave

Ca—Camas gravelly sandy loam

Map Unit Setting
Elevation: 130 to 500 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F

Frost-free period: 200 to 210 days

Map Unit Composition

Camas and similar soils: 85 percent

Description of Camas

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Recent alluvium derived from igneous and sedimentary rock

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water capacity: Very low (about 2.8 inches)

Interpretive groups

Land capability classification (irrigated): 4w
Land capability (nonirrigated): 4w

Typical profile

0 to 9 inches: Gravelly sandy loam
9 to 60 inches: Very gravelly sand

Ck—Clackamas gravelly loam

Map Unit Setting

Elevation: 170 to 800 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 165 to 210 days

Map Unit Composition

Clackamas and similar soils: 85 percent
Minor components: 8 percent

Description of Clackamas

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly mixed alluvium

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w

Typical profile

0 to 15 inches: Gravelly loam
15 to 24 inches: Gravelly clay loam
24 to 60 inches: Extremely gravelly clay loam

Minor Components

Courtney

Percent of map unit: 8 percent
Landform: Terraces

Cm—Cloquato silt loam

Map Unit Setting

Elevation: 100 to 650 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition

Cloquato and similar soils: 85 percent

Description of Cloquato

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water capacity: High (about 10.9 inches)

Interpretive groups
Land capability (nonirrigated): 2w

Typical profile
0 to 9 inches: Silt loam
9 to 41 inches: Silt loam
41 to 83 inches: Silt loam

Co—Concord silt loam

Map Unit Setting
Elevation: 120 to 350 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition
Concord and similar soils: 90 percent
Minor components: 10 percent

Description of Concord

Setting
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Mixed mineralogy alluvium

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water capacity: High (about 11.4 inches)

Interpretive groups
Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w

Typical profile
0 to 15 inches: Silt loam

15 to 29 inches: Silty clay
29 to 60 inches: Silt loam

Minor Components

Dayton

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave

Cu—Courtney gravelly silty clay loam

Map Unit Setting

Elevation: 170 to 650 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Courtney and similar soils: 85 percent

Description of Courtney

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Various aged alluvium

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water capacity: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): 4w
Land capability (nonirrigated): 4w

Typical profile

0 to 12 inches: Gravelly silty clay loam
12 to 24 inches: Gravelly clay
24 to 49 inches: Very gravelly clay loam

49 to 60 inches: Very gravelly sand

Da—Dayton silt loam

Map Unit Setting

Elevation: 120 to 350 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Dayton and similar soils: 95 percent
Minor components: 5 percent

Description of Dayton

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Mixed alluvium with some loess in the upper layers

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 12 to 24 inches to abrupt textural change
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Land capability classification (irrigated): 4w
Land capability (nonirrigated): 4w

Typical profile

0 to 13 inches: Silt loam
13 to 46 inches: Clay
46 to 60 inches: Silty clay loam

Minor Components

Concord

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave

MaA—McAlpin silty clay loam, 0 to 3 percent slopes

Map Unit Setting

Elevation: 250 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Mcalpin and similar soils: 95 percent
Minor components: 2 percent

Description of Mcalpin

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 2e

Typical profile

0 to 23 inches: Silty clay loam
23 to 65 inches: Silty clay

Minor Components

Waldo

Percent of map unit: 2 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear

Mb—McBee silty clay loam

Map Unit Setting

Elevation: 100 to 650 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition

Mcbee and similar soils: 85 percent
Minor components: 5 percent

Description of Mcbee

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water capacity: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability (nonirrigated): 2w

Typical profile

0 to 10 inches: Silty clay loam
10 to 65 inches: Clay loam

Minor Components

Wapato

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Linear

NeB—Nekia silty clay loam, 2 to 7 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Nekia and similar soils: 85 percent
Minor components: 2 percent

Description of Nekia

Setting

Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 3e

Typical profile

0 to 9 inches: Silty clay loam
9 to 36 inches: Clay
36 to 40 inches: Unweathered bedrock

Minor Components

Aquults

Percent of map unit: 2 percent
Landform: Hills

NeC—Nekia silty clay loam, 7 to 12 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Nekia and similar soils: 86 percent
Minor components: 2 percent

Description of Nekia

Setting

Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities

Slope: 7 to 12 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 3e

Typical profile

0 to 9 inches: Silty clay loam
9 to 36 inches: Clay
36 to 40 inches: Unweathered bedrock

Minor Components

Aquults

Percent of map unit: 2 percent
Landform: Hills

NeD—Nekia silty clay loam, 12 to 20 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Nekia and similar soils: 90 percent

Description of Nekia

Setting

Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 3e

Typical profile

0 to 9 inches: Silty clay loam
9 to 36 inches: Clay
36 to 40 inches: Unweathered bedrock

NeE—Nekia silty clay loam, 20 to 30 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches

Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition
Nekia and similar soils: 92 percent

Description of Nekia

Setting
Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities
Slope: 20 to 30 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups
Land capability (nonirrigated): 4e

Typical profile
0 to 9 inches: Silty clay loam
9 to 36 inches: Clay
36 to 40 inches: Unweathered bedrock

NeF—Nekia silty clay loam, 30 to 50 percent slopes

Map Unit Setting
Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition
Nekia and similar soils: 92 percent

Description of Nekia

Setting
Landform: Hills
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Concave, linear

Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities

Slope: 30 to 50 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Land capability (nonirrigated): 6e

Typical profile

0 to 9 inches: Silty clay loam
9 to 36 inches: Clay
36 to 40 inches: Unweathered bedrock

NkC—Nekia stony silty clay loam, 2 to 12 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Nekia and similar soils: 90 percent

Description of Nekia

Setting

Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities

Slope: 2 to 12 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability (nonirrigated): 3e

Typical profile

0 to 9 inches: Stony silty clay loam
9 to 36 inches: Clay
36 to 46 inches: Unweathered bedrock

NsE—Nekia very stony silty clay loam, 2 to 30 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Nekia and similar soils: 85 percent

Description of Nekia

Setting

Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities

Slope: 2 to 30 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.1 inches)

Interpretive groups

Land capability (nonirrigated): 6s

Typical profile

0 to 9 inches: Very stony silty clay loam
9 to 36 inches: Clay
36 to 46 inches: Unweathered bedrock

NsF—Nekia very stony silty clay loam, 30 to 50 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Nekia and similar soils: 90 percent

Description of Nekia

Setting

Landform: Hills
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Residuum weathered from tuffs and basalt

Properties and qualities

Slope: 30 to 50 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.1 inches)

Interpretive groups

Land capability (nonirrigated): 6s

Typical profile

0 to 9 inches: Very stony silty clay loam
9 to 36 inches: Clay
36 to 46 inches: Unweathered bedrock

Nu—Newberg fine sandy loam

Map Unit Setting

Elevation: 100 to 650 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition

Newberg and similar soils: 85 percent

Description of Newberg

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium over sandy or gravelly material

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water capacity: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability (nonirrigated): 2w

Typical profile

0 to 10 inches: Fine sandy loam
10 to 60 inches: Sandy loam

Nw—Newberg silt loam

Map Unit Setting

Elevation: 100 to 650 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition

Newberg and similar soils: 100 percent

Description of Newberg

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium over sandy or gravelly material

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water capacity: High (about 9.2 inches)

Interpretive groups
Land capability classification (irrigated): 2w
Land capability (nonirrigated): 2w

Typical profile
0 to 10 inches: Silt loam
10 to 60 inches: Sandy loam

Sa—Salem gravelly silt loam

Map Unit Setting
Elevation: 100 to 600 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition
Salem and similar soils: 90 percent

Description of Salem

Setting
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly mixed alluvium

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups
Land capability classification (irrigated): 2s
Land capability (nonirrigated): 2s

Typical profile
0 to 9 inches: Gravelly silt loam

9 to 30 inches: Gravelly clay loam
30 to 60 inches: Very gravelly sand

SuC—Silverton silt loam, 2 to 12 percent slopes

Map Unit Setting

Elevation: 230 to 300 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition

Silverton and similar soils: 90 percent

Description of Silverton

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty material over fine-textured material that contains gravel

Properties and qualities

Slope: 2 to 12 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 6.9 inches)

Interpretive groups

Land capability (nonirrigated): 2e

Typical profile

0 to 16 inches: Silt loam
16 to 25 inches: Silty clay loam
25 to 37 inches: Gravelly silty clay
37 to 47 inches: Unweathered bedrock

SuD—Silverton silt loam, 12 to 20 percent slopes

Map Unit Setting

Elevation: 230 to 300 feet
Mean annual precipitation: 40 to 45 inches

Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition
Silverton and similar soils: 90 percent

Description of Silverton

Setting
Landform: Terraces
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty material over fine-textured material that contains gravel

Properties and qualities
Slope: 12 to 20 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 6.9 inches)

Interpretive groups
Land capability (nonirrigated): 3e

Typical profile
0 to 16 inches: Silt loam
16 to 25 inches: Silty clay loam
25 to 37 inches: Gravelly silty clay
37 to 41 inches: Unweathered bedrock

SvB—Stayton silt loam, 0 to 7 percent slopes

Map Unit Setting
Elevation: 250 to 1,200 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition
Stayton and similar soils: 97 percent
Minor components: 3 percent

Description of Stayton

Setting
Landform: Hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Nose slope, interfluve, crest

Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium over basalt

Properties and qualities

Slope: 0 to 7 percent
Depth to restrictive feature: 12 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.0 inches)

Interpretive groups

Land capability (nonirrigated): 6e

Typical profile

0 to 12 inches: Silt loam
12 to 20 inches: Silt loam
20 to 24 inches: Unweathered bedrock

Minor Components

Aquands

Percent of map unit: 3 percent
Landform: Hills

Te—Terrace escarpments

Map Unit Setting

Elevation: 50 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 165 to 210 days

Map Unit Composition

Terrace escarpments: 100 percent

Description of Terrace Escarpments

Properties and qualities

Slope: 20 to 40 percent
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 36 to 72 inches
Available water capacity: Moderate (about 8.0 inches)

Interpretive groups

Land capability (nonirrigated): 6e

Typical profile

0 to 8 inches: Silt loam
8 to 48 inches: Gravelly loam
48 to 60 inches: Very cobbly clay loam

W—Water

Map Unit Composition

Water: 100 percent

Wa—Waldo silty clay loam

Map Unit Setting

Elevation: 250 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days

Map Unit Composition

Waldo and similar soils: 90 percent
Minor components: 5 percent

Description of Waldo

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water capacity: High (about 10.0 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w

Typical profile

0 to 10 inches: Silty clay loam
10 to 60 inches: Clay

Minor Components

Aquolls, very poorly drained

Percent of map unit: 5 percent
Landform: Flood plains

Wc—Wapato silty clay loam

Map Unit Setting

Elevation: 100 to 650 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition

Wapato and similar soils: 90 percent

Description of Wapato

Setting

Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Available water capacity: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability (nonirrigated): 3w

Typical profile

0 to 16 inches: Silty clay loam
16 to 60 inches: Silty clay loam

WtE—Witzel very stony silt loam, 3 to 40 percent slopes

Map Unit Setting

Elevation: 300 to 1,000 feet
Mean annual precipitation: 40 to 60 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 200 days

Map Unit Composition

Witzel and similar soils: 95 percent

Description of Witzel

Setting

Landform: Hills
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Crest, interfluve, nose slope, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived partly from loess but mainly from basic igneous rock

Properties and qualities

Slope: 3 to 40 percent
Depth to restrictive feature: 12 to 20 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 1.3 inches)

Interpretive groups

Land capability (nonirrigated): 6s

Typical profile

0 to 4 inches: Very stony silt loam
4 to 19 inches: Very stony silty clay loam
19 to 23 inches: Unweathered bedrock

WuA—Woodburn silt loam, 0 to 3 percent slopes

Map Unit Setting

Elevation: 150 to 350 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F

Frost-free period: 200 to 210 days

Map Unit Composition

Woodburn and similar soils: 85 percent
Minor components: 1 percent

Description of Woodburn

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and mixed mineralogy loess

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 25 to 32 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability (nonirrigated): 2w

Typical profile

0 to 17 inches: Silt loam
17 to 32 inches: Silty clay loam
32 to 68 inches: Silt loam

Minor Components

Aquolls, somewhat poorly drained

Percent of map unit: 1 percent
Landform: Terraces

WuC—Woodburn silt loam, 3 to 12 percent slopes

Map Unit Setting

Elevation: 150 to 350 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days

Map Unit Composition

Woodburn and similar soils: 95 percent

Minor components: 5 percent

Description of Woodburn

Setting

Landform: Terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and mixed mineralogy loess

Properties and qualities

Slope: 3 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 25 to 32 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability (nonirrigated): 2e

Typical profile

0 to 17 inches: Silt loam
17 to 32 inches: Silty clay loam
32 to 68 inches: Silt loam

Minor Components

Aquolls, poorly drained

Percent of map unit: 5 percent
Landform: Terraces

References

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Appendix B

study area data ▪ master plan

B.2 Silver Creek FEMA Information

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	August 30, 1974	June 5, 1997	January 19, 2000
	November 1, 1974	June 30, 1976	January 19, 2000
	N/A	N/A	N/A
	July 2, 1976	December 4, 1979	January 19, 2000
	N/A	N/A	N/A
	May 10, 1974	February 5, 1986	January 19, 2000
	August 30, 1974	March 1, 1979	January 19, 2000
	February 1, 1974	March 1, 1979	January 19, 2000
	May 1, 1985	May 1, 1985	January 19, 2000
	N/A	N/A	N/A
63,364,375,652,656,657,676,677	August 9, 1974	June 15, 1979	January 02, 2003
	December 20, 1974	March 1, 1979	January 19, 2000
	May 10, 1974	March 1, 1979	January 19, 2000
	January 23, 1974	March 1, 1979	January 19, 2000
	N/A	N/A	N/A
	N/A	N/A	N/A
	January 16, 1974	April 2, 1979	January 02, 2003
	May 24, 1974	March 1, 1979	January 19, 2000
	January 24, 1975	August 15, 1979	January 02, 2003

ORIES

hot for distribution)

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om 325

City of Scotts Mills
c\o Katherina Martin, City Recorder
871 Grandview Heights
Scotts Mills, OR 97375

City of Silverton
City Hall
306 South Water Street
Silverton, OR 97381

City of Stayton
City Administration Hall
362 North 3rd Avenue
Stayton, OR 97383

City of Turner
7250 3rd Street
Turner, OR 97392

City of Woodburn
City Hall
270 Montgomery Street
Woodburn, OR 97071

ELEVATION DATUM

Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, contact the National Geodetic Survey at the following address:

The Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East West Highway
Silver Spring, Maryland 20910
(301) 713–3191

BASE MAP SOURCE

Base map data have been obtained from Marion County

NOTICE

Future revisions to this FIRM Index will only be issued to communities that are located on the FIRM panels being revised. Therefore, this FIRM Index remains valid for FIRM panels dated January 2, 2003 or earlier. Please refer to the "MOST RECENT FIRM PANEL DATE" column in the *LISTING OF COMMUNITIES* table to determine the most recent FIRM Index date for each community.

This FIRM Index displays the map dates for each FIRM panel at the time that this Index was printed. Because this Index may not be distributed to unaffected communities in subsequent revisions, users may determine the most current map date for each FIRM panel by visiting the FEMA Map Service Center website at http://web1.msc.fema.gov, or by calling the Map Service Center at 1–800–358–9616.

Communities annexing land on adjacent FIRM panels must obtain current copies of the adjacent panels as well as the current FIRM Index. These may be ordered directly from the Map Service Center at the number listed above.

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

MARION COUNTY, OREGON AND INCORPORATED AREAS

(SEE TABLE SHOWN ABOVE FOR LISTING OF COMMUNITIES)

MAP INDEX

PANELS PRINTED:25,50,75,100,117,119, 125,130,131,132,133,134,136,137,138, 139,141,145,175,192,193,194,200,213, 225,243,244,250,266,275,325,327,328, 329,331,332,333,334,336,337,338,339, 341,342,343,344,351,361,363,364,375, 382,400,425,650,652,656,657,675,676, 677,679,681,682,683,684,700,701,703, 704,708,716,725,750,775,793,794,800, 975,1000,1025,1060,1078,1079,1083

MAP NUMBER
41047CIND0

MAP REVISED:
JANUARY 2, 2003

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

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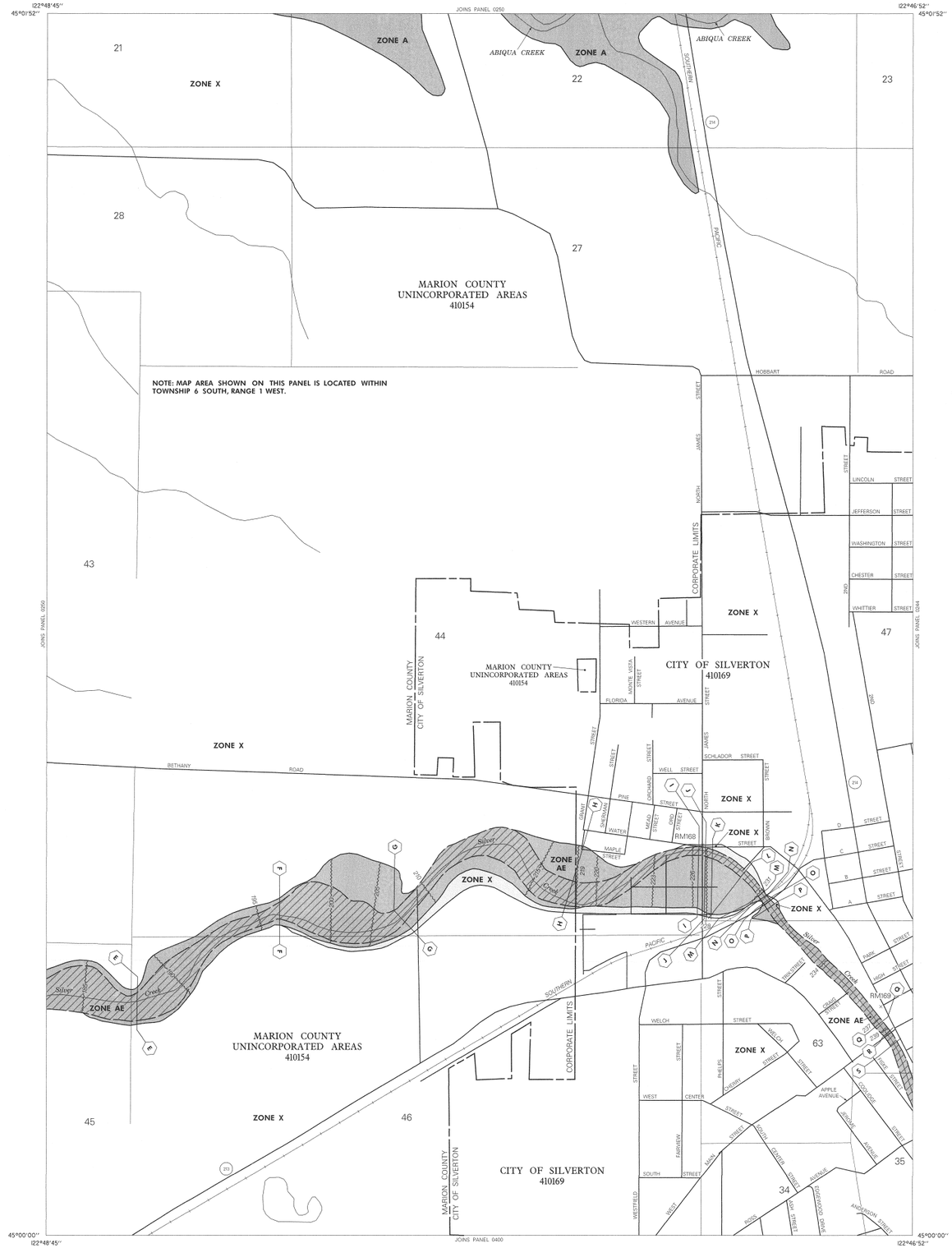
ELEVATION REFERENCE MARKS

REFERENCE MARK	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
RM168	231.914	Oregon State Highway Department brass disk stamped A444 1951, located at northwest corner of South James Street bridge at intersection of South James and Water Streets.
RM169	249.146	USC&GS brass cap stamped SOR 248 1935, located in west curb of Water Street at dead end of Oak Street, approximately 7 feet west of centerline of Oak Street in front of Western Auto Hardware Store.



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100-year flood by Federal flood protection system under construction; no base flood elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500-year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

~~~513~~~ Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

D—D Cross Section Line

(EL 987) Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 × Elevation Reference Mark

• M2 River Mile

97°07'30", 32°22'30" Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.

NOTES

This map is for use in administering the National Flood Insurance Program; it does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size, or all planimetric features outside Special Flood Hazard Areas. The community map repository should be consulted for more detailed data on BFE's, and for any information on floodway delineations, prior to use of this map for property purchase or construction purposes.

Areas of Special Flood Hazard (100-year flood) include Zones A, AE, A1-A30, AH, AO, A99, V, VE and V1-V30.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Refer to Floodway Data Table where floodway width is shown at 1/20 inch.

Coastal base flood elevations apply only landward of 0.0 NGVD, and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

This map may incorporate approximate boundaries of Coastal Barrier Resource System Units and /or Otherwise Protected Areas established under the Coastal Barrier Improvement Act of 1990 (PL 101-591).

For community map revision history prior to countywide mapping, see Section 6.0 of the Flood Insurance Study Report.

For adjoining map panels and base map source see separately printed Map Index.

MAP REPOSITORY
Refer to Repository Listing on Map Index

EFFECTIVE DATE OF
COUNTYWIDE FLOOD INSURANCE RATE MAP:
JANUARY 19, 2000

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL:

Refer to the FLOOD INSURANCE RATE MAP EFFECTIVE DATE shown on this map to determine when actuarial rates apply to structures in zones where elevations or depths have been established.

To determine if flood insurance is available, contact an insurance agent or call the National Flood Insurance Program at (800-638-6620).

APPROXIMATE SCALE IN FEET
500 0 500

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

MARION COUNTY,
OREGON AND
INCORPORATED AREAS

PANEL 243 OF 150
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS: COMMUNITY	NUMBER	PANEL	SUFFIX
SILVERTON, CITY OF	410169	0243	G
MARION COUNTY, UNINCORPORATED AREAS	410154	0243	G

MAP NUMBER
41047C0243 G

EFFECTIVE DATE:
JANUARY 19, 2000

Federal Emergency Management Agency
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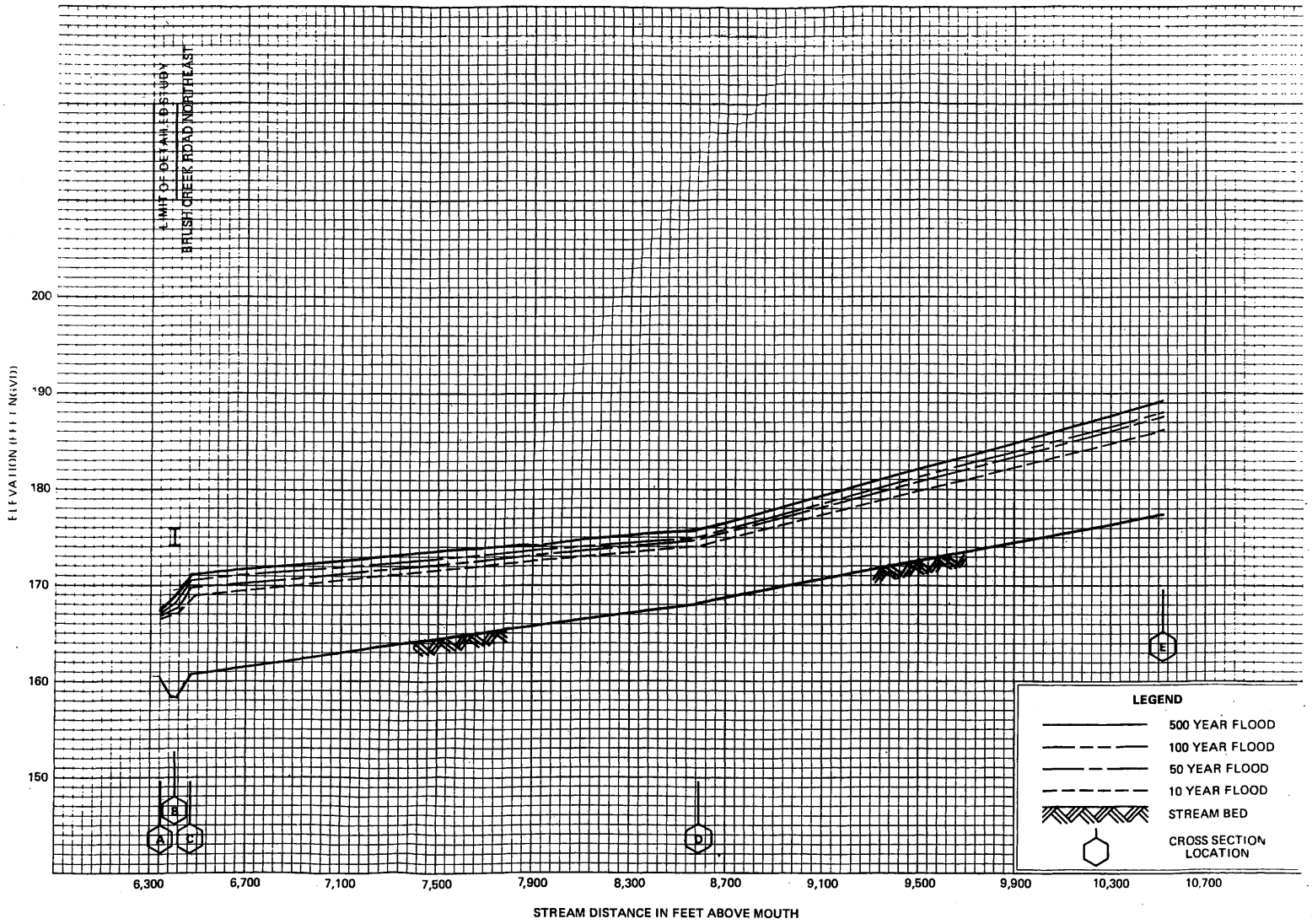
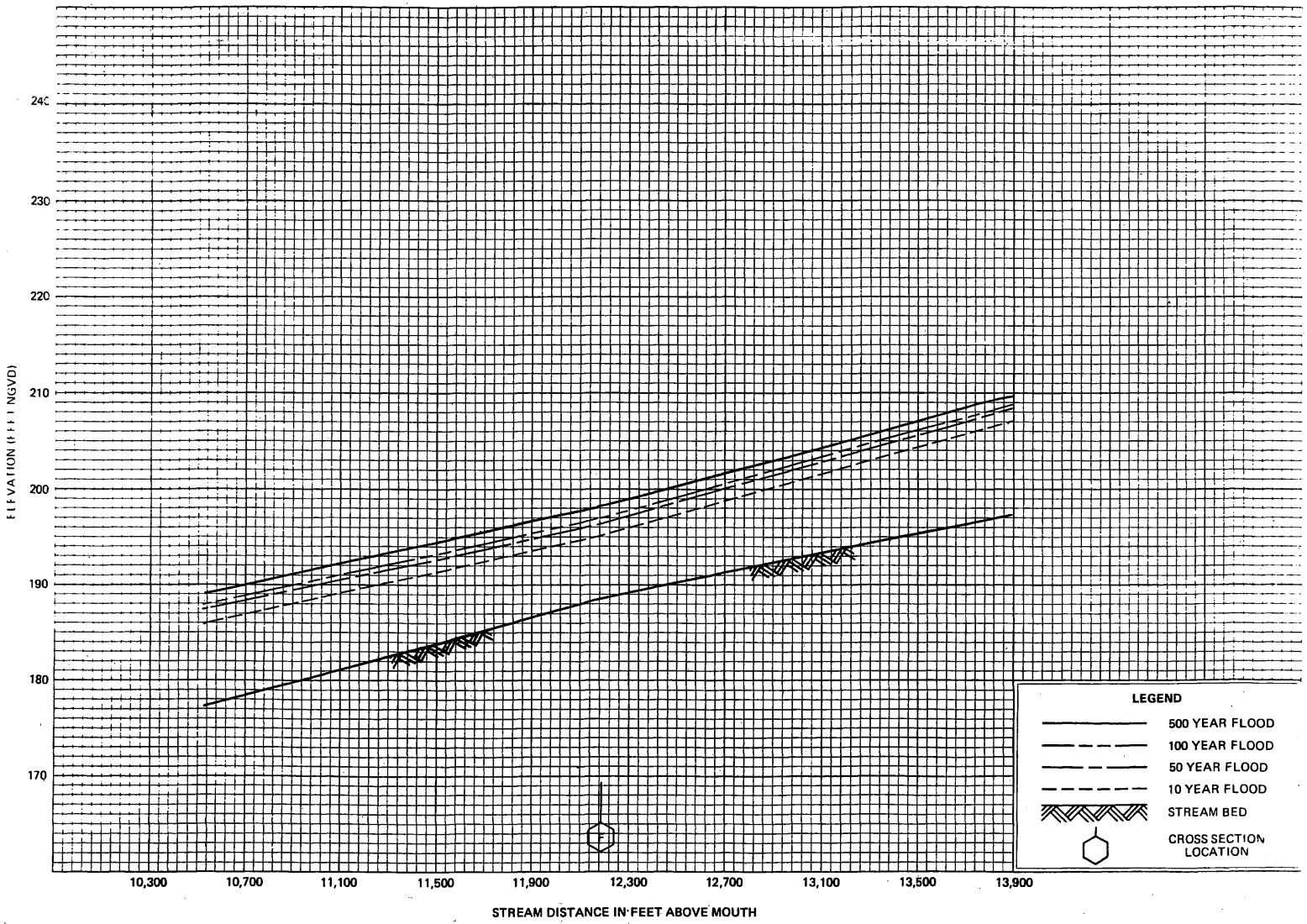


FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARION COUNTY, OR
AND INCORPORATED AREAS

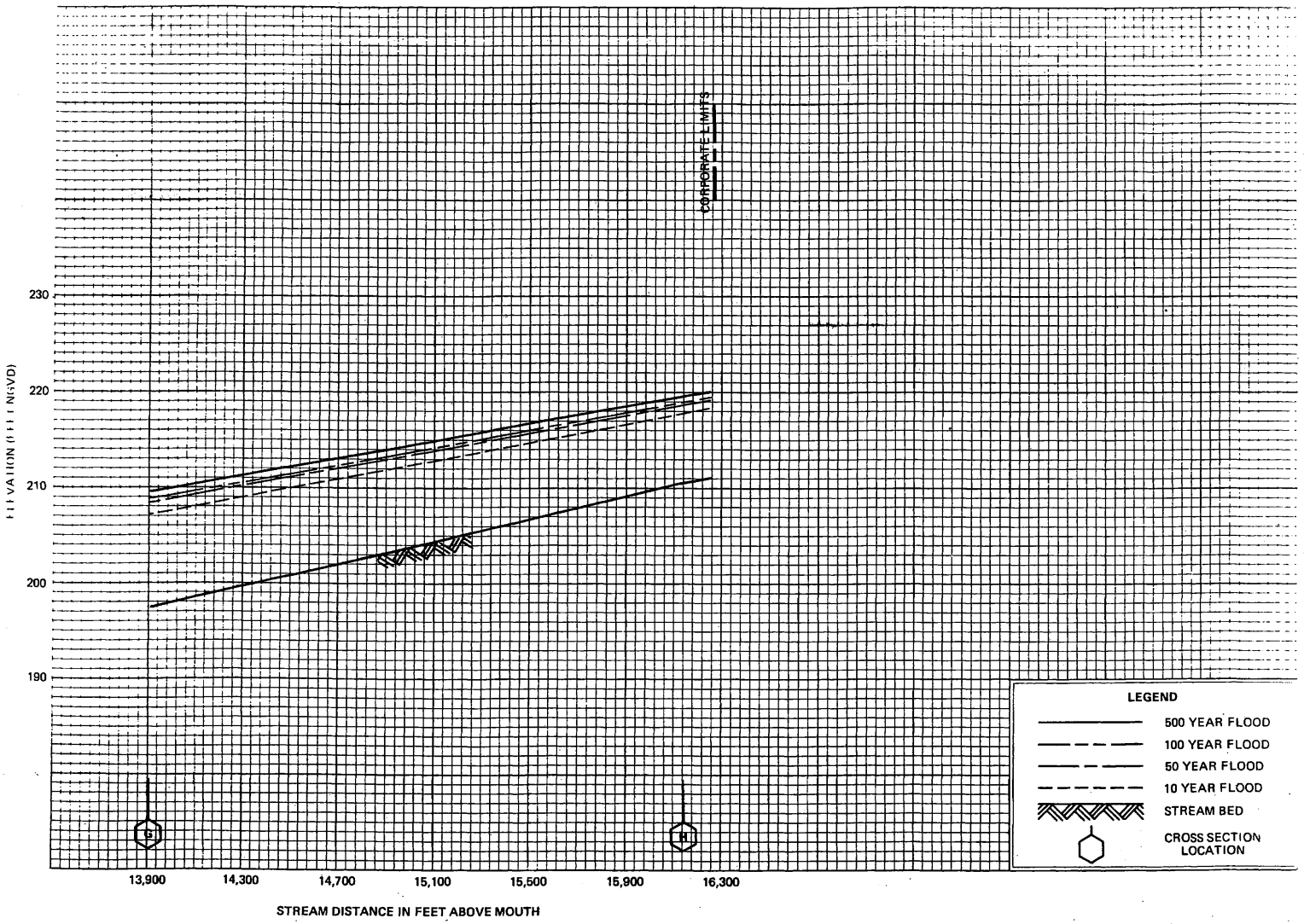


FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARION COUNTY, OR
AND INCORPORATED AREAS

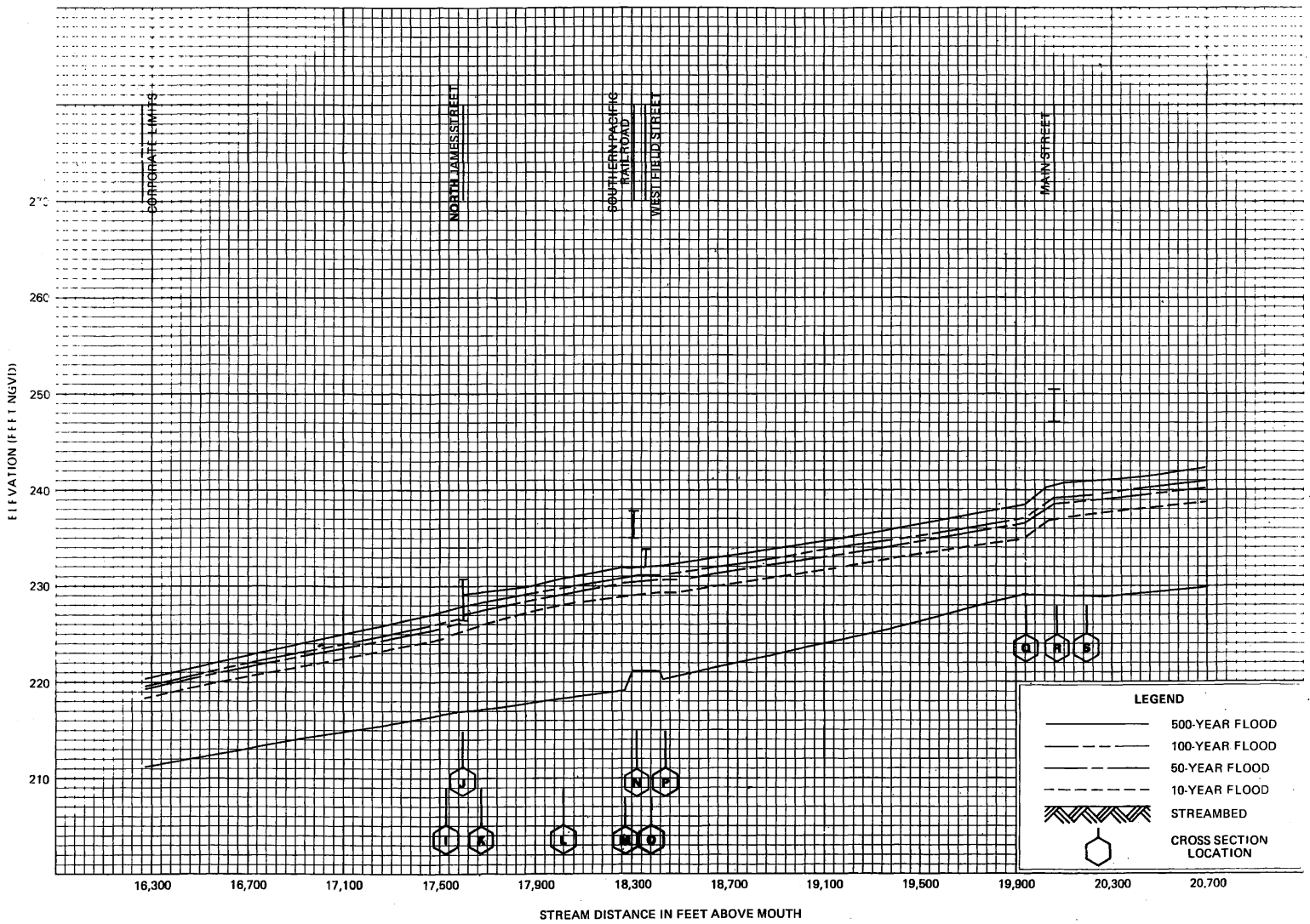


FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARION COUNTY OR
AND INCORPORATED AREAS



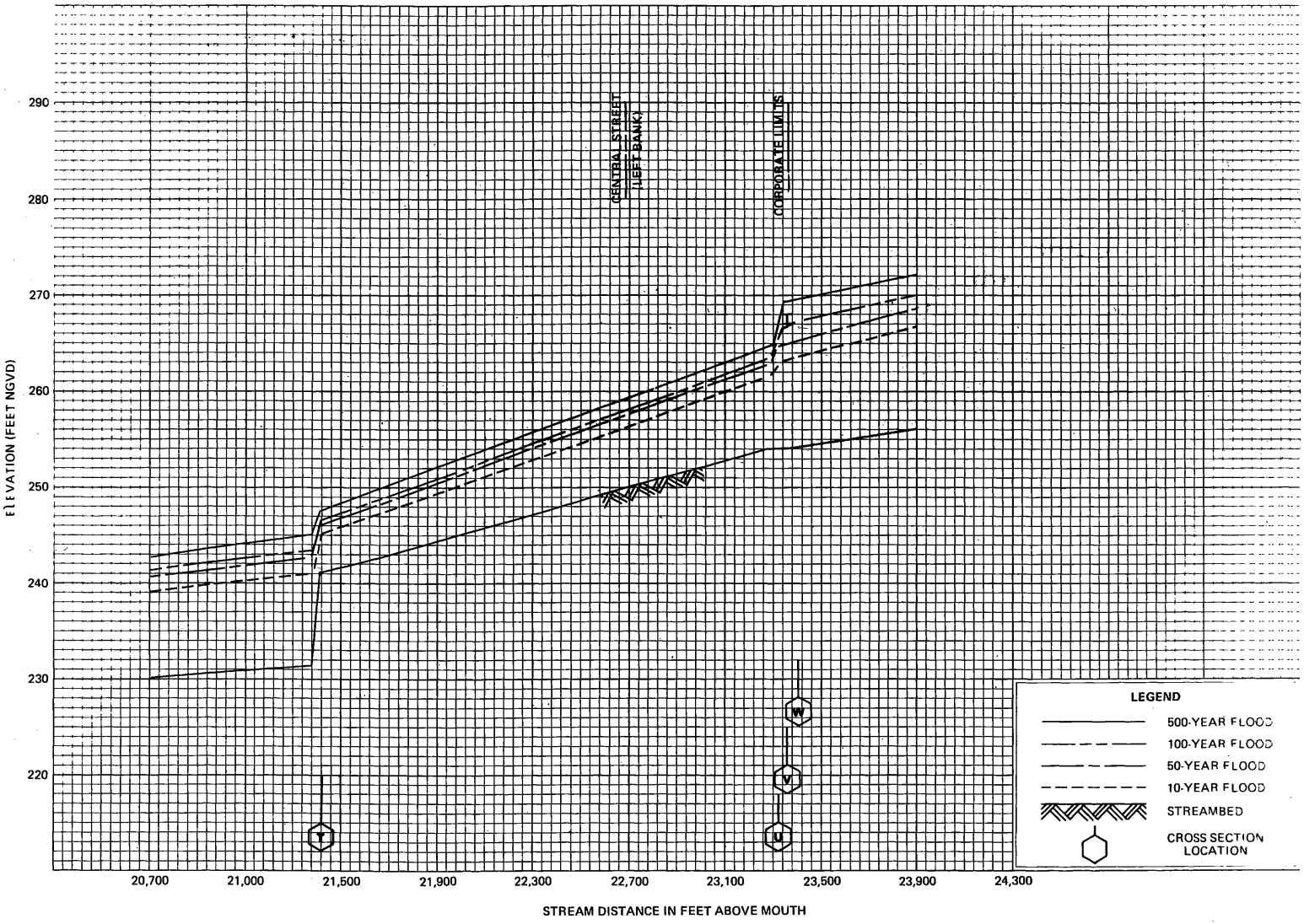
FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARION COUNTY, OR
AND INCORPORATED AREAS

100P

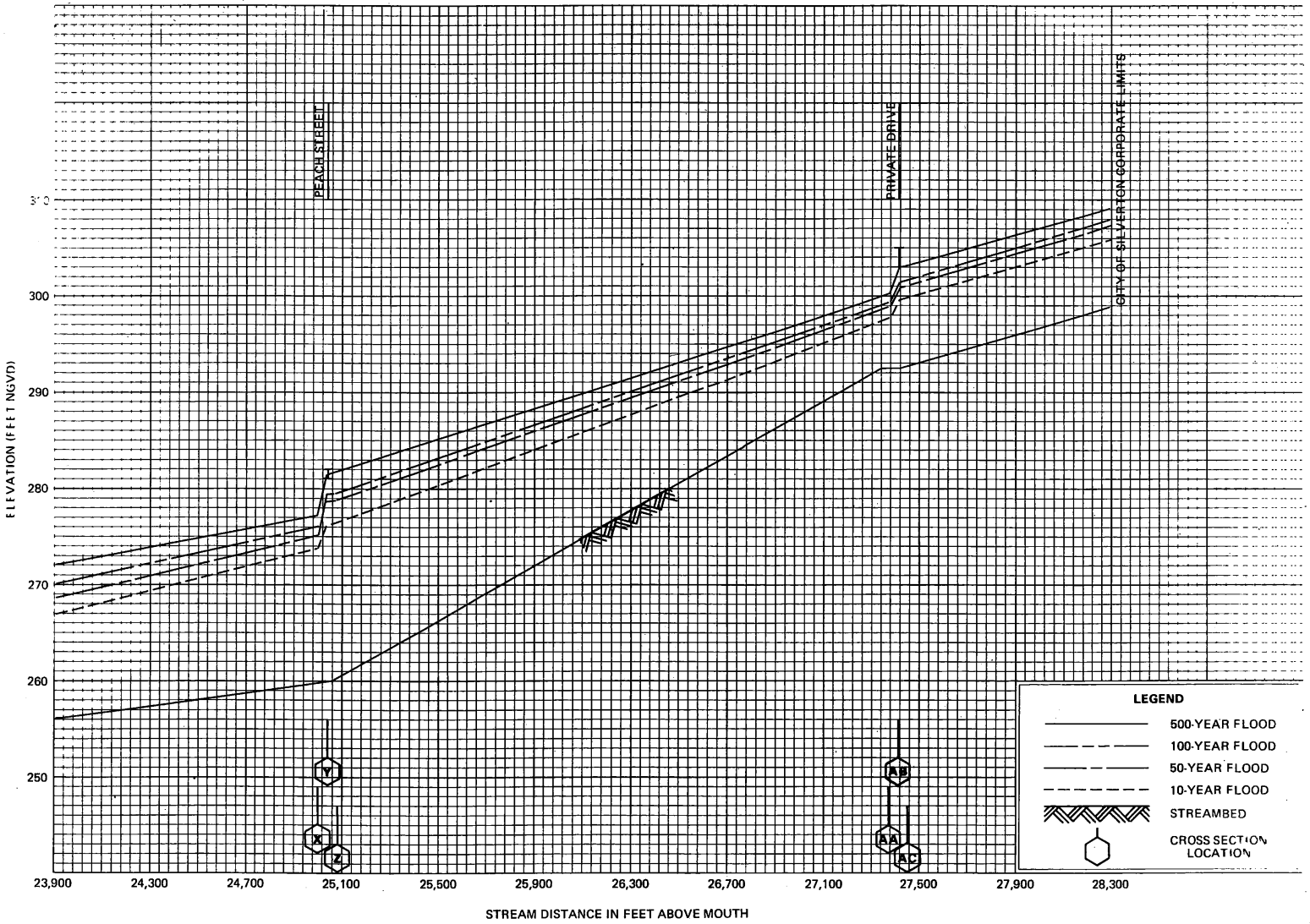


FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARION COUNTY, OR
AND INCORPORATED AREAS



FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARION COUNTY, OR
AND INCORPORATED AREAS

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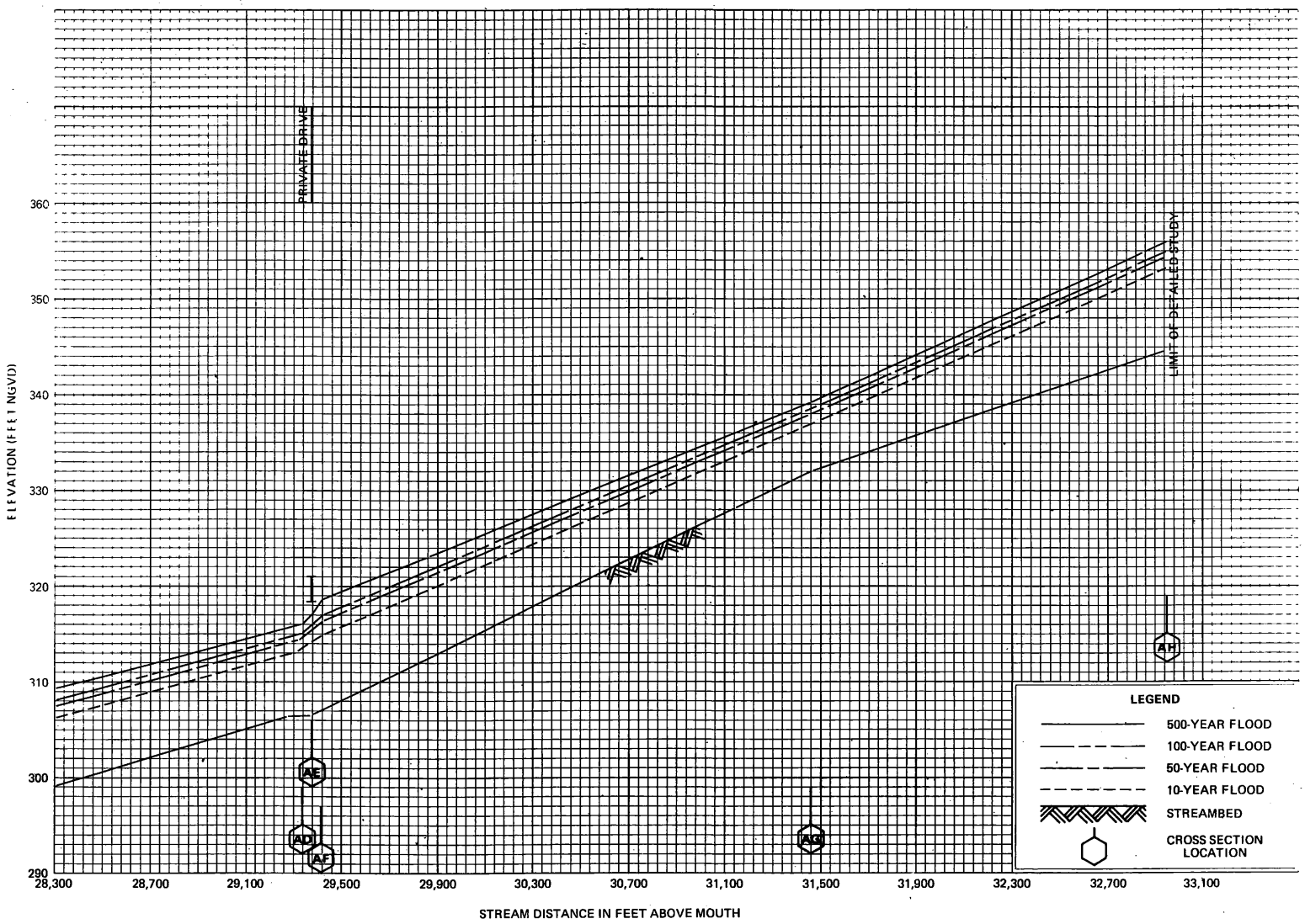

FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARION COUNTY, OR
AND INCORPORATED AREAS

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Appendix B

study area data ▪ master plan

B.3 Oregon Drainage Law – ODOT Interpretation

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2.1 Introduction

Oregon drainage law and regulations that apply to highway drainage facilities are discussed in this chapter. The intention is to only provide information and guidance on the engineer's role in the legal aspects of highway drainage. This chapter should not be treated as a manual upon which to base legal advice or make legal decisions. It is also not a summary of all existing drainage laws, and most emphatically, this chapter is not intended as a substitute for legal counsel.

The following generalizations can be made in reaching the proper conclusions regarding liability:

- a goal in highway drainage should be to perpetuate the natural drainage, insofar as practical, and
- the courts look with disfavor upon infliction of injury or damage that could be avoided by a prudent designer, even where some alteration of flow is legally permissible.

Additional information about highways and drainage law is in American Association of State Highway and Transportation Officials (AASHTO) Highway Drainage Guidelines, Volume V. This reference gives advice on expert testimony and the role of the hydraulics engineer during litigation. This manual can be ordered from the AASTHO website.

2.2 Oregon Drainage Law

Oregon drainage law, which originates from common law or case law, has developed without legislative action, and it is embodied in the decisions of the courts. Therefore, there are no Oregon Revised Statues to cite pertaining to Oregon drainage law.

Oregon has adopted the civil law doctrine of drainage. Under this doctrine, adjoining landowners are entitled to have the normal course of natural drainage maintained. The lower owner must accept water that naturally comes to his land from above, but he is entitled to not have the normal drainage changed or substantially increased. The lower landowner may not obstruct the runoff from the upper land if the upper landowner is properly discharging the water.

For a landowner to drain water onto lands of another in the State of Oregon, one of two conditions must be satisfied initially: (1) the lands must contain a natural drainage course; or, (2) the landowner must have acquired the right of drainage supported by valuable consideration (i.e. a

purchased drainage easement). In addition, because Oregon has adopted the civil law doctrine of drainage, the following three basic elements must be followed.

1. A landowner may not divert water onto adjoining land that would not otherwise have flowed there. "Divert water" includes but is not necessarily limited to:

    a. water diverted from one drainage area to another, and,

    b. water collected and discharged which normally would infiltrate into the ground, pond, and/or evaporate.

2. The upper landowner may not change the place where the water flows onto the lower owner's land. (Most of the diversions not in compliance with this element result from grading and paving work and/or improvements to water collection systems.)

3. The upper landowner may not accumulate a large quantity of water, then release it, greatly accelerating the flow onto the lower owner's land. This does not mean that the upper landowner cannot accelerate the water at all; experience has found the drainage to be improper only when the acceleration and concentration were substantially increased.

Subsurface waters which percolate to the surface can be intercepted and diverted for the protection of the highway without regard for the loss of these waters to the adjacent landowners. In those cases where wells and springs are involved, the right-of-way agent should contact the affected owner(s) to prevent any misunderstanding over damage that could be claimed.

Drainage designs should satisfy Oregon drainage law to avoid claims or litigation resulting from improper drainage design. When it is apparent that the drainage design will not satisfy the law, then drainage easements should be obtained from the affected property owners. The legal staff should be consulted in those situations that appear to be unique and could result in litigation.

Where certain drainage patterns have been established over long periods of time (i.e. in excess of at least 10 years), that are not the original natural drainage, there may be legal rights acquired which allow the continuance of the altered drainage pattern. Again, legal staff should be consulted in such situations.

Appendix B

study area data ▪ master plan

B.4 Oregon Drainage Law – Marion County Interpretation

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Oregon Drainage Law

Oregon has adopted the civil law doctrine of drainage. Under this doctrine, adjoining landowners are entitled to have the normal course of natural drainage maintained. The lower owner must accept water which naturally comes to his land from above, but he is entitled not to have the normal drainage changed or substantially increased. The lower landowner may not obstruct the run-off from the upper land, if the upper landowner is properly discharging the water.

For a landowner to drain water onto lands of another in the State of Oregon, two conditions must be satisfied initially: 1) the lands must contain a natural drainage course; and 2) the landowner must have acquired the right of drainage supported by consideration. In addition, because Oregon has adopted the civil law doctrine of drainage, three basic elements must be followed:

1. A landowner may not divert water onto adjoining land that would not otherwise have flowed there. "Divert water" includes but is not necessarily limited to: 1) water diverted from one drainage area to another; and 2) water collected and discharged which normally would infiltrate into the ground, pond, and/or evaporate.

2. The upper landowner may not change the place where the water flows onto the lower owner's land (Most of the diversions not in compliance with this element result from grading and paving work and/or improvements to water collection systems).

3. The upper landowner may not accumulate large quantities of water, then release it, greatly accelerating the flow onto the lower owner's land. This does not mean that the upper landowner can not accelerate the flow of water at all; experience has found drainage to be improper only when acceleration and concentration of the water were substantially increased.

Page Updated
January 10, 2012
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Appendix C

model data ▪ master plan

C.1 – Model Parameters
C.2 – Model Calibration
C.3 – Model Data and Results

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Appendix C

model data ▪ master plan

C.1 Model Parameters

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Table 1
Drainage Basin Parameters

Basin Name	Area (acres)	CCn	Tc (min)
1	12.1	87	50
2	13.8	80	30
3	6.8	86	21
4	16.9	93	24
5	2.6	77	20
6	4.5	87	5
7	5.2	84	14
8	23.6	85	51
9	12.4	83	48
10	18.0	80	50
11	10.2	84	25
12	10.5	80	47
13	4.5	78	27
14	56.3	83	100
15	12.4	85	85
16	36.1	88	56
17	25.7	88	25
18	12.3	77	25
19	14.7	80	33
20	19.6	87	26
21	17.4	83	20
22	108.0	76	60
23	37.6	77	30
24	101.1	74	60
25	42.6	81	26
26	23.4	80	35
27	22.2	80	18
28	12.6	87	46
29	15.9	93	31
30.1	10.61	93	18
30.2	10.99	93	18
31	42.4	81	36

Basin Name	Area (acres)	CCn	Tc (min)
32	21.1	85	20
33	14.9	78	45
34	33.4	88	29
35	4.1	96	37
36	10.7	87	32
37	10.8	88	37
38	13.0	84	15
39	5.3	95	35
40	9.1	95	5
41	8.1	85	30
42	13.8	90	35
43	3.8	79	9
44	26.0	84	59
45	7.8	62	41
46	7.7	85	21
47	36.6	79	56
48	13.6	96	20
49	48.1	78	25
50	10.3	92	18
51	11.7	90	18
52	17.3	90	20
53	75.4	86	30
54	20.7	81	14
55	35.8	81	30
56	17.5	73	18
57	32.1	74	76
58	14.8	82	15
59	25.1	78	20
60	43.7	77	41
61	18.1	75	25
62	37.8	76	39
63	21.8	81	25

Basin Name	Area (acres)	CCn	Tc (min)
64	10.1	71	30
65	12.9	79	26
66	24.4	82	25
67	121.2	71	41
68	12.4	74	46
69	5.0	73	45
70	30.0	69	25
71	17.2	76	41
72	15.9	76	49
73	140.3	67	71
74	148.2	62	74
75	86.0	74	46
76	14.8	80	16
77	8.6	83	48
78	7.4	86	20
79	34.3	78	51
80	11.6	84	43
81	4.0	82	38
82	37.1	87	20
83	1.8	96	5
84	10.8	87	36
85	67.4	79	60
86	24.1	80	39
87	12.7	77	25
88	25.5	82	30
89	11.4	94	5
90	7.6	88	23
91	2.3	90	5
92	31.5	84	32
93	19.0	80	36
94	13.8	87	27

Tc = Time of Concentration
CCn = Composite Curve Number

Area

The basin area is all of the area that collects and contributes runoff to the basin's outlet point. The basins areas were delineated with the use of two foot contours as shown in Figure 2 in Appendix A. Other physical boundaries such as roads and storm lines were also considered during the basin delineation process. After the basins were delineated, the areas for each of the basins were calculated with the use of a scaled drawing of the city.

Slope

The slope is the average slope along the time of concentration flow path. The slope is computed by dividing the difference between the beginning and ending elevation, by the flow path length. This parameter is given in feet per feet.

Time of Concentration

The time of concentration can be defined as the time at which outflow from a basin is equal to inflow. This state of equilibrium occurs because the drainage basin is assumed to be saturated at the time of concentration and all of the precipitation is going straight to runoff.

The time of concentration is calculated as the sum of the times of travel within the basin. Travel times represent various forms of flow within the basin. The following equations were used to calculate the times of travel for each of the flow types.

- Sheet flow (flow path less than 300 feet): $\mathbf{Ts=0.007*(nL)^{0.8}/(P_2)^{0.5}s^{0.4}}$

  Where: Ts=travel time for sheet flow (hr)
  n=Manning's roughness coefficient (Table 4.2)
  L=flow length (ft)
  P_2=2-year, 24-hour rainfall (in)
  s=slope of a hydraulic grade line (ft/ft)

- Shallow Concentrated Flow (flow path greater than 300 feet):

  - Slopes greater than 0.005: $\mathbf{Tsc=L/V}$

    Where: Tsc=travel time for shallow concentrated flow with slopes less than 0.005 (sec)
    L=flow length (ft)
    V=flow velocity (ft/sec) determined from Marion County Chart included in Appendix C.

  - Slopes less than 0.005: $\mathbf{Tss=L/20.3282s^{0.5}}$

    Where: Tss=travel time for shallow concentrated flow with slopes less than 0.005 (seconds)
    L=flow length (ft)
    s=slope of a hydraulic grade line (ft/ft)

- Pipe Flow: **Tp=L/2.0**
  Where: Tp=travel time for pipe flow (seconds)
  L=flow length (ft)
  Assumed: Pipe flow velocity = 2.0 ft/sec

- Total Time of Concentration**: Tc=Ts+Tsc+Tss+Tp**

As can be seen in the preceding equations, several parameters affect the time of concentration. One of the more significant parameters in the time of concentration calculations is the roughness value commonly referred to as Manning's n. The n values listed in the Table 2 were utilized in calculating the times of concentration for the various basins.

Table 2
Roughness Coefficients
(Manning's n) for Sheet Flow

Surface Description	Manning's n[1]
Smooth Surfaces (Concrete, Asphalt, Gravel or Bare Soil)	0.011
Fallow (No Residue)	0.05
Cultivated Soils:	
Residue Cover ≤ 20%	0.06
Residue Cover > 20%	0.17
Grass:	
Short Grass Prairie	0.15
Dense Grasses[2]	0.24
Bermuda Grass	0.41
Range (Natural)	0.13
Woods:[3]	
Light Underbrush	0.40
Dense Ynderbrush	0.80

Notes:

1) The n values are a composite of information compiled by Engman (1986).
2) Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3) When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

Composite Curve Number

There are several acceptable and well established methods to define a drainage basin's hydrologic character. Use of a curve number implies the application of the principles from the TR-55 Method. The USDA's "Urban Hydrology for Small Watersheds Technical Release 55" (TR-55) outlines the process for computing the NRCS Curve Number (CN) for minor basins. The CN is used as an index of the potential runoff from a storm event over a given basin. The general relationship between the CN and predicted runoff is the higher the CN, the greater the runoff.

The curve number is based on the hydrologic soil group, ground cover, percent impervious and land use. Table 3 from TR-55 shows average CN for a variety of land uses, hydrologic soil groups and ground cover.

In order to accurately assign a CN, it is necessary to determine the percentage of the minor basin area that is impervious or pervious. Pervious surfaces are those which are covered primarily with vegetation and permit the infiltration of water. Impervious areas are those which inhibit infiltration of water, such as pavement, roadways, sidewalks, and roofs. An aerial image of the city was used to directly measure the percent impervious area for typical land use designations such as low density residential, commercial, and industrial areas.

The percent impervious is a key parameter used to determine a composite CN and Tc. Generally, as the percent impervious increases the infiltration decreases, resulting in more rapid runoff, shorter Tc, and greater CN. All of these factors combined lead to higher peak runoff rates.

In addition to land use designations, the permeability of each of the basins is also a function of soil types.

The predominant soil types within each of the minor basins were obtained from the USDA's soil survey data base. A soils map of the City of Silverton can be found in Appendix B along with descriptions of each soil type. There are four general hydrologic soil groups. Group A soils are defined as soils having high infiltration rates and low runoff rates. Group B soils have moderate infiltration rates. Group C soils have slow infiltration rates. Group D soils have very slow infiltration rates and therefore higher runoff values.

Table 3 displays the effects of various land use types and soils groups on curve number values. Modified curve number values specifically calculated for Silverton were used in creating the model, but the values shown in Table 3 served as a starting point in assigning curve numbers to the various drainage basins.

Table 3
Runoff Curve Numbers For Urban Areas

Land Use	Cover Description		CN for Hydrologic Soil Group			
	Cover Type and Hydrologic Condition	Average % Imp.	A	B	C	D
	Fully Developed urban Areas (Vegetation Established)					
Public/ Semi - Public	Open Space (Lawn, Parks, Golf Courses, Cemeteries, Etc.)[3]					
	Poor Condition (Grass Cover <50%)		68	79	86	89
	Fair Condition (Grass Cover 50% to 75%)		49	69	79	84
	Good Condition (Grass Cover >75%)		39	61	74	80
	Impervious Areas:					
	Paved Parking Lots, Roofs, Driveways, Etc. (Excluding right-of-way)		98	98	98	98
	Streets and Roads: Paved; Curbs and Storm Sewers (including right-of-way)		98	98	98	98
	Paved; open ditches (Including right-of-way)		83	89	92	93
	Gravel (Including right-of-way)		76	85	89	91
	Dirt (Including right-of-way)		72	82	87	89
	Western Desert Urban Areas:					
	Natural Desert Landscaping (pervious areas only)		63	77	85	88
	Artificial Desert Landscaping (Impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Industrial/ Commercial	Urban Districts:					
	Commercial and Business	85	89	92	94	95
	Industrial	72	81	88	91	93
Residential	Residential District by Average Lot Size:					
	1/8 acre or Less (town houses)	65	77	85	90	92
	¼ Acre	38	61	75	83	87
	1/3 acre	30	57	72	81	86
	½ Acre	25	54	70	80	85
	1 Acre	20	51	68	79	84
	2 Acres	12	46	65	77	82
	Developing Urban Areas					
	Newly Graded Areas (pervious area only, no vegetation)		77	86	91	94

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Appendix C

model data ▪ master plan

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C.2 Model Calibration

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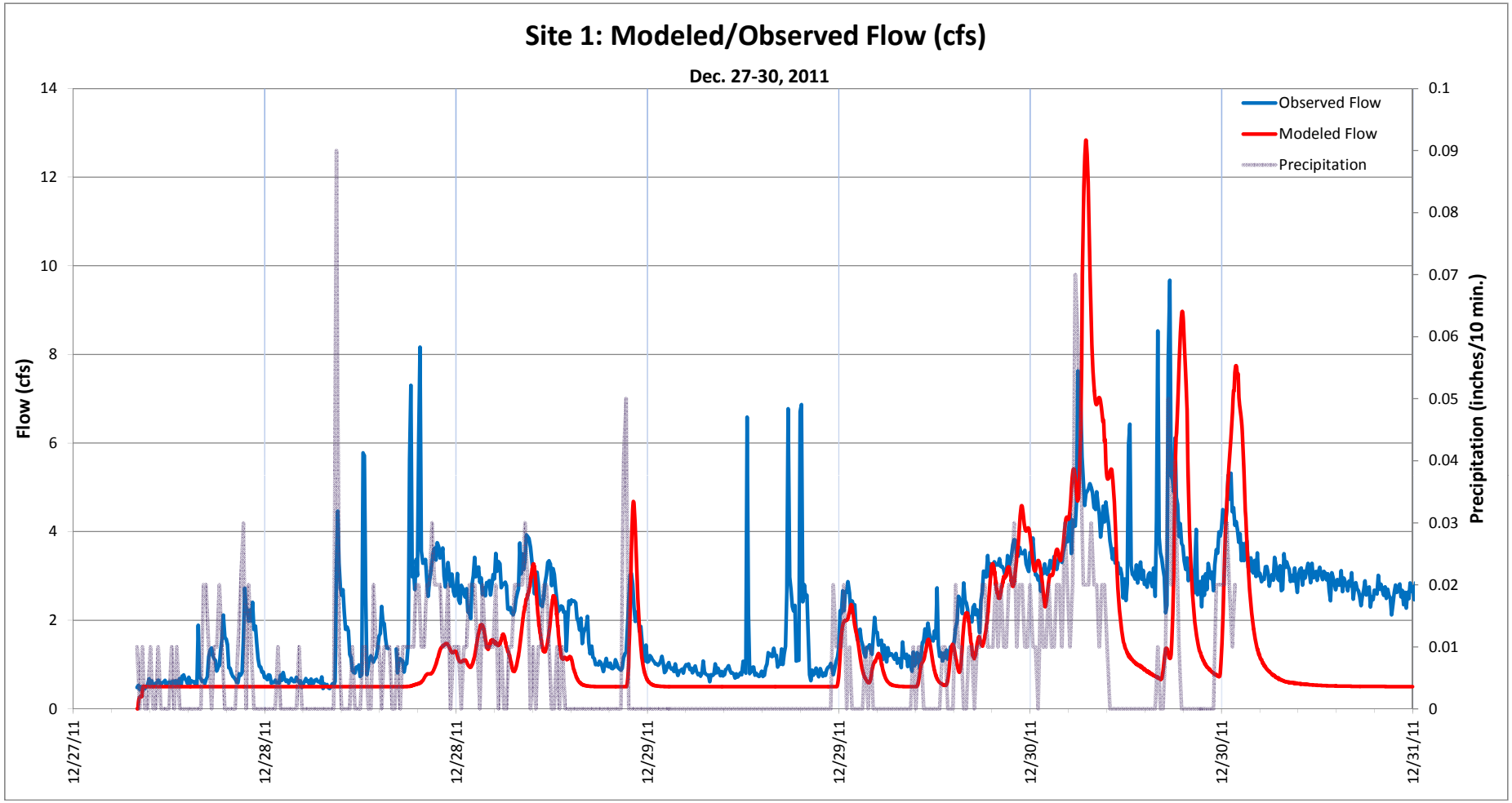
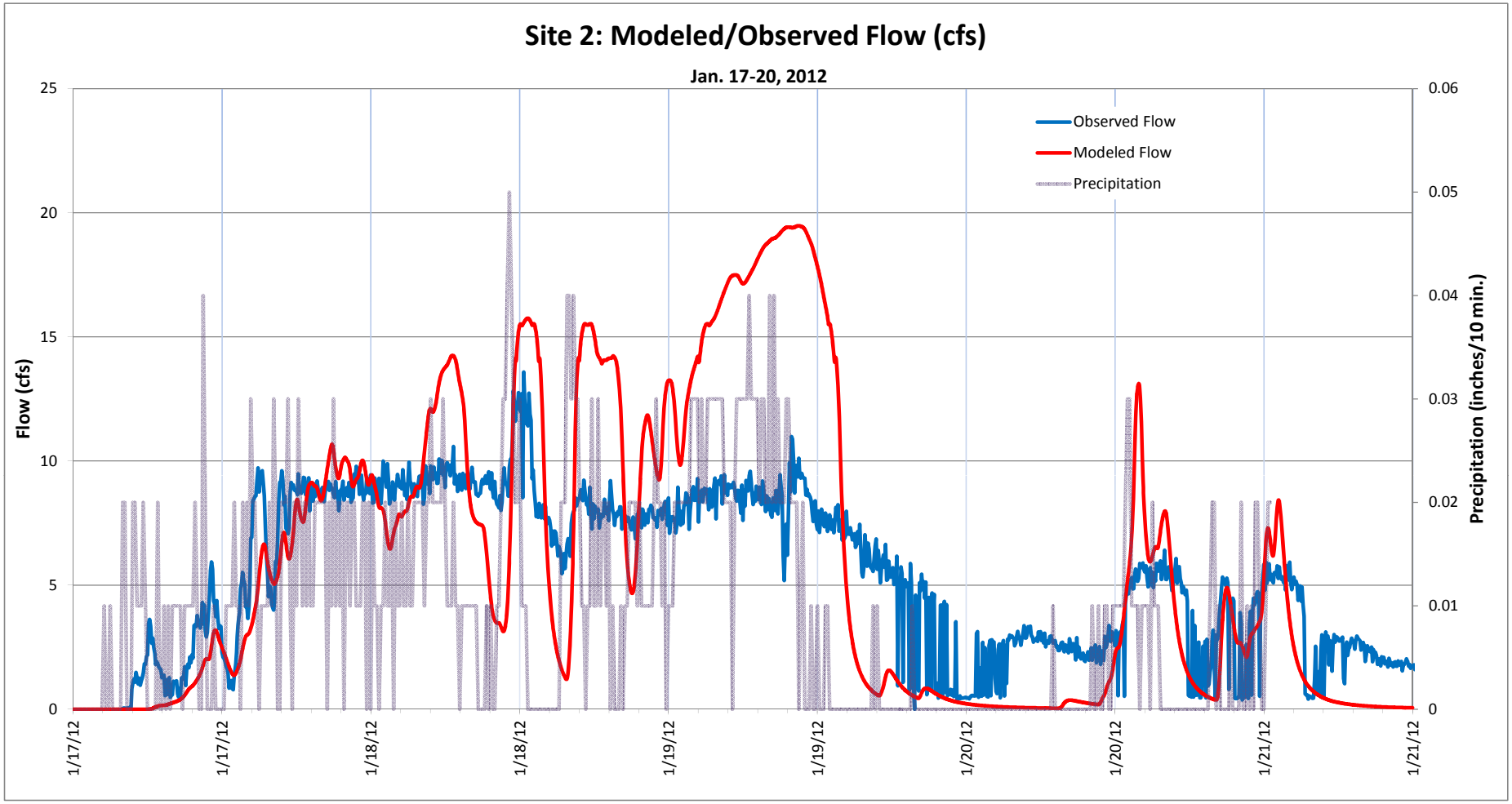
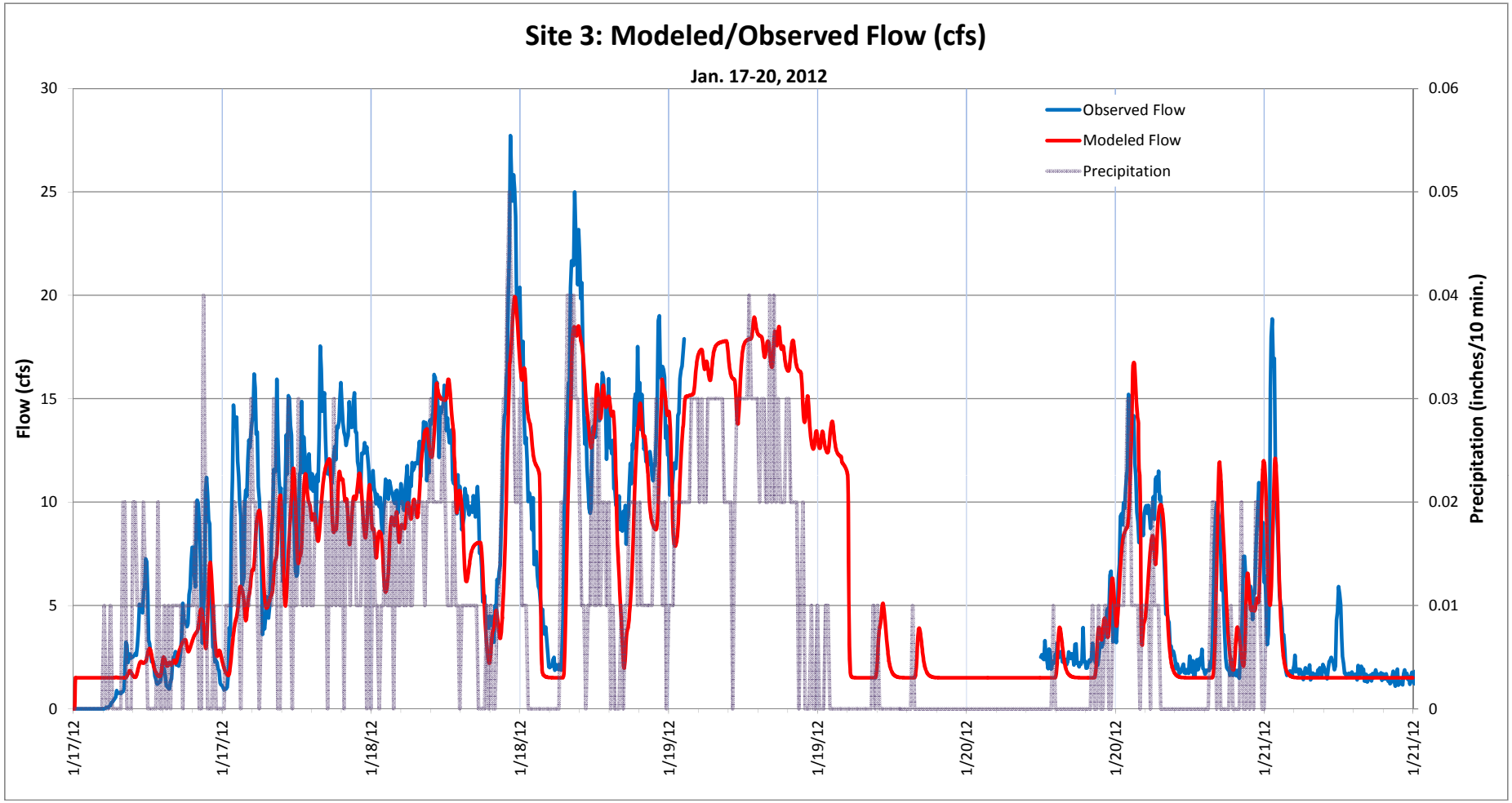

Site 1: Modeled/Observed Flow (cfs)
Dec. 27-30, 2011
Observed Flow
Modeled Flow
Precipitation
Flow (cfs)
Precipitation (inches/10 min.)
0
2
4
6
8
10
12
14
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
12/27/11
12/28/11
12/28/11
12/29/11
12/29/11
12/30/11
12/30/11
12/31/11


Site 2: Modeled/Observed Flow (cfs)
Jan. 17-20, 2012
Observed Flow
Modeled Flow
Precipitation
Flow (cfs)
Precipitation (inches/10 min.)
25
20
15
10
5
0
0.06
0.05
0.04
0.03
0.02
0.01
0
1/17/12
1/17/12
1/18/12
1/18/12
1/19/12
1/19/12
1/20/12
1/20/12
1/21/12
1/21/12


Site 3: Modeled/Observed Flow (cfs)
Jan. 17-20, 2012
Observed Flow
Modeled Flow
Precipitation
Flow (cfs)
Precipitation (inches/10 min.)
30
25
20
15
10
5
0
0.06
0.05
0.04
0.03
0.02
0.01
0
1/17/12
1/17/12
1/18/12
1/18/12
1/19/12
1/19/12
1/20/12
1/20/12
1/21/12
1/21/12

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Appendix C

model data ▪ master plan

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C.3 Model Data and Results

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Junction Data

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
11-34	213.37	226.42
11-35	212.50	226.00
11-4	216.20	221.84
11-40	212.34	226.00
11-41	212.04	226.90
11-42	211.75	213.75
11-5	216.20	222.84
11-6	215.34	226.00
11-88	194.58	210.57
11-89	194.12	209.76
11-90	193.89	209.30
11-91	193.34	208.05
11-92	192.50	203.53
11-95	209.70	211.74
11-96	211.00	214.00
12-11	215.34	221.54
12-12	216.75	224.00
12-133	224.62	228.00
12-134	225.42	228.00
12-135	226.34	229.17
12-16	218.00	224.00
12-17	220.23	227.94
12-18	220.54	224.54
12-19	225.67	230.00
12-192	230.34	232.84
12-193	230.68	237.31
12-196	231.97	240.00
12-20	227.85	232.00
12-232	232.83	240.00
12-234	233.54	240.00
12-237	234.14	240.00
12-238	235.17	241.82
12-274	230.14	238.00
12-279	229.56	236.93
12-282	229.42	236.60
12-283	228.96	236.00
12-288	228.34	234.40
12-294	226.66	232.91
12-295	226.39	232.01
12-328	232.40	240.00
12-71	228.54	232.77
12-72	224.34	230.86
12-74	224.05	231.46
12-76	228.44	232.81

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
400-20	214.80	220.70
400-21	214.20	220.81
400-24	212.50	215.01
400-25	212.30	214.86
400-26	212.38	214.88
400-27	212.13	214.63
400-28	217.70	221.79
400-30	217.50	221.78
400-31	217.30	221.73
400-33	217.78	221.96
400-34	220.63	225.28
400-35	220.43	224.69
400-38	215.59	221.59
400-39	215.38	220.00
400-40	215.40	220.40
400-41	216.61	222.61
400-42	221.95	226.00
400-43	221.04	226.34
400-46	275.58	279.68
400-56	220.25	225.83
400-57	220.72	226.36
400-59	217.30	220.00
400-60	217.20	220.00
400-61	216.62	221.50
400-62	215.00	219.00
400-8	215.00	217.00
400-9	214.90	217.00
4-1	216.59	221.84
44-30	303.44	306.00
500-1	213.50	216.00
500-11	244.10	248.10
500-12	236.51	241.01
500-14	236.34	240.34
500-15	211.40	218.00
500-18	224.33	228.08
500-19	215.60	220.00
500-2	214.00	217.00
500-20	213.60	218.00
500-22	216.00	222.00
500-7	211.70	214.20
500-8	215.27	219.80
500-9	247.39	251.50
5-100	221.70	227.20
5-13	221.59	226.00

Junction Data

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
12-87	226.14	232.00
12-88	224.12	232.00
12-89	223.18	230.96
12-90	221.67	230.00
12-91	229.84	232.89
12-92	229.79	233.20
12-93	229.42	235.24
13-1	230.17	235.39
13-10	238.18	244.00
13-13	243.00	246.75
13-14	244.20	248.30
13-16	247.15	251.55
13-19	248.78	255.28
13-20	249.00	254.50
13-21	314.44	321.84
13-22	309.04	316.00
13-23	306.04	311.50
13-24	306.34	311.60
13-25	309.50	311.50
13-5	233.69	239.99
13-6	237.40	243.50
13-7	243.20	249.00
13-8	247.50	251.80
14-14	384.59	395.74
14-15	346.37	352.81
14-15A	383.84	393.60
14-15A.1	361.33	368.60
14-15A.2	370.33	378.10
14-23	304.48	308.66
14-24	303.84	307.55
14-25	303.44	307.39
14-27	302.34	305.91
14-29	305.52	310.50
14-31	303.38	306.00
1465 Copy	226.19	235.74
16-110	222.62	227.89
16-111	223.99	228.00
16-119	215.68	220.68
16-128	222.18	226.81
16-131	222.55	226.00
16-79	217.50	222.00
17-116	321.60	326.87
17-117	327.90	335.38
17-131	325.40	331.08

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
5-132	221.56	227.30
5-138	219.56	223.60
5-144	218.19	224.00
5-151	218.09	224.00
5-57	219.98	224.40
5-65	219.77	224.15
6-100	216.24	220.98
6-101	216.94	221.67
6-102	217.86	222.00
6-103	219.65	223.27
6-105	220.74	225.06
6-111	222.72	228.00
6-113	216.50	218.50
6-136	214.28	216.78
6-137	213.00	215.00
6-2	220.98	226.53
6-37	222.72	228.00
6-4	221.27	228.00
6-44	223.93	230.00
6-86	225.48	232.00
7-13	231.17	234.70
7-136	231.33	234.44
7-137	231.08	234.64
7-142	230.70	234.83
7-143	230.04	234.00
7-145	229.32	238.34
7-147	227.74	232.59
7-29	238.38	243.43
7-32	237.43	242.50
7-45	233.64	238.00
7-46	232.96	238.00
7-47	234.25	240.00
7-60	236.92	243.16
7-62	237.77	245.61
7-74	245.74	247.81
7-77	246.22	250.10
8-172	253.56	256.89
8-176	252.34	256.34
8-177	251.92	257.46
8-178	251.20	253.70
8-27	253.56	257.39
8-28	253.00	256.05
8-29	252.92	255.93
8-32	252.60	256.61

Junction Data

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
17-132	334.00	339.74
17-134	227.54	234.64
17-134Copy	227.54	234.64
17-135	227.97	233.14
17-137	226.19	235.74
17-138	226.93	232.25
17-139	226.93	231.34
17-18	313.40	316.64
17-35	338.50	343.90
17-74	231.01	235.36
17-76	276.54	280.72
17-78	281.54	286.95
17-92	248.51	252.94
17-93	244.11	248.10
18-1	245.31	251.35
18-13	265.10	271.73
18-14	263.60	270.11
18-15	262.60	272.00
18-16	249.80	254.16
18-17	333.88	350.62
18-18	281.99	291.05
18-19	269.88	276.84
18-2	244.88	251.36
18-20	267.33	275.25
18-21	263.83	275.44
18-22	263.27	276.00
18-23	262.60	274.00
18-25	236.00	252.00
19-1	415.18	422.00
19-2	406.61	419.31
19-4	371.81	382.71
19-5	359.99	366.87
2-1	219.28	226.00
2-11	219.92	238.34
2-12	216.22	221.43
2-13	219.28	225.70
2-14	219.51	227.30
2-15	224.15	232.37
2-16	229.08	237.63
2-17	235.08	239.30
2-2	219.04	226.00
2-20	237.46	243.06
22-1	298.10	302.07
22-2	294.10	298.44

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
8-33	252.60	256.61
8-34	252.58	258.00
8-35	252.57	257.45
8-36	252.57	257.45
8-37	251.78	258.00
8-43	253.01	260.65
8-51	250.23	256.00
8-55	249.35	254.90
8-56	249.28	254.00
8-57	249.04	254.00
8-59	248.98	253.00
8-61	251.09	258.73
8-79	270.36	275.05
8-82	259.98	268.72
8-83	258.09	266.80
8-90	256.97	266.65
Basin 01	218.80	224.00
Basin 02	219.00	222.00
Basin 03	239.10	244.00
Basin 04	234.49	238.34
Basin 05	235.34	243.87
Basin 06	236.45	242.00
Basin 07	236.68	243.08
Basin 08	240.78	244.00
Basin 09	242.37	248.00
Basin 10	253.90	258.83
Basin 11	250.98	257.38
Basin 12	246.80	249.80
Basin 13	238.04	242.92
Basin 14	237.19	242.50
Basin 15	229.78	235.48
Basin 16	221.76	228.00
Basin 17	234.27	238.00
Basin 18	246.49	253.39
Basin 19	299.90	304.70
Basin 20	254.73	259.02
Basin 21	251.44	264.76
Basin 22	257.58	262.00
Basin 23	281.00	284.50
Basin 24	303.59	306.31
Basin 25	334.07	343.94
Basin 26	385.68	394.00
Basin 27	235.57	240.00
Basin 28	230.41	235.47

Junction Data

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
22-3	292.20	297.29
23-1	261.45	265.41
23-21	266.69	278.00
23-24	269.30	278.90
23-25	269.45	279.29
23-3	265.93	270.00
23-31	270.29	282.00
23-32	270.19	281.29
23-40	279.57	286.00
23-41	278.75	285.31
23-42	277.31	284.38
23-43	272.73	275.21
23-48	282.68	290.07
2-38	235.08	242.23
2-39	234.89	243.18
24-16	287.18	292.00
24-17	284.61	290.00
24-19	286.22	292.00
24-34	290.11	297.46
24-36	289.75	296.69
24-38	289.73	291.73
2-44	234.70	240.84
24-40	293.87	299.05
24-41	294.98	300.16
24-50	294.89	306.49
24-51	299.66	307.54
24-52	300.45	308.00
24-56	302.29	309.13
24-58	302.62	311.34
25-110	332.10	338.37
25-111	331.76	338.41
25-122	344.95	350.00
25-123	339.35	346.05
25-124	338.57	345.27
25-13	373.54	380.82
25-131	343.41	350.00
25-133	348.44	354.00
25-135	348.66	358.64
25-15	368.51	375.02
25-17	358.68	366.00
25-180	357.07	360.66
25-19	357.24	362.00
25-2	427.13	432.73
2-52	221.33	224.50

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
Basin 29	249.50	253.80
Basin 30	230.22	240.00
Basin 31	221.44	226.00
Basin 32	214.90	218.90
Basin 33	211.74	216.75
Basin 34	224.42	231.67
Basin 35	230.12	235.16
Basin 36	231.74	234.96
Basin 37	224.65	228.21
Basin 38	232.76	237.43
Basin 39	221.90	226.00
Basin 40	220.69	226.00
Basin 41	222.05	227.29
Basin 42	220.37	224.50
Basin 43	218.75	224.00
Basin 44	214.33	226.00
Basin 45	197.00	210.01
Basin 46	195.45	210.00
Basin 47	0.00	217.75
Basin 48	236.18	240.45
Basin 49	0.00	249.77
Basin 50	241.53	244.45
Basin 51	242.95	246.65
Basin 52	246.89	250.79
Basin 53	252.74	256.94
Basin 54	266.50	274.10
Basin 55	402.41	415.53
Basin 56	416.66	424.66
Basin 57	433.46	440.10
Basin 58	450.04	463.03
Basin 59	275.34	288.25
Basin 60	287.74	294.90
Basin 61	290.58	298.00
Basin 62	295.41	302.00
Basin 63	309.89	314.00
Basin 64	310.88	316.84
Basin 65	318.84	323.95
Basin 66	348.22	355.48
Basin 67	354.31	359.34
Basin 68	374.67	377.08
Basin 69	432.34	437.07
Basin 70	383.95	389.29
Basin 71	377.54	397.54
Basin 72	352.80	361.50

Junction Data

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
25-20	356.82	360.45
25-26	374.41	377.43
25-27	373.48	378.71
25-3	421.50	427.25
2-53	221.53	224.50
25-32	372.84	376.66
25-35	365.09	369.12
25-4	396.54	400.66
25-42	354.47	362.77
25-45	355.58	359.33
25-47	354.33	359.13
25-52	348.66	358.76
25-54	348.27	354.00
25-57	347.38	353.32
25-60	346.18	351.24
25-64	356.99	365.88
25-70	354.35	361.75
25-72	352.42	356.44
25-73	353.08	358.33
25-75	351.72	356.78
25-77	351.21	356.70
25-79	350.32	354.00
25-83	343.15	350.72
25-84	342.23	350.00
25-87	336.21	344.00
25-9	378.06	382.16
25-90	335.01	343.09
25-91	329.01	338.26
25-96	327.16	336.00
2-7	218.47	226.00
30-11	310.39	314.78
30-12	310.66	315.88
30-2	305.32	312.00
30-32	314.91	319.36
30-42	316.91	320.00
30-43	316.34	319.70
30-44	313.97	319.56
30-45	313.34	319.89
30-47	310.90	314.90
30-5	306.64	312.00
30-6	307.49	312.37
30-69	304.00	313.60
30-7	308.58	313.11
30-70	294.08	300.97

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
Basin 73	361.84	365.51
Basin 74	353.56	358.36
Basin 75	318.04	326.65
Basin 76	0.00	305.00
Basin 77	317.68	321.95
Basin 78	317.51	320.00
Basin 79	0.00	212.00
Basin 80	224.24	232.00
Basin 81	227.05	232.00
Basin 82	0.00	231.77
Basin 83	231.14	234.80
Basin 84	227.54	230.00
Basin 85	246.55	252.85
Basin 86	340.70	344.50
Basin 87	337.70	343.20
Basin 88	283.16	287.74
Basin 89	226.93	237.34
Basin 90	226.41	229.16
Basin 91	0.00	228.14
Basin 92	232.34	236.29
Basin 93	219.13	226.00
Basin 94	211.45	213.95
Node 1446	429.65	436.74
Node 912	219.20	222.39
Node1415	0.00	210.00
Node1419	421.75	440.12
Node1424	354.34	359.28
Node1426	344.00	350.72
Node1431	217.80	226.97
Node1432	354.31	360.34
Node1433	234.92	242.01
Node1435	234.70	242.00
Node1437	227.88	234.86
Node1438	229.59	231.59
Node1440	227.06	238.41
Node1445	420.80	424.50
Node1452	280.50	283.50
Node1453	260.00	263.00
Node1454	252.50	255.00
Node1459	247.93	251.50
Node1461	253.34	256.34
Node1462	320.70	326.28
Node1468	415.21	424.66
Node1472	348.27	354.00

Junction Data

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
30-8	309.21	313.61
30-9	309.53	314.00
31-11	323.54	330.39
31-111	317.32	329.73
31-112	316.44	326.13
31-12	320.84	327.14
31-123	314.69	330.00
31-13	319.59	326.28
31-139	313.71	330.00
31-141	312.74	332.00
31-145	312.04	316.04
31-16	319.72	331.94
31-17	319.61	332.13
31-3	315.79	322.86
31-86	320.09	326.28
400-11	219.40	222.00
400-18	222.21	226.00
400-19	222.08	228.00

Node Name	Invert Elevation (ft)	Ground Elevation (Spill Crest) (ft)
Node1473	310.70	315.98
Node1480	315.64	322.34
Node1481	316.84	322.34
Node1484	324.84	330.34
Node1485	327.34	330.34
Node1486	334.07	343.94
Node1487	408.24	419.00
Node1488	407.88	417.50
Node1489	392.60	403.87
Node1490	392.29	399.43
Node1491	392.29	399.43
Node1492	407.88	417.50
Node1493	218.70	224.00
Node1501	220.30	226.00
Node904	250.50	253.00
Node927	211.74	214.24
Node929	217.20	219.20

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
1929.1	129.38	2-11	219.92	2-12	216.22	0.014	2.86	3.00	104.74	37.54
1940.1	85.83	7-32	237.43	Basin 14	237.19	0.014	0.28	3.91	112.86	32.74
1949.1	159.57	8-33	252.60	8-34	252.58	0.01	0.02	2.00	3.68	2.51
1961.1	87.00	8-61	255.09	Basin 11	253.64	0.014	1.67	2.00	27.12	19.59
2187.1	51.82	13-16	247.15	Basin 52	246.89	0.014	0.50	1.00	2.34	3.20
2187.2	51.82	13-16	247.15	Basin 52	246.89	0.014	0.50	1.00	2.34	3.20
2187.3	51.82	13-16	247.15	Basin 52	246.89	0.014	0.50	1.00	2.34	3.20
2315.1	43.89	Node1433	234.92	Node1435	234.70	0.014	0.50	4.00	247.12	43.37
2376.1	16.00	Node1459	249.17	500-9	248.56	0.014	3.81	1.50	19.05	16.93
2376.2	19.00	Node1459	249.04	500-9	248.46	0.014	3.05	1.50	17.04	15.35
2376.3	18.00	Node1459	247.93	500-9	247.39	0.014	3.00	1.50	16.89	15.61
4-31	65.00	31-11	323.54	31-12	323.14	0.014	0.62	4.00	104.64	80.98
1-13	246.79	Basin 28	230.41	13-1	230.17	0.014	0.10	2.00	6.55	17.92
1-18	43.68	18-1	245.31	18-2	245.08	0.014	0.53	2.00	15.24	23.32
1-19	182.32	19-1	415.18	19-2	407.05	0.012	4.46	1.50	24.03	14.33
1-22	108.02	22-1	298.10	22-2	294.10	0.014	3.70	1.50	18.77	14.77
1-23	492.27	18-23	262.60	23-1	261.45	0.012	0.23	2.00	11.85	22.80
1-25	347.17	25-135	348.66	25-133	348.44	0.014	0.06	3.16	29.89	5.33
2-06	343.59	6-4	221.27	6-2	220.98	0.014	0.08	1.50	2.83	12.98
2-18	185.27	18-2	244.88	18-25	236.00	0.014	4.79	1.50	21.35	23.32
2-19	63.75	19-2	406.61	Basin 55	402.52	0.012	6.42	1.50	28.82	14.33
3-06	43.97	Basin 16	221.76	6-4	221.45	0.014	0.71	1.50	8.19	13.24
3-11	225.89	11-5	216.20	11-6	215.34	0.014	0.38	1.50	6.02	10.11
3-13	316.28	Basin 27	235.57	Basin 38	232.99	0.014	0.82	1.50	8.81	8.72
3-19	216.85	Basin 55	402.41	19-4	371.81	0.012	14.11	1.50	42.75	30.70
4-11	35.59	11-6	215.34	Basin 44	214.94	0.014	1.12	1.50	10.34	10.12
4-13	99.73	13-1	230.17	Basin 35	230.12	0.014	0.05	2.00	4.70	17.96
4-19	108.30	19-4	371.81	19-5	360.21	0.012	10.71	1.50	37.24	30.70
4-30	135.44	30-5	306.64	30-2	305.32	0.014	0.97	2.00	20.74	13.44
5-16	26.77	16-110	222.64	16-128	222.35	0.014	1.08	1.50	10.15	16.11
5-30	85.29	30-6	307.49	30-5	306.64	0.014	1.00	2.00	20.97	13.44

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
6-13	226.61	13-8	247.50	13-7	243.20	0.014	1.90	1.50	13.44	10.95
6-14	262.00	14-15A.1	361.33	14-15	346.37	0.014	5.71	1.00	7.91	8.09
6-16	322.86	Basin 92	232.34	16-110	222.62	0.014	3.01	1.50	16.92	16.13
6-30	135.82	Basin 63	309.89	30-8	309.21	0.014	0.50	2.00	14.86	10.70
7-14	236.42	14-15A	383.84	14-15A.2	370.33	0.014	5.71	1.00	7.91	8.11
7-30	108.94	30-7	308.58	30-6	307.49	0.014	1.00	2.00	21.01	13.44
8-13	344.21	13-10	238.18	Basin 48	236.42	0.012	0.51	2.00	17.52	21.98
8-17	209.22	17-93	244.11	17-74	231.01	0.014	6.26	1.50	24.40	12.39
8-30	81.47	30-8	309.21	30-7	308.58	0.014	0.77	2.00	18.47	13.44
9-13	378.01	Basin 50	241.53	13-10	238.18	0.012	0.89	2.00	23.07	21.97
9-14	63.01	14-14	384.59	14-15A	383.84	0.014	1.19	1.50	10.64	8.16
9-17	71.27	17-92	248.51	17-93	244.11	0.014	6.17	1.50	24.24	12.39
9-30	39.22	30-9	309.53	30-8	309.21	0.014	0.82	1.25	5.42	3.16
10-12	127.18	12-12	216.75	12-11	215.34	0.014	1.11	2.00	22.12	23.84
10-13	153.93	Basin 51	242.95	Basin 50	241.53	0.013	0.92	1.50	10.09	15.75
10-14	252.01	14-15	346.37	Basin 25	334.29	0.012	4.79	1.50	24.91	8.09
10-30	15.93	30-12	310.70	30-11	310.39	0.014	1.95	1.25	8.37	3.15
10-31	35.58	30-11	310.39	30-9	309.53	0.014	2.42	1.25	9.33	3.15
11-13	19.56	13-13	243.00	Basin 51	242.95	0.013	0.26	1.50	5.31	11.80
12-13	377.46	13-14	244.20	13-13	243.00	0.013	0.32	1.50	5.92	11.19
12-24	367.91	24-16	287.18	24-17	285.06	0.014	0.58	2.00	15.95	12.38
100-16	16.03	16-79	217.50	16-119	217.44	0.014	0.37	2.00	12.85	8.15
100-25	20.36	Basin 73	361.84	25-64	357.34	0.014	22.10	2.50	179.06	29.16
101-16	259.56	Basin 93	219.13	16-79	217.60	0.014	0.59	1.50	7.49	8.15
104-17	200.81	17-117	327.90	17-131	325.40	0.014	1.24	1.50	10.88	14.80
105-31	589.43	31-112	316.44	31-123	314.69	0.014	0.30	4.00	72.68	67.18
106-07	21.98	Basin 17	234.27	7-46	233.34	0.014	4.23	2.50	78.35	16.01
106-17	199.70	17-132	334.00	17-117	328.20	0.014	2.90	1.50	16.62	14.83
106-31	224.13	31-123	314.69	31-139	313.77	0.014	0.41	4.00	85.46	67.17
107-07	344.15	7-46	232.96	7-13	231.17	0.014	0.52	2.50	27.47	19.93
107-17	140.00	Node1437	227.88	17-134Copy	227.74	0.014	0.10	4.00	42.18	-1.25

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
107-31	234.99	31-139	313.71	31-141	313.42	0.014	0.12	4.00	46.86	67.17
108-16	15.70	16-128	222.18	400-57	222.03	0.014	0.96	1.50	9.54	16.10
108-25	54.26	Node1432	354.34	25-47	354.33	0.014	0.02	2.00	2.85	11.05
108-31	222.84	31-141	312.74	31-145	312.04	0.014	0.31	4.00	74.76	67.17
109-17	10.60	Basin 89	226.93	17-139	226.93	0.014	0.00	2.00	0.66	8.49
110-08	107.05	Basin 10	253.90	8-27	253.68	0.012	0.21	1.50	5.16	6.92
110-17	10.00	17-139	226.93	17-137	226.90	0.014	0.50	1.50	5.34	4.89
111-08	205.26	8-27	253.56	8-28	253.07	0.012	0.24	1.50	5.56	6.92
111-25	104.38	25-45	355.58	25-42	355.17	0.014	0.39	2.00	13.17	16.58
112-06	451.92	7-143	230.04	Basin 34	227.06	0.014	0.66	2.21	42.66	26.64
112-08	51.14	8-28	253.00	8-29	252.99	0.012	0.02	1.50	1.59	5.36
112-25	168.73	25-42	354.47	Node1424	354.34	0.014	0.08	3.00	17.19	20.30
113-08	115.13	8-29	252.92	8-32	252.72	0.012	0.17	1.50	4.74	5.02
113-25	142.70	25-47	354.34	Basin 66	349.42	0.014	3.45	3.00	115.00	21.67
114-08	211.59	Basin 20	254.73	8-172	253.67	0.014	0.50	1.50	6.90	11.69
114-17	10.00	17-138	226.93	17-139	226.93	0.014	0.00	2.00	0.66	-3.48
114-25	251.59	Basin 66	348.22	25-83	344.15	0.014	1.62	4.00	169.65	32.62
116-07A	85.83	7-32	237.43	Basin 14	237.19	0.014	0.28	3.91	112.87	32.74
117-08	58.89	8-177	251.92	8-178	251.20	0.014	1.22	1.75	16.27	6.52
117-25	256.48	Node1426	344.32	25-131	343.41	0.014	0.35	3.00	36.89	-0.47
118-08	26.84	8-176	252.34	8-177	252.02	0.014	1.19	1.75	16.07	6.52
118-25	85.93	25-83	343.15	25-84	342.23	0.014	1.07	3.00	64.08	32.62
119-08	31.43	8-172	253.56	Node1461	253.34	0.014	0.70	1.75	12.31	11.67
119-25	310.00	25-84	342.23	25-87	336.21	0.014	1.94	3.00	86.31	32.62
121-08	159.57	8-33	252.60	8-34	252.58	0.01	0.02	2.00	3.68	2.51
122-25	60.95	25-87	336.21	25-90	335.11	0.014	1.80	3.00	83.20	32.62
123-08	170.85	8-90	256.97	Basin 21	251.68	0.014	3.10	2.00	36.96	11.43
123-25	202.52	25-90	335.01	25-91	329.01	0.014	2.96	3.00	106.61	32.62
124-08	71.00	8-83	258.09	8-90	256.97	0.014	1.58	2.00	26.38	11.42
124-25	92.16	25-110	332.10	25-111	331.76	0.014	0.37	4.00	81.02	58.31
125-08	134.76	8-82	259.98	8-83	258.12	0.014	1.38	2.00	24.68	11.42

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
125-25	243.83	25-91	329.11	25-96	327.36	0.014	0.72	4.00	113.00	32.62
126-08	237.80	8-79	270.36	8-82	260.17	0.014	4.29	2.00	43.48	11.42
126-25	244.14	25-96	327.16	31-11	323.59	0.014	1.46	4.00	161.29	32.61
127-08	389.86	8-51	250.23	8-56	249.28	0.014	0.24	2.50	18.80	24.03
128-08	307.78	8-51	250.23	8-55	249.35	0.014	0.29	2.50	20.37	23.89
129-08	91.00	8-55	249.35	8-57	249.04	0.014	0.34	2.50	22.23	23.89
130-08	64.04	8-57	249.04	8-59	248.98	0.014	0.09	2.50	11.66	23.89
131-08	67.32	8-56	249.28	8-59	248.98	0.014	0.45	2.50	25.43	24.03
13-13.1	419.59	Basin 52	246.89	13-14	244.20	0.013	0.64	1.50	8.41	10.99
132-07	95.51	Basin 15	229.78	7-145	229.36	0.014	0.44	2.00	13.93	20.53
132-08	234.54	8-43	253.01	8-37	251.79	0.014	0.52	3.00	44.67	24.85
133-07	255.22	7-145	229.32	7-147	227.74	0.014	0.62	2.00	16.53	20.48
133-08	91.99	Basin 22	257.58	8-43	255.67	0.014	2.08	3.00	89.25	24.83
134-08	125.67	8-37	251.78	Basin 11	250.98	0.014	0.64	3.00	49.42	29.13
135-08	113.10	Basin 11	250.98	8-51	250.23	0.014	0.66	3.00	50.43	47.92
139-25	10.00	25-133	348.44	Node1472	348.44	0.014	0.00	1.75	0.47	5.33
140-25	10.00	25-52	348.66	25-135	348.66	0.014	0.00	1.75	0.47	5.34
14-05	90.23	Basin 39	221.90	5-13	221.59	0.014	0.34	1.50	5.72	4.58
14-12	45.25	12-16	218.00	12-12	216.75	0.014	2.76	2.00	34.91	23.84
141-25	19.70	25-180	357.07	25-20	356.91	0.014	0.81	2.50	34.33	16.58
14-18	133.90	Basin 54	266.50	18-13	265.10	0.014	1.05	1.50	9.97	11.03
146-07	59.04	Basin 35	230.12	7-143	230.04	0.014	0.14	2.21	19.34	26.44
15-05	280.95	5-13	221.59	Basin 40	220.69	0.014	0.32	1.50	5.52	4.58
15-12	116.44	12-17	220.23	12-16	218.10	0.014	1.83	2.00	28.41	23.84
15-13	238.44	13-19	248.78	13-16	247.15	0.013	0.68	1.50	8.69	9.94
15-18	286.17	18-13	265.10	18-14	263.60	0.014	0.52	1.50	7.06	11.02
157-12	48.78	12-193	230.68	12-192	230.34	0.012	0.70	2.50	37.10	32.76
160-12	176.13	12-196	231.97	12-193	230.68	0.012	0.73	2.50	38.03	32.76
16-06	26.09	Basin 33	211.74	Node927	211.74	0.014	0.00	2.50	1.20	26.69
16-12	115.67	12-18	220.54	12-17	220.23	0.014	0.27	2.00	10.88	23.84
16-13	145.83	13-20	249.00	13-19	248.78	0.013	0.15	1.50	4.08	10.05

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
16-14	71.29	14-23	304.48	14-24	303.84	0.014	0.90	1.50	9.24	6.21
16-18	218.50	18-14	263.60	18-15	262.60	0.014	0.46	1.50	6.60	11.02
17-06	101.10	6-136	214.28	6-137	213.00	0.014	1.27	2.00	23.64	23.08
17-13	380.04	Basin 25	334.07	13-21	316.34	0.012	4.67	1.50	24.58	24.34
17-14	12.40	14-24	303.84	14-25	303.44	0.014	3.23	1.00	5.94	5.06
17-18.1	194.14	18-15	262.60	18-16	249.80	0.014	6.59	1.50	25.05	11.02
18-06	554.00	400-11	219.40	Node929	217.20	0.014	0.40	2.00	13.24	23.08
18-13.1	357.08	13-21	314.44	13-22	309.34	0.012	1.43	2.00	29.29	24.83
18-14.1	142.22	14-25	303.44	14-27	302.34	0.014	0.77	1.00	2.91	4.64
18-18.1	103.72	19-5	359.99	18-17	333.91	0.012	25.14	1.50	57.06	30.70
19-13	146.47	13-22	309.04	13-23	306.04	0.012	2.05	2.00	35.07	24.82
19-14	28.21	Basin 24	303.59	44-30	303.44	0.014	0.53	2.00	15.32	34.84
19-18	269.20	18-17	333.88	18-18	281.99	0.012	19.28	2.00	107.60	30.70
198-12	138.49	12-328	232.40	12-196	231.97	0.012	0.31	2.50	24.76	32.76
1D18	10.00	8-34	252.58	8-35	252.57	0.014	0.10	1.50	2.18	2.51
1U18	10.00	8-32	252.60	8-33	252.60	0.01	0.00	1.50	0.43	2.51
201-12	109.58	12-232	232.83	12-328	232.42	0.012	0.37	2.50	27.18	32.76
20-14	15.48	14-29	305.52	14-23	304.48	0.014	6.72	1.50	25.28	6.21
20-14A	15.24	44-30	303.44	14-31	303.38	0.014	0.39	2.00	13.18	34.84
20-18	120.38	18-18	281.99	18-19	270.41	0.012	9.62	2.00	76.01	30.70
20-31	222.93	Basin 65	318.84	31-3	316.79	0.014	0.92	3.00	59.39	39.96
203-12	75.47	12-234	233.54	12-232	232.83	0.012	0.94	2.50	43.10	32.76
204-12	117.89	12-237	234.14	12-234	233.54	0.012	0.51	2.50	31.70	32.76
207-12	219.97	12-238	235.17	12-237	234.14	0.012	0.47	2.50	30.41	32.76
2-11.1	39.19	4-1	216.59	11-4	216.20	0.014	1.00	1.50	9.73	10.09
211-12	302.37	Basin 48	236.18	12-238	235.17	0.012	0.33	2.50	25.68	32.77
21-14	19.22	14-31	303.38	Basin 19	299.90	0.014	18.11	2.00	89.39	34.84
21-18	393.61	18-19	269.88	18-20	267.33	0.012	0.65	2.00	19.73	22.80
2-13.1	286.19	Basin 38	232.76	Basin 28	231.33	0.014	0.50	1.50	6.89	12.20
2-16.1	160.14	16-111	223.99	16-131	222.55	0.014	0.90	1.50	9.25	3.74
22-18	402.11	18-20	267.33	18-21	264.03	0.012	0.82	2.00	22.20	22.80

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
228-12	248.00	Basin 30	230.22	12-274	230.14	0.014	0.03	2.00	3.77	16.22
23-18	96.56	18-21	263.83	18-22	263.34	0.012	0.51	2.00	17.46	22.80
23-24.1	51.44	24-19	286.22	24-16	287.28	0.014	-2.06	1.50	14.00	-12.38
23-25.1	31.54	Basin 68	374.67	25-26	374.61	0.014	0.19	1.50	4.25	3.98
236-12	232.82	12-274	230.14	12-279	229.56	0.014	0.25	2.00	10.48	17.18
237-12	57.85	12-279	229.56	12-282	229.42	0.014	0.24	2.00	10.33	17.66
240-12	183.47	12-282	229.42	12-283	228.96	0.014	0.25	2.00	10.52	17.46
24-13	67.42	13-24	306.34	14-29	305.52	0.014	1.22	1.50	10.76	6.22
24-18	399.18	18-22	263.27	18-23	262.64	0.012	0.16	2.00	9.74	22.79
24-24	231.78	Basin 60	287.74	24-19	286.28	0.014	0.63	1.50	7.74	12.38
24-25	64.56	25-26	374.41	25-27	374.13	0.014	0.43	1.50	6.42	3.98
244-12	251.61	12-283	228.96	12-288	228.34	0.014	0.25	2.00	10.43	22.74
248-12	245.53	12-288	228.34	12-294	226.66	0.014	0.68	2.25	23.79	22.73
25-13.1	227.82	13-5	233.69	Basin 30	230.32	0.014	1.48	1.75	17.89	12.68
252-12	70.09	12-294	226.66	12-295	226.41	0.014	0.36	2.25	17.18	22.71
25-25.1	123.68	25-27	373.48	25-32	372.85	0.014	0.51	1.50	6.96	3.98
26-11	257.23	Basin 44	214.33	11-34	213.47	0.014	0.33	2.00	12.15	17.48
27-11	230.55	11-34	213.37	11-35	212.60	0.014	0.33	2.00	12.14	17.48
27-23	215.24	Basin 59	275.34	23-31	270.49	0.014	2.25	1.50	14.64	11.52
28-02	299.76	Basin 06	236.45	Basin 05	235.59	0.014	0.29	1.75	7.88	3.02
28-11	28.00	11-35	212.50	11-40	212.44	0.014	0.21	2.00	9.72	17.48
28-23	38.18	23-31	270.29	23-32	270.19	0.014	0.26	1.75	7.53	11.51
29-02	59.00	Basin 05	235.34	2-38	235.14	0.014	0.34	2.00	12.23	7.07
29-03	57.20	Basin 08	240.78	Basin 03	240.20	0.014	1.01	1.75	14.82	10.75
29-11	59.82	11-40	212.34	11-41	212.14	0.014	0.33	2.00	12.15	17.48
29-23	373.34	23-32	270.19	23-25	269.45	0.014	0.20	1.75	6.55	11.50
2D18	10.00	8-34	252.58	8-35	252.57	0.014	0.10	1.50	2.18	2.51
2U18	10.00	8-32	252.60	8-33	252.60	0.01	0.00	1.50	0.43	2.51
300-1	23.00	400-8	215.00	400-9	214.90	0.014	0.43	2.00	13.85	23.08
300-13	45.00	Basin 02	219.00	Basin 01	218.80	0.014	0.44	2.00	14.00	18.29
300-16A	23.00	400-20	214.80	400-21	214.20	0.014	2.61	3.00	182.18	66.24

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
300-16B	23.00	400-20	214.80	400-21	214.20	0.014	2.61	2.00	33.93	19.57
300-17	31.00	400-18	222.21	400-19	222.08	0.014	0.42	1.50	6.32	9.92
300-2	59.38	Node1501	220.30	400-11	220.30	0.014	0.00	1.50	1.25	48.13
30-02	440.96	2-20	237.46	2-17	235.28	0.014	0.49	2.00	14.77	13.35
300-26	266.00	Basin 53	252.74	13-20	249.00	0.013	1.41	1.50	12.46	12.97
300-29	243.00	Basin 23	281.00	400-46	275.58	0.014	2.23	1.25	8.96	11.42
300-3	26.41	400-62	215.00	Basin 32	214.90	0.014	0.38	1.25	3.69	5.60
30-03	171.90	Basin 03	239.10	2-20	237.91	0.014	0.69	2.00	17.48	13.36
300-31	20.00	400-28	217.70	400-30	217.50	0.014	1.00	2.00	21.01	10.51
300-32	20.00	400-30	217.50	400-31	217.30	0.014	1.00	2.00	21.01	10.51
300-35	66.50	400-42	221.95	400-43	221.65	0.014	0.45	2.50	25.58	4.51
300-36	68.00	400-38	215.59	400-39	215.38	0.014	0.31	2.50	21.17	8.12
300-37	30.00	400-40	217.16	400-41	216.61	0.014	1.83	1.00	9.66	8.14
300-38	24.00	400-34	220.63	400-35	220.43	0.014	0.83	1.00	6.51	18.07
300-40	12.40	400-26	213.20	400-27	213.00	0.014	2.42	1.00	4.20	5.38
300-42	35.50	400-57	220.72	400-56	220.25	0.014	1.32	2.00	24.17	18.14
300-43	40.00	400-24	212.50	400-25	212.30	0.014	0.50	2.00	14.85	6.69
30-06	12.45	6-37	222.72	6-111	222.72	0.014	0.00	3.00	1.96	72.24
300-61	240.00	400-46	275.58	8-79	270.36	0.014	2.17	1.50	14.39	11.42
30-11.1	98.52	11-41	212.04	11-42	211.75	0.014	0.29	2.00	11.40	17.48
30-23	232.38	23-24	269.30	23-21	266.82	0.014	1.07	1.50	10.08	11.39
30-25	156.20	25-35	365.09	25-42	356.07	0.014	5.77	1.25	14.41	3.98
31-02	207.91	2-38	235.08	2-39	234.89	0.014	0.09	2.50	11.51	7.07
31-23	76.74	23-21	266.69	23-3	265.93	0.014	0.99	1.50	9.71	11.37
32-02	96.01	2-39	234.89	2-44	234.70	0.014	0.20	2.50	16.94	7.07
32-05	195.70	Basin 40	220.69	5-57	220.03	0.014	0.34	1.50	5.66	9.71
33-02	18.64	2-1	219.28	2-2	219.20	0.014	0.43	2.50	24.95	9.92
33-30	314.00	Basin 64	310.88	Node1473	310.70	0.014	0.06	3.00	14.83	3.18
34-02	414.27	2-2	219.04	2-7	218.47	0.014	0.14	2.50	14.13	9.91
34-17	155.11	Basin 85	246.55	18-1	245.33	0.014	0.79	2.00	18.63	23.33
35-02	12.77	2-7	218.47	Node1431	218.05	0.014	3.29	2.50	69.07	9.91

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
36 Orifice	10.00	31-12	0.05	Node1462	0.00	0.014	0.00	0.05	90.40	25.67
36-02	438.84	2-15	224.15	2-14	219.76	0.014	1.00	2.50	38.09	13.35
36-06	100.58	Basin 37	224.65	6-37	222.72	0.014	1.92	1.50	13.51	6.07
37-02	500.01	2-16	229.08	2-15	224.45	0.014	0.93	2.50	36.65	13.35
37-06	258.30	6-44	223.93	6-37	222.72	0.014	0.47	3.00	42.39	66.39
37-24	240.09	Basin 61	290.58	24-34	290.12	0.014	0.19	2.00	9.19	7.15
38-02	255.82	2-17	235.08	2-16	231.08	0.014	1.56	2.50	47.63	13.35
38-06	254.42	Basin 34	224.42	6-44	223.93	0.014	0.19	3.00	27.18	66.42
38-24	69.99	24-34	290.11	24-36	289.77	0.014	0.49	2.00	14.64	7.14
38-31	247.53	31-86	320.09	31-16	319.72	0.014	0.15	4.00	51.57	43.82
39-24	303.94	24-36	289.75	24-38	289.73	0.014	0.01	2.00	1.70	7.14
39-31	23.09	31-16	319.72	31-17	319.67	0.014	0.22	4.00	62.06	43.82
400-1	226.26	13-6	237.40	13-5	233.69	0.014	1.64	1.75	18.84	10.94
400-33.1	140.11	Node 912	219.20	400-33	217.78	0.014	1.01	1.50	9.82	14.65
400-60A	50.43	400-59	217.30	400-60	217.20	0.014	0.20	1.08	1.82	6.65
400-60B	50.43	400-59	217.30	400-60	217.20	0.014	0.20	1.17	2.22	7.91
40-24	110.10	24-41	294.98	24-40	293.87	0.014	1.01	3.50	93.80	13.73
40-31	306.04	31-17	319.61	Basin 75	318.11	0.014	0.49	4.00	93.38	43.84
41-02	58.35	2-14	219.57	2-13	219.28	0.014	0.50	4.00	94.03	23.26
41-06	124.65	Basin 31	221.44	6-105	220.74	0.014	0.56	1.50	7.31	11.27
41-23	192.54	23-42	277.31	23-43	273.21	0.014	2.13	2.00	30.65	12.34
41-24	111.12	Basin 62	295.41	24-41	294.98	0.014	0.39	3.50	58.11	13.73
41-31	156.68	Basin 75	318.04	31-111	317.42	0.014	0.40	4.00	83.90	67.18
42-02	42.95	2-44	234.70	Basin 04	234.70	0.014	0.00	2.00	0.66	7.06
42-06	264.97	6-105	220.74	6-103	219.77	0.014	0.37	1.50	5.90	8.84
42-2	45.26	2-52	221.66	2-53	221.53	0.014	0.29	2.00	11.26	10.52
42-23	330.93	23-41	278.75	23-42	277.40	0.014	0.41	2.00	13.42	12.34
42-31	112.44	31-111	317.32	31-112	316.46	0.014	0.76	4.00	116.65	67.18
43-06	189.35	6-103	219.65	6-102	217.88	0.014	0.93	1.50	9.43	7.72
43-17	60.17	Basin 86	340.70	17-35	338.50	0.014	3.66	1.50	18.65	10.12
43-23	313.70	23-40	279.57	23-41	278.85	0.014	0.23	2.00	10.06	12.36

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
44-06	85.93	6-102	217.86	6-101	217.47	0.014	0.45	1.50	6.57	6.68
44-23	535.30	23-48	282.68	23-40	279.66	0.014	0.56	2.00	15.78	12.37
45-06	145.27	25-32	372.84	25-35	365.19	0.014	5.27	1.00	7.59	3.98
46-06	39.10	400-61	216.62	6-100	216.28	0.014	0.87	1.00	3.09	5.66
46-17	276.90	17-35	338.50	Basin 87	337.70	0.014	0.29	1.50	5.24	10.14
47-11	98.45	Basin 45	197.00	11-91	193.44	0.014	3.62	1.50	18.55	1.63
47-17	165.17	Basin 87	337.70	17-132	334.20	0.014	2.12	1.50	14.20	14.86
48-11	41.81	Basin 46	195.45	11-88	194.58	0.014	2.08	2.50	54.94	4.49
48-17	200.99	17-131	325.40	17-116	321.60	0.014	1.89	1.50	13.41	14.77
48-23	22.69	23-25	269.45	23-24	269.30	0.014	0.66	1.50	7.93	11.44
48-24	170.42	24-51	299.66	24-50	295.14	0.014	2.65	2.25	46.83	13.44
49-11	71.37	11-88	194.58	11-89	194.12	0.014	0.64	2.50	30.58	4.49
49-12	44.30	12-76	228.67	12-71	228.54	0.014	0.29	1.00	1.79	-0.23
49-17	242.39	17-116	321.60	17-18	313.90	0.014	3.18	1.50	17.39	14.77
49-24	94.19	24-52	300.45	24-51	299.66	0.014	0.84	2.25	26.34	13.44
500-1.1	75.71	31-13	319.59	Basin 65	318.84	0.014	0.99	3.00	61.64	37.06
500-2.1	76.86	25-123	339.35	25-124	338.57	0.014	1.01	4.00	134.37	58.31
500-3.1	23.17	22-2	294.10	22-3	292.20	0.014	8.20	1.50	27.93	14.77
500-4	31.77	6-101	216.94	400-61	216.91	0.014	0.09	1.00	1.02	5.88
500-5	420.00	Basin 21	251.44	8-61	251.09	0.014	0.08	4.00	38.50	20.62
500-9.1	12.00	8-36	252.57	8-37	252.46	0.012	0.92	1.00	3.70	5.06
50-11	24.65	11-89	194.12	11-90	193.89	0.014	0.93	2.50	36.79	4.49
50-17	252.88	17-18	313.40	22-1	298.30	0.014	5.97	1.50	23.84	14.77
50-23	63.68	24-17	284.61	23-48	282.68	0.014	3.03	2.00	36.57	12.38
50-25	67.74	Basin 69	432.34	25-2	427.48	0.014	7.17	1.50	26.13	1.56
51-11	139.32	11-90	193.89	11-91	193.34	0.014	0.39	2.50	23.93	4.49
51-25	39.91	25-2	427.13	25-3	421.60	0.014	13.86	1.50	36.31	1.56
5-13.1	475.99	13-7	243.20	13-6	237.40	0.014	1.22	1.50	10.77	10.95
52-11	86.99	11-91	193.34	11-92	192.50	0.014	0.97	2.50	37.43	5.80
52-25	236.49	25-3	421.50	25-4	396.89	0.014	10.41	1.50	31.47	1.56
53-05	292.00	5-132	221.56	Basin 42	220.41	0.014	0.39	1.50	6.12	4.37

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
53-25	39.79	25-4	396.54	Basin 71	393.34	0.014	8.04	1.50	27.66	1.56
54-05	246.15	Basin 42	220.37	5-138	219.57	0.014	0.33	1.50	5.56	8.47
55-05	60.57	5-57	219.98	5-65	219.82	0.014	0.26	1.75	7.56	9.64
55-17	146.24	17-78	281.54	17-76	276.64	0.014	3.35	1.50	17.85	12.38
56-05	305.81	5-65	219.77	Basin 43	218.81	0.014	0.31	1.75	8.24	9.58
56-17	500.21	17-76	276.54	17-92	248.51	0.014	5.60	1.50	23.09	12.39
56-24	45.89	24-58	302.62	24-56	302.29	0.014	0.72	2.25	24.39	13.44
56-25	147.30	Basin 70	383.95	25-9	378.09	0.014	3.98	2.00	41.90	9.53
57-05	223.59	5-138	219.56	Basin 43	218.76	0.014	0.36	1.75	8.80	8.42
57-17	56.11	Basin 88	283.16	17-78	281.84	0.014	2.35	1.50	14.96	12.39
57-24	161.78	24-56	302.29	24-52	300.46	0.014	1.13	2.25	30.59	13.44
58-05	204.02	5-144	218.19	5-151	218.19	0.014	0.00	2.00	0.66	18.32
58-24	285.75	30-69	304.00	24-58	302.62	0.014	0.48	2.50	26.47	13.44
58-25	198.03	25-9	378.06	Basin 71	377.74	0.014	0.16	2.00	8.44	9.52
59-05	226.70	5-151	218.09	4-1	217.32	0.014	0.34	2.00	12.24	18.29
59-24	92.03	24-50	294.89	30-70	294.08	0.014	0.88	2.25	26.98	13.44
59-25	197.32	Basin 71	377.54	25-13	373.64	0.014	1.98	2.00	29.53	16.58
61-05	44.85	5-100	221.70	5-132	221.56	0.014	0.31	1.50	5.45	4.38
61-12	90.38	Basin 83	231.14	12-91	229.94	0.014	1.33	1.50	11.24	1.58
61-30	187.63	Basin 78	317.51	30-42	316.91	0.014	0.32	1.50	5.52	4.51
62-07	115.27	Basin 36	231.74	7-136	231.33	0.014	0.36	1.50	5.82	6.08
62-12	11.25	12-91	229.84	12-92	229.79	0.014	0.44	1.50	6.50	1.58
62-25	119.62	25-13	373.54	25-15	368.61	0.014	4.12	2.00	42.65	16.58
62-30	166.93	Basin 77	317.68	30-42	316.91	0.014	0.46	1.50	6.62	3.73
63-05	136.64	Basin 41	222.05	5-100	221.70	0.014	0.26	1.50	4.94	4.39
63-07	46.29	7-136	231.33	7-137	231.08	0.014	0.54	1.50	7.17	6.04
63-12	97.49	12-92	229.79	12-93	229.42	0.014	0.38	1.50	6.01	1.58
63-25	219.19	25-15	368.51	25-17	358.76	0.014	4.45	2.00	44.30	16.58
63-30	178.49	30-42	316.91	30-43	316.34	0.014	0.32	2.00	11.87	7.34
64-07	84.77	7-137	231.08	7-142	230.94	0.014	0.17	1.50	3.96	6.02
64-12	190.35	12-93	229.42	12-71	228.87	0.014	0.29	1.75	7.91	1.58

Link Data and Results for 25-Year Event

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64-30	16.21	30-43	316.34	30-44	316.04	0.014	1.85	2.00	28.58	7.34
65-07	304.95	7-47	234.25	7-45	233.64	0.014	0.20	1.50	4.36	4.02
65-12	99.51	12-71	228.73	12-72	227.14	0.014	1.60	1.00	4.18	1.35
66-07	344.40	7-60	236.92	7-47	234.25	0.014	0.78	1.50	8.59	4.02
66-25	246.81	25-17	358.68	25-19	357.32	0.014	0.55	2.00	15.59	16.59
67-05	30.59	Basin 43	218.75	5-144	218.19	0.014	1.83	2.00	28.42	18.31
67-07	181.12	7-62	237.77	7-60	236.92	0.014	0.47	1.50	6.68	4.02
67-12	90.54	12-72	224.34	Basin 80	224.24	0.014	0.11	1.50	3.24	6.61
68-12	43.25	Basin 80	224.24	12-74	224.05	0.014	0.44	2.00	13.92	11.93
68-25	99.78	25-19	357.24	25-180	357.07	0.014	0.17	2.50	15.72	16.58
69-07	225.28	7-74	245.74	7-62	237.77	0.014	3.54	1.50	18.35	4.02
69-12	179.37	Basin 84	227.54	12-72	224.54	0.014	1.67	1.50	12.61	5.92
69-25	137.29	25-20	356.82	25-45	355.94	0.014	0.64	2.00	16.82	16.58
70-07	189.23	Basin 18	246.49	7-77	246.22	0.014	0.14	1.50	3.68	4.02
70-07A	79.16	7-77	246.22	7-74	245.74	0.014	0.61	0.83	1.58	4.03
70-25	141.29	Basin 72	352.80	25-52	350.64	0.014	1.53	1.50	12.06	5.34
71-07	243.53	Basin 07	236.68	Basin 05	235.83	0.014	0.35	1.50	5.76	3.07
7-13.1	227.51	Basin 29	249.50	13-8	247.50	0.014	0.88	1.50	9.15	10.96
71-30	67.27	30-45	313.34	30-47	310.90	0.014	3.63	4.00	254.04	45.02
7-14.1	157.60	14-15A.2	370.33	14-15A.1	361.33	0.014	5.71	1.00	7.91	8.09
72-07	288.35	Basin 09	242.37	7-29	239.23	0.014	1.09	1.50	10.18	5.38
72-30	256.65	30-44	313.97	30-45	313.34	0.014	0.25	4.00	66.08	45.02
73-07	69.05	7-29	238.38	Basin 13	238.04	0.014	0.49	1.50	6.84	5.36
73-25	343.00	25-54	348.27	25-57	347.38	0.014	0.76	1.50	4.97	5.29
73-30	404.26	30-32	314.91	30-44	313.97	0.014	0.23	4.00	64.32	39.96
74-07	11.98	7-45	234.25	7-46	234.08	0.014	1.42	1.50	11.62	4.02
74-30	359.97	31-3	315.79	30-32	314.91	0.014	0.24	4.00	65.95	39.96
75-07	113.96	7-142	230.70	Basin 35	230.12	0.014	0.51	2.00	14.99	5.99
78-11	179.91	12-133	224.62	16-111	223.99	0.014	0.35	1.50	5.77	3.74
79-12	50.70	Basin 81	227.05	12-87	226.24	0.014	1.60	1.50	12.33	14.13
79-25	163.09	25-57	347.38	25-60	346.18	0.014	0.74	1.50	8.37	5.26

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
8.4Orifice	10.00	17-137	0.05	1465 Copy	0.00	0.014	0.00	0.05	0.00	2.19
80-11	404.46	11-96	211.00	11-95	209.70	0.014	0.32	1.50	5.53	10.76
80-12	148.11	12-87	226.14	12-88	224.22	0.014	1.30	1.50	11.11	14.12
80-25	43.90	25-60	346.33	25-122	345.74	0.014	1.34	1.50	11.31	5.25
81-12	82.97	12-88	224.12	12-89	223.28	0.014	1.01	1.50	9.81	14.12
81-25	213.35	25-79	350.32	25-122	344.95	0.014	2.52	3.00	98.26	53.91
8-14.1	155.01	Basin 26	385.68	14-14	384.65	0.014	0.66	1.50	7.95	8.25
82-12	84.71	12-89	223.18	12-90	222.34	0.014	0.99	1.50	9.71	14.11
83-06	185.22	6-86	225.48	Basin 34	224.42	0.014	0.57	2.50	28.81	22.66
83-12	316.63	12-90	221.67	12-18	221.39	0.014	0.09	2.00	6.25	14.20
84-06	145.90	12-295	226.39	6-86	225.48	0.014	0.62	2.50	30.08	22.68
84-12	90.38	12-19	225.67	12-90	224.34	0.014	1.47	1.00	4.01	0.23
84-25	124.82	25-77	351.21	25-79	350.42	0.014	0.63	3.00	49.27	53.91
85-12	124.95	17-74	231.01	Basin 81	227.05	0.014	3.17	1.50	17.36	12.37
85-25	66.13	25-75	351.72	25-77	351.31	0.014	0.62	3.00	48.77	53.91
86-12	124.95	12-20	227.85	12-19	225.87	0.014	1.58	1.00	4.16	0.23
86-25	25.38	Basin 74	353.56	25-73	353.13	0.014	1.69	2.50	49.58	24.84
87-12	33.00	12-76	228.44	12-20	228.05	0.014	1.18	1.00	3.60	0.23
90-25	99.14	25-72	352.42	25-75	351.82	0.014	0.61	3.00	48.18	53.91
91-25	155.00	25-73	353.08	25-72	352.49	0.014	0.38	3.00	38.21	24.84
92-25	430.00	25-70	354.35	25-72	352.52	0.014	0.43	2.50	24.85	29.08
97-06	140.50	6-100	216.24	500-8	215.27	0.014	0.69	1.00	2.75	5.60
98-25	286.88	25-64	356.99	25-70	354.45	0.014	0.89	2.50	35.84	29.13
C-1	67.53	6-137	213.00	Basin 33	211.74	0.014	1.87	1.50	33.73	23.08
C-10A	18.00	400-56	220.25	400-34	220.63	0.014	-2.11	2.00	59.89	-18.12
C-10B	172.00	400-35	220.43	Node 912	219.20	0.014	0.72	2.00	34.86	17.79
C-11	317.86	400-33	217.78	400-59	217.30	0.014	0.15	1.00	6.93	14.58
C-12	440.59	400-60	217.20	500-7	213.00	0.014	1.22	1.00	47.94	14.55
C-13A	229.00	400-39	215.38	400-26	212.38	0.014	1.31	2.50	85.55	8.06
C-13B	60.00	400-27	212.13	Basin 94	211.45	0.014	1.13	2.50	79.57	4.72
C-13B.1	352.00	Basin 94	211.45	400-24	212.50	0.014	-0.30	2.50	40.82	-7.35

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
C-14	96.56	400-41	216.61	400-38	215.59	0.014	1.06	6.00	1063.44	8.13
C-18A	54.82	8-178	251.20	Node904	250.50	0.014	1.28	2.50	8.73	24.92
C-18B	371.00	Node904	250.50	Basin 12	246.80	0.014	1.00	2.50	7.71	19.74
C-19	139.00	Basin 12	246.80	500-11	244.10	0.014	1.94	3.00	49.48	20.83
C-2	154.00	500-1	213.50	Node927	211.74	0.014	1.14	2.00	16.86	17.09
C-20	409.00	500-9	248.46	500-11	244.10	0.014	1.07	2.00	70.54	47.83
C-21	445.00	500-11	244.10	7-32	237.43	0.014	1.50	4.00	118.59	65.60
C-22	376.91	Basin 14	237.19	500-12	236.51	0.014	0.18	4.00	147.71	82.19
C-23	500.00	Basin 13	238.04	500-12	236.51	0.014	0.31	3.00	129.25	5.21
C-24A	442.56	500-14	236.34	Node1433	234.92	0.014	0.32	3.64	76.23	86.76
C-24B	18.03	Node1435	234.70	Basin 04	234.70	0.014	0.00	3.64	4.26	86.75
C-26	94.09	500-12	236.51	500-14	236.34	0.014	0.18	4.00	52.47	86.77
C-27	99.98	400-21	214.20	500-15	211.40	0.014	2.80	5.00	653.42	85.81
C-28	99.00	2-12	216.22	400-20	214.80	0.014	1.43	4.00	470.21	85.81
C-29B	55.00	2-13	219.28	2-12	216.22	0.014	5.56	4.00	644.39	23.26
C-30	63.00	400-19	222.08	2-1	219.28	0.014	4.44	3.00	270.10	9.92
C-31A	243.00	500-18	224.33	400-18	222.21	0.014	0.87	2.50	92.75	20.45
C-31B	140.62	400-18	222.21	2-52	221.33	0.014	0.63	2.50	78.56	10.53
C-34	71.00	400-31	217.30	500-19	215.60	0.014	2.39	2.00	63.79	10.51
C-35A	262.38	6-2	220.98	Basin 02	219.00	0.014	0.76	3.00	56.83	12.98
C-35C	323.40	Node1493	218.70	500-22	216.00	0.014	0.84	3.00	59.78	23.85
C-36	127.00	500-19	215.60	500-20	213.60	0.014	1.57	2.00	51.73	34.32
C-37	493.00	2-53	221.53	400-28	217.70	0.014	0.78	2.00	26.76	10.51
C-38	620.00	7-147	227.74	500-18	224.33	0.014	0.55	3.00	114.23	20.46
C-39A	197.08	7-13	231.17	Basin 15	229.78	0.014	0.71	3.00	116.77	18.95
C-3A	60.00	400-9	214.90	6-136	214.28	0.014	1.10	2.00	53.42	23.08
C-3B	179.00	6-113	216.50	400-8	215.00	0.014	0.84	2.00	48.11	23.08
C-4	125.45	Node929	217.20	6-113	216.50	0.014	0.56	2.00	39.26	23.08
C-40	513.61	12-74	224.05	12-18	220.54	0.014	0.68	4.00	481.51	11.87
C-41	10.00	16-119	215.68	400-40	215.40	0.014	2.80	5.00	4576.47	8.14
C-41A	127.70	13-25	309.50	13-24	306.34	0.014	2.48	2.00	26.17	6.26

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
C-41B	85.82	14-27	302.34	Basin 24	303.59	0.014	-1.46	0.50	1.23	-4.78
C-43	86.23	30-2	305.32	30-69	304.00	0.014	1.53	1.00	4.77	13.44
C-44	299.92	25-111	331.76	31-11	323.54	0.014	2.74	4.71	323.19	58.28
C-45	229.83	25-124	338.57	25-110	332.10	0.014	2.82	5.00	308.76	58.32
C-46A	217.79	25-122	344.95	25-131	343.41	0.014	0.71	4.89	161.58	58.34
C-46B	214.74	25-131	343.41	25-123	339.35	0.014	1.89	4.89	264.21	58.32
C-47A	509.14	Basin 19	299.90	Node1452	280.50	0.014	3.81	3.00	172.30	39.25
C-47B	734.39	Node1452	280.50	Node1453	260.00	0.014	2.79	3.00	147.48	39.24
C-48	80.74	Node1454	252.50	8-178	251.20	0.014	1.61	2.00	20.37	34.26
C-49	399.95	Node1453	260.00	Node1454	252.50	0.014	1.88	2.50	92.57	39.24
C-5	236.00	500-2	214.00	500-1	213.50	0.014	0.21	2.50	12.11	17.09
C-50A	127.00	400-25	212.30	500-7	211.70	0.014	0.47	2.50	39.12	6.46
C-50B	193.00	500-7	211.70	11-96	211.00	0.014	0.36	2.50	34.28	14.23
C-51	516.00	8-59	248.98	Node1459	248.98	0.014	0.00	2.50	2.17	47.84
C-6A	55.26	500-8	215.27	400-62	215.00	0.014	0.49	3.00	23.79	5.60
C-6B	205.00	Basin 32	214.90	500-2	214.00	0.014	0.44	3.00	22.55	17.12
C-7	377.80	6-111	222.72	Node1501	220.30	0.014	0.64	3.00	174.27	49.75
C-9A	97.85	16-131	222.55	400-42	221.95	0.014	0.61	2.50	83.95	3.94
C-9B	10.00	400-43	221.04	400-57	220.72	0.014	3.20	2.50	191.77	4.73
Link5	209.00	Basin 58	450.04	Node1419	427.49	0.014	10.79	1.00	10.87	8.12
Link6	316.00	Node 1446	429.65	Node1445	420.80	0.01	2.80	1.00	7.75	8.44
Link677	54.26	Node1424	354.34	Node1432	354.31	0.014	0.06	2.00	4.94	9.79
Link680	13.14	Node1431	217.80	2-14	219.51	0.014	-13.01	3.00	223.42	-9.91
Link685	90.00	17-135	227.97	Node1437	227.88	0.014	0.10	3.00	19.59	-0.26
Link686	104.80	Node1438	229.59	Node1437	228.54	0.014	1.00	0.83	2.03	-1.18
Link687	46.80	Node1438	229.59	17-138	226.93	0.014	5.68	0.83	4.85	-1.98
Link689	37.75	17-134	227.54	Node1440	227.16	0.014	1.01	1.00	3.32	-1.45
Link690	14.31	Node1440	227.06	Basin 89	227.03	0.014	0.21	1.00	1.51	-1.48
Link695	103.00	1465 Copy	226.89	Basin 90	226.41	0.014	0.47	1.00	2.26	4.84
Link696	17.00	Node1445	420.80	Basin 56	420.74	0.01	0.35	1.00	2.75	11.41
Link7	216.00	Node1419	421.75	Node1445	420.84	0.014	0.42	1.00	2.15	8.11

Link Data and Results for 25-Year Event

Name	Length (ft)	Upstream Node Name	Upstream Invert Elevation (ft)	Downstream Node Name	Downstream Invert Elevation (ft)	Roughness	Conduit Slope	Diameter (Height) (ft)	Design Full Flow (cfs)	Max Flow (cfs)
Link704	125.00	Basin 57	433.46	Node 1446	429.65	0.01	3.05	1.00	8.09	8.44
Link717	22.00	Node1462	320.70	31-86	320.09	0.014	2.77	4.00	222.10	43.82
Link718	31.78	Basin 90	226.41	12-135	226.34	0.014	0.22	1.00	1.55	4.98
Link719	266.94	12-135	226.34	12-134	225.42	0.014	0.34	1.00	1.94	3.74
Link720	10.00	12-134	226.25	12-133	224.62	0.014	16.30	0.67	4.59	3.74
Link724	606.40	13-23	306.04	Basin 24	303.59	0.014	0.40	1.50	6.20	10.81
Link729	76.00	Node1480	315.64	13-21	314.94	0.014	0.92	1.25	5.76	-0.25
Link732	228.00	Node1486	334.07	Node1484	328.34	0.014	2.51	1.00	5.24	0.64
Link734	86.00	Node1485	327.34	Node1481	320.34	0.014	8.14	2.00	59.93	0.30
Link736	360.00	Node1487	408.24	Node1492	407.88	0.014	0.10	3.00	19.59	9.22
Link737	490.00	Node1488	407.88	Node1489	394.00	0.014	2.83	1.00	5.57	5.52
Link738	400.00	Node1489	392.60	Node1491	392.29	0.014	0.08	4.00	37.13	12.96
Link742	15.00	Basin 01	218.80	Node1493	218.70	0.014	0.50	3.00	50.57	23.86
Link743	48.00	500-22	216.00	500-19	215.60	0.014	0.83	2.00	19.18	23.84
siphon	87.00	8-61	251.09	Basin 11	250.98	0.014	0.13	0.50	0.19	1.15
webculvert	43.89	Node1433	234.92	Node1435	234.70	0.014	0.50	4.00	247.12	43.37
weblake	129.38	2-11	219.92	2-12	216.22	0.014	2.86	3.00	104.74	37.54

Subcatchment Results

2-year Storm Event: 2.4 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 01	2.4	1.419	0.981	0.252	3.02
Basin 02	2.4	1.089	1.311	0.345	2.909
Basin 03	2.4	1.366	1.034	0.268	2.074
Basin 04	2.4	1.793	0.607	0.138	6.993
Basin 05	2.4	0.973	1.427	0.377	0.517
Basin 06	2.4	1.419	0.981	0.252	1.556
Basin 07	2.4	1.267	1.133	0.297	1.513
Basin 08	2.4	1.315	1.085	0.283	5.331
Basin 09	2.4	1.22	1.18	0.31	2.601
Basin 10	2.4	1.089	1.311	0.345	3.219
Basin 11	2.4	1.266	1.134	0.297	2.722
Basin 12	2.4	1.09	1.31	0.345	1.927
Basin 13	2.4	1.01	1.39	0.367	0.879
Basin 14	2.4	1.219	1.181	0.31	8.783
Basin 15	2.4	1.315	1.085	0.283	2.274
Basin 16	2.4	1.302	1.098	0.29	7.854
Basin 17	2.4	1.474	0.926	0.236	8.305
Basin 18	2.4	0.686	1.714	0.488	1.212
Basin 19	2.4	1.09	1.31	0.345	3.021
Basin 20	2.4	1.421	0.979	0.252	5.982
Basin 21	2.4	1.219	1.181	0.31	4.615
Basin 22	2.4	0.642	1.758	0.502	6.991
Basin 23	2.4	0.973	1.427	0.377	6.88
Basin 24	2.4	0.561	1.839	0.529	4.905
Basin 25	2.4	0.879	1.521	0.428	6.522
Basin 26	2.4	0.827	1.573	0.444	2.959
Basin 27	2.4	1.09	1.31	0.345	5.2
Basin 28	2.4	1.424	0.976	0.252	3.275
Basin 29	2.4	1.796	0.604	0.138	6.195
Basin 30.1	2.4	1.794	0.606	0.138	9.386
Basin 30.2	2.4	1.794	0.606	0.138	9.386
Basin 31	2.4	1.131	1.269	0.334	8.91
Basin 32	2.4	1.315	1.085	0.283	6.163
Basin 33	2.4	1.01	1.39	0.367	2.526
Basin 34	2.4	1.475	0.925	0.236	10.451
Basin 35	2.4	2.025	0.375	0.068	1.727
Basin 36	2.4	1.421	0.979	0.252	3.112
Basin 37	2.4	1.476	0.924	0.236	3.15
Basin 38	2.4	1.267	1.133	0.297	3.758
Basin 39	2.4	1.943	0.457	0.091	2.21

Subcatchment Results

2-year Storm Event: 2.4 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 40	2.4	1.942	0.458	0.091	4.543
Basin 41	2.4	1.315	1.085	0.283	2.181
Basin 42	2.4	1.593	0.807	0.2	4.506
Basin 43	2.4	1.05	1.35	0.356	0.905
Basin 44	2.4	1.267	1.133	0.297	5.294
Basin 45	2.4	0.54	1.86	0.486	0.614
Basin 46	2.4	1.315	1.085	0.283	2.233
Basin 47	2.4	1.05	1.35	0.356	5.989
Basin 48	2.4	2.032	0.368	0.067	6.672
Basin 49	2.4	1.01	1.39	0.367	9.667
Basin 50	2.4	1.74	0.66	0.156	4.298
Basin 51	2.4	1.614	0.786	0.195	4.458
Basin 52	2.4	1.593	0.807	0.2	6.42
Basin 53	2.4	1.3	1.1	0.288	20.012
Basin 54	2.4	1.131	1.269	0.334	5.228
Basin 55	2.4	1.131	1.269	0.334	7.92
Basin 56	2.4	0.836	1.564	0.413	2.951
Basin 57	2.4	0.869	1.531	0.404	3.673
Basin 58	2.4	1.175	1.225	0.322	3.893
Basin 59	2.4	1.01	1.39	0.367	5.268
Basin 60	2.4	0.686	1.714	0.488	3.702
Basin 61	2.4	0.902	1.498	0.396	3.154
Basin 62	2.4	0.937	1.463	0.386	6.101
Basin 63	2.4	1.131	1.269	0.334	5.054
Basin 64	2.4	0.774	1.626	0.429	1.396
Basin 65	2.4	1.05	1.35	0.356	2.686
Basin 66	2.4	1.174	1.226	0.322	5.922
Basin 67	2.4	0.775	1.625	0.429	15.167
Basin 68	2.4	0.869	1.531	0.404	1.729
Basin 69	2.4	0.836	1.564	0.413	0.67
Basin 70	2.4	0.716	1.684	0.443	3.924
Basin 71	2.4	0.937	1.463	0.386	2.734
Basin 72	2.4	0.937	1.463	0.386	2.371
Basin 73	2.4	0.662	1.738	0.456	11.716
Basin 74	2.4	0.54	1.86	0.486	9.389
Basin 75	2.4	0.869	1.531	0.404	11.951
Basin 76	2.4	1.093	1.307	0.345	3.541
Basin 77	2.4	1.22	1.18	0.31	1.798
Basin 78	2.4	1.366	1.034	0.268	2.279
Basin 79	2.4	1.01	1.39	0.367	5.552

Subcatchment Results

2-year Storm Event: 2.4 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 80	2.4	1.267	1.133	0.297	2.664
Basin 81	2.4	1.175	1.225	0.322	0.863
Basin 82	2.4	1.419	0.981	0.252	11.929
Basin 83	2.4	2.023	0.377	0.068	0.942
Basin 84	2.4	1.419	0.981	0.252	3.021
Basin 85	2.4	1.049	1.351	0.356	10.737
Basin 86	2.4	1.089	1.311	0.345	4.708
Basin 87	2.4	0.973	1.427	0.377	2.429
Basin 88	2.4	1.175	1.225	0.322	5.913
Basin 89	2.4	1.865	0.535	0.115	5.454
Basin 90	2.4	1.477	0.923	0.236	2.513
Basin 91	2.4	1.592	0.808	0.2	0.911
Basin 92	2.4	1.268	1.132	0.297	7.909
Basin 93	2.4	1.089	1.311	0.345	3.797
Basin 94	2.4	1.419	0.981	0.252	4.184

Subcatchment Results

5-year Storm Event: 2.9 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 01	2.9	1.853	1.047	0.264	4.022
Basin 02	2.9	1.467	1.433	0.377	4.029
Basin 03	2.9	1.792	1.108	0.282	2.775
Basin 04	2.9	2.269	0.631	0.135	8.909
Basin 05	2.9	1.326	1.574	0.415	0.726
Basin 06	2.9	1.852	1.048	0.264	2.065
Basin 07	2.9	1.677	1.223	0.317	2.047
Basin 08	2.9	1.733	1.167	0.3	7.188
Basin 09	2.9	1.622	1.278	0.333	3.547
Basin 10	2.9	1.467	1.433	0.377	4.46
Basin 11	2.9	1.676	1.224	0.317	3.688
Basin 12	2.9	1.468	1.432	0.377	2.67
Basin 13	2.9	1.372	1.528	0.403	1.229
Basin 14	2.9	1.621	1.279	0.333	11.964
Basin 15	2.9	1.733	1.167	0.3	3.065
Basin 16	2.9	1.736	1.164	0.295	10.867
Basin 17	2.9	1.915	0.985	0.244	10.981
Basin 18	2.9	1.012	1.888	0.533	2.119
Basin 19	2.9	1.467	1.433	0.377	4.182
Basin 20	2.9	1.855	1.045	0.264	7.96
Basin 21	2.9	1.621	1.279	0.333	6.284
Basin 22	2.9	0.958	1.942	0.55	12.635
Basin 23	2.9	1.326	1.574	0.415	9.667
Basin 24	2.9	0.856	2.044	0.582	9.59
Basin 25	2.9	1.247	1.653	0.458	10.175
Basin 26	2.9	1.184	1.716	0.478	4.74
Basin 27	2.9	1.468	1.432	0.377	7.19
Basin 28	2.9	1.859	1.041	0.263	4.358
Basin 29	2.9	2.272	0.628	0.135	7.897
Basin 30.1	2.9	2.27	0.63	0.135	11.955
Basin 30.2	2.9	2.27	0.63	0.135	11.955
Basin 31	2.9	1.517	1.383	0.363	12.278
Basin 32	2.9	1.733	1.167	0.3	8.299
Basin 33	2.9	1.372	1.528	0.403	3.535
Basin 34	2.9	1.916	0.984	0.244	13.819
Basin 35	2.9	2.517	0.383	0.068	2.145
Basin 36	2.9	1.855	1.045	0.264	4.145
Basin 37	2.9	1.917	0.983	0.244	4.167
Basin 38	2.9	1.677	1.223	0.317	5.083
Basin 39	2.9	2.43	0.47	0.087	2.771

Subcatchment Results

5-year Storm Event: 2.9 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 40	2.9	2.428	0.472	0.087	5.682
Basin 41	2.9	1.733	1.167	0.3	2.939
Basin 42	2.9	2.049	0.851	0.203	5.88
Basin 43	2.9	1.42	1.48	0.39	1.255
Basin 44	2.9	1.676	1.224	0.317	7.177
Basin 45	2.9	0.781	2.119	0.556	0.934
Basin 46	2.9	1.733	1.167	0.3	3.006
Basin 47	2.9	1.419	1.481	0.39	8.336
Basin 48	2.9	2.523	0.377	0.066	8.278
Basin 49	2.9	1.371	1.529	0.403	13.511
Basin 50	2.9	2.21	0.69	0.155	5.508
Basin 51	2.9	2.07	0.83	0.199	5.794
Basin 52	2.9	2.049	0.851	0.203	8.368
Basin 53	2.9	1.722	1.178	0.301	27.247
Basin 54	2.9	1.517	1.383	0.363	7.185
Basin 55	2.9	1.517	1.383	0.363	10.914
Basin 56	2.9	1.158	1.742	0.46	4.222
Basin 57	2.9	1.199	1.701	0.449	5.237
Basin 58	2.9	1.568	1.332	0.348	5.324
Basin 59	2.9	1.372	1.528	0.403	7.357
Basin 60	2.9	1.013	1.887	0.533	6.49
Basin 61	2.9	1.239	1.661	0.438	4.474
Basin 62	2.9	1.283	1.617	0.427	8.621
Basin 63	2.9	1.516	1.384	0.363	6.956
Basin 64	2.9	1.08	1.82	0.481	2.019
Basin 65	2.9	1.42	1.48	0.39	3.736
Basin 66	2.9	1.568	1.332	0.348	8.109
Basin 67	2.9	1.081	1.819	0.481	21.956
Basin 68	2.9	1.199	1.701	0.449	2.468
Basin 69	2.9	1.158	1.742	0.46	0.961
Basin 70	2.9	1.007	1.893	0.5	5.735
Basin 71	2.9	1.283	1.617	0.427	3.861
Basin 72	2.9	1.283	1.617	0.427	3.349
Basin 73	2.9	0.938	1.962	0.517	17.304
Basin 74	2.9	0.78	2.12	0.556	14.262
Basin 75	2.9	1.199	1.701	0.449	17.054
Basin 76	2.9	1.471	1.429	0.377	4.895
Basin 77	2.9	1.622	1.278	0.333	2.452
Basin 78	2.9	1.792	1.108	0.282	3.051
Basin 79	2.9	1.372	1.528	0.403	7.769

Subcatchment Results

5-year Storm Event: 2.9 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 80	2.9	1.677	1.223	0.317	3.611
Basin 81	2.9	1.57	1.33	0.348	1.183
Basin 82	2.9	1.853	1.047	0.264	15.868
Basin 83	2.9	2.514	0.386	0.068	1.169
Basin 84	2.9	1.853	1.047	0.264	4.022
Basin 85	2.9	1.419	1.481	0.39	14.948
Basin 86	2.9	1.467	1.433	0.377	6.52
Basin 87	2.9	1.326	1.574	0.415	3.411
Basin 88	2.9	1.568	1.332	0.348	8.104
Basin 89	2.9	2.346	0.554	0.111	6.88
Basin 90	2.9	1.919	0.981	0.244	3.321
Basin 91	2.9	2.048	0.852	0.203	1.185
Basin 92	2.9	1.678	1.222	0.317	10.718
Basin 93	2.9	1.467	1.433	0.377	5.259
Basin 94	2.9	1.853	1.047	0.264	5.566

Subcatchment Results

10-year Storm Event: 3.3 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 01	3.3	2.21	1.09	0.269	4.854
Basin 02	3.3	1.785	1.515	0.396	4.989
Basin 03	3.3	2.144	1.156	0.289	3.36
Basin 04	3.3	2.654	0.646	0.132	10.452
Basin 05	3.3	1.626	1.674	0.44	0.907
Basin 06	3.3	2.209	1.091	0.269	2.486
Basin 07	3.3	2.017	1.283	0.328	2.495
Basin 08	3.3	2.08	1.22	0.309	8.744
Basin 09	3.3	1.957	1.343	0.346	4.348
Basin 10	3.3	1.785	1.515	0.396	5.524
Basin 11	3.3	2.017	1.283	0.328	4.501
Basin 12	3.3	1.786	1.514	0.396	3.306
Basin 13	3.3	1.678	1.622	0.426	1.531
Basin 14	3.3	1.956	1.344	0.346	14.653
Basin 15	3.3	2.079	1.221	0.309	3.728
Basin 16	3.3	2.095	1.205	0.296	13.363
Basin 17	3.3	2.278	1.022	0.248	13.19
Basin 18	3.3	1.295	2.005	0.56	2.931
Basin 19	3.3	1.785	1.515	0.396	5.177
Basin 20	3.3	2.212	1.088	0.269	9.601
Basin 21	3.3	1.956	1.344	0.346	7.695
Basin 22	3.3	1.234	2.066	0.58	17.788
Basin 23	3.3	1.627	1.673	0.44	12.087
Basin 24	3.3	1.116	2.184	0.618	14.028
Basin 25	3.3	1.56	1.74	0.475	13.35
Basin 26	3.3	1.49	1.81	0.497	6.294
Basin 27	3.3	1.785	1.515	0.396	8.892
Basin 28	3.3	2.216	1.084	0.268	5.256
Basin 29	3.3	2.658	0.642	0.132	9.269
Basin 30.1	3.3	2.655	0.645	0.132	14.023
Basin 30.2	3.3	2.655	0.645	0.132	14.023
Basin 31	3.3	1.84	1.46	0.38	15.15
Basin 32	3.3	2.079	1.221	0.309	10.087
Basin 33	3.3	1.678	1.622	0.426	4.405
Basin 34	3.3	2.278	1.022	0.248	16.599
Basin 35	3.3	2.912	0.388	0.075	2.478
Basin 36	3.3	2.212	1.088	0.269	5.003
Basin 37	3.3	2.28	1.02	0.248	5.007
Basin 38	3.3	2.017	1.283	0.328	6.197
Basin 39	3.3	2.822	0.478	0.083	3.218

Subcatchment Results

10-year Storm Event: 3.3 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 40	3.3	2.82	0.48	0.083	6.597
Basin 41	3.3	2.08	1.22	0.309	3.574
Basin 42	3.3	2.421	0.879	0.203	7.003
Basin 43	3.3	1.732	1.568	0.411	1.556
Basin 44	3.3	2.017	1.283	0.328	8.764
Basin 45	3.3	0.994	2.306	0.607	1.225
Basin 46	3.3	2.08	1.22	0.309	3.653
Basin 47	3.3	1.731	1.569	0.411	10.353
Basin 48	3.3	2.918	0.382	0.072	9.56
Basin 49	3.3	1.677	1.623	0.426	16.825
Basin 50	3.3	2.591	0.709	0.153	6.486
Basin 51	3.3	2.443	0.857	0.199	6.885
Basin 52	3.3	2.421	0.879	0.203	9.959
Basin 53	3.3	2.072	1.228	0.308	33.288
Basin 54	3.3	1.841	1.459	0.38	8.852
Basin 55	3.3	1.841	1.459	0.38	13.467
Basin 56	3.3	1.435	1.865	0.492	5.339
Basin 57	3.3	1.481	1.819	0.48	6.605
Basin 58	3.3	1.898	1.402	0.363	6.537
Basin 59	3.3	1.678	1.622	0.426	9.159
Basin 60	3.3	1.296	2.004	0.56	8.991
Basin 61	3.3	1.527	1.773	0.467	5.625
Basin 62	3.3	1.577	1.723	0.454	10.812
Basin 63	3.3	1.84	1.46	0.38	8.579
Basin 64	3.3	1.345	1.955	0.516	2.57
Basin 65	3.3	1.732	1.568	0.411	4.638
Basin 66	3.3	1.897	1.403	0.363	9.966
Basin 67	3.3	1.346	1.954	0.516	27.961
Basin 68	3.3	1.482	1.818	0.48	3.115
Basin 69	3.3	1.434	1.866	0.492	1.217
Basin 70	3.3	1.26	2.04	0.539	7.345
Basin 71	3.3	1.577	1.723	0.454	4.841
Basin 72	3.3	1.577	1.723	0.454	4.201
Basin 73	3.3	1.18	2.12	0.56	22.313
Basin 74	3.3	0.994	2.306	0.607	18.696
Basin 75	3.3	1.482	1.818	0.48	21.524
Basin 76	3.3	1.79	1.51	0.396	6.054
Basin 77	3.3	1.957	1.343	0.346	3.005
Basin 78	3.3	2.144	1.156	0.289	3.694
Basin 79	3.3	1.678	1.622	0.426	9.684

Subcatchment Results

10-year Storm Event: 3.3 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 80	3.3	2.018	1.282	0.328	4.41
Basin 81	3.3	1.899	1.401	0.363	1.455
Basin 82	3.3	2.21	1.09	0.269	19.133
Basin 83	3.3	2.909	0.391	0.075	1.351
Basin 84	3.3	2.21	1.09	0.269	4.852
Basin 85	3.3	1.731	1.569	0.411	18.568
Basin 86	3.3	1.785	1.515	0.396	8.072
Basin 87	3.3	1.626	1.674	0.44	4.262
Basin 88	3.3	1.898	1.402	0.363	9.965
Basin 89	3.3	2.735	0.565	0.107	8.022
Basin 90	3.3	2.281	1.019	0.248	3.988
Basin 91	3.3	2.42	0.88	0.203	1.409
Basin 92	3.3	2.019	1.281	0.328	13.087
Basin 93	3.3	1.785	1.515	0.396	6.511
Basin 94	3.3	2.21	1.09	0.269	6.714

Subcatchment Results

25-year Storm Event: 3.8 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 01	3.8	2.666	1.134	0.272	5.92
Basin 02	3.8	2.197	1.603	0.415	6.25
Basin 03	3.8	2.594	1.206	0.295	4.112
Basin 04	3.8	3.139	0.661	0.127	12.386
Basin 05	3.8	2.018	1.782	0.467	1.147
Basin 06	3.8	2.664	1.136	0.272	3.025
Basin 07	3.8	2.455	1.345	0.338	3.076
Basin 08	3.8	2.524	1.276	0.317	10.753
Basin 09	3.8	2.389	1.411	0.358	5.389
Basin 10	3.8	2.197	1.603	0.415	6.923
Basin 11	3.8	2.454	1.346	0.338	5.554
Basin 12	3.8	2.198	1.602	0.415	4.142
Basin 13	3.8	2.077	1.723	0.45	1.93
Basin 14	3.8	2.388	1.412	0.358	18.149
Basin 15	3.8	2.523	1.277	0.317	4.584
Basin 16	3.8	2.553	1.247	0.294	16.548
Basin 17	3.8	2.739	1.061	0.249	16.008
Basin 18	3.8	1.67	2.13	0.588	4.029
Basin 19	3.8	2.198	1.602	0.415	6.484
Basin 20	3.8	2.668	1.132	0.272	11.706
Basin 21	3.8	2.388	1.412	0.358	9.528
Basin 22	3.8	1.601	2.199	0.61	24.829
Basin 23	3.8	2.019	1.781	0.467	15.3
Basin 24	3.8	1.466	2.334	0.654	20.185
Basin 25	3.8	1.968	1.832	0.49	17.542
Basin 26	3.8	1.89	1.91	0.516	8.366
Basin 27	3.8	2.198	1.602	0.415	11.126
Basin 28	3.8	2.672	1.128	0.272	6.408
Basin 29	3.8	3.144	0.656	0.127	10.987
Basin 30.1	3.8	3.14	0.66	0.127	16.614
Basin 30.2	3.8	3.14	0.66	0.127	16.614
Basin 31	3.8	2.259	1.541	0.397	18.911
Basin 32	3.8	2.523	1.277	0.317	12.393
Basin 33	3.8	2.077	1.723	0.45	5.557
Basin 34	3.8	2.74	1.06	0.249	20.144
Basin 35	3.8	3.407	0.393	0.083	2.894
Basin 36	3.8	2.668	1.132	0.272	6.101
Basin 37	3.8	2.741	1.059	0.249	6.08
Basin 38	3.8	2.455	1.345	0.338	7.64
Basin 39	3.8	3.314	0.486	0.088	3.777

Subcatchment Results

25-year Storm Event: 3.8 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 40	3.8	3.312	0.488	0.088	7.74
Basin 41	3.8	2.524	1.276	0.317	4.394
Basin 42	3.8	2.893	0.907	0.202	8.427
Basin 43	3.8	2.138	1.662	0.433	1.953
Basin 44	3.8	2.455	1.345	0.338	10.823
Basin 45	3.8	1.283	2.517	0.665	1.628
Basin 46	3.8	2.524	1.276	0.317	4.489
Basin 47	3.8	2.137	1.663	0.433	13.017
Basin 48	3.8	3.413	0.387	0.083	11.157
Basin 49	3.8	2.076	1.724	0.45	21.212
Basin 50	3.8	3.073	0.727	0.15	7.716
Basin 51	3.8	2.915	0.885	0.198	8.266
Basin 52	3.8	2.893	0.907	0.202	11.972
Basin 53	3.8	2.521	1.279	0.313	41.059
Basin 54	3.8	2.259	1.541	0.397	11.035
Basin 55	3.8	2.259	1.541	0.397	16.81
Basin 56	3.8	1.8	2	0.527	6.838
Basin 57	3.8	1.853	1.947	0.513	8.438
Basin 58	3.8	2.323	1.477	0.378	8.118
Basin 59	3.8	2.077	1.723	0.45	11.545
Basin 60	3.8	1.672	2.128	0.588	12.387
Basin 61	3.8	1.906	1.894	0.498	7.161
Basin 62	3.8	1.962	1.838	0.483	13.73
Basin 63	3.8	2.259	1.541	0.397	10.705
Basin 64	3.8	1.696	2.104	0.555	3.315
Basin 65	3.8	2.138	1.662	0.433	5.828
Basin 66	3.8	2.322	1.478	0.378	12.392
Basin 67	3.8	1.697	2.103	0.555	36.073
Basin 68	3.8	1.854	1.946	0.513	3.982
Basin 69	3.8	1.799	2.001	0.527	1.56
Basin 70	3.8	1.597	2.203	0.582	9.533
Basin 71	3.8	1.963	1.837	0.483	6.148
Basin 72	3.8	1.963	1.837	0.483	5.337
Basin 73	3.8	1.503	2.297	0.607	29.159
Basin 74	3.8	1.282	2.518	0.665	24.838
Basin 75	3.8	1.854	1.946	0.513	27.517
Basin 76	3.8	2.204	1.596	0.415	7.575
Basin 77	3.8	2.389	1.411	0.358	3.724
Basin 78	3.8	2.594	1.206	0.295	4.519
Basin 79	3.8	2.077	1.723	0.45	12.221

Subcatchment Results

25-year Storm Event: 3.8 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 80	3.8	2.457	1.343	0.338	5.445
Basin 81	3.8	2.325	1.475	0.378	1.81
Basin 82	3.8	2.665	1.135	0.272	23.313
Basin 83	3.8	3.403	0.397	0.083	1.577
Basin 84	3.8	2.666	1.134	0.272	5.917
Basin 85	3.8	2.136	1.664	0.433	23.343
Basin 86	3.8	2.197	1.603	0.415	10.113
Basin 87	3.8	2.018	1.782	0.467	5.391
Basin 88	3.8	2.323	1.477	0.378	12.394
Basin 89	3.8	3.223	0.577	0.103	9.453
Basin 90	3.8	2.743	1.057	0.249	4.838
Basin 91	3.8	2.891	0.909	0.202	1.692
Basin 92	3.8	2.457	1.343	0.338	16.159
Basin 93	3.8	2.197	1.603	0.415	8.157
Basin 94	3.8	2.666	1.134	0.272	8.186

Subcatchment Results

50-year Storm Event: 4.3 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 01	4.3	3.129	1.171	0.273	7.007
Basin 02	4.3	2.623	1.677	0.429	7.565
Basin 03	4.3	3.053	1.247	0.297	4.88
Basin 04	4.3	3.628	0.672	0.123	14.323
Basin 05	4.3	2.426	1.874	0.487	1.399
Basin 06	4.3	3.127	1.173	0.273	3.572
Basin 07	4.3	2.904	1.396	0.344	3.672
Basin 08	4.3	2.977	1.323	0.321	12.815
Basin 09	4.3	2.832	1.468	0.366	6.464
Basin 10	4.3	2.623	1.677	0.429	8.382
Basin 11	4.3	2.903	1.397	0.344	6.637
Basin 12	4.3	2.624	1.676	0.429	5.014
Basin 13	4.3	2.49	1.81	0.469	2.349
Basin 14	4.3	2.831	1.469	0.366	21.762
Basin 15	4.3	2.977	1.323	0.321	5.463
Basin 16	4.3	3.019	1.281	0.29	19.783
Basin 17	4.3	3.207	1.093	0.249	18.867
Basin 18	4.3	2.064	2.236	0.608	5.2
Basin 19	4.3	2.623	1.677	0.429	7.849
Basin 20	4.3	3.132	1.168	0.273	13.849
Basin 21	4.3	2.831	1.469	0.366	11.42
Basin 22	4.3	1.987	2.313	0.633	32.404
Basin 23	4.3	2.426	1.874	0.487	18.682
Basin 24	4.3	1.836	2.464	0.683	26.877
Basin 25	4.3	2.392	1.908	0.5	21.915
Basin 26	4.3	2.306	1.994	0.528	10.543
Basin 27	4.3	2.624	1.676	0.429	13.452
Basin 28	4.3	3.137	1.163	0.272	7.582
Basin 29	4.3	3.633	0.667	0.123	12.706
Basin 30.1	4.3	3.628	0.672	0.123	9.433
Basin 30.2	4.3	3.628	0.672	0.123	9.771
Basin 31	4.3	2.691	1.609	0.409	22.821
Basin 32	4.3	2.977	1.323	0.321	14.756
Basin 33	4.3	2.491	1.809	0.469	6.766
Basin 34	4.3	3.208	1.092	0.249	23.743
Basin 35	4.3	3.903	0.397	0.094	3.308
Basin 36	4.3	3.132	1.168	0.273	7.22
Basin 37	4.3	3.21	1.09	0.249	7.168
Basin 38	4.3	2.904	1.396	0.344	9.124
Basin 39	4.3	3.808	0.492	0.097	4.334

Subcatchment Results

50-year Storm Event: 4.3 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 40	4.3	3.806	0.494	0.097	8.88
Basin 41	4.3	2.977	1.323	0.321	5.235
Basin 42	4.3	3.37	0.93	0.198	9.864
Basin 43	4.3	2.558	1.742	0.449	2.367
Basin 44	4.3	2.904	1.396	0.344	12.942
Basin 45	4.3	1.593	2.707	0.716	2.07
Basin 46	4.3	2.977	1.323	0.321	5.345
Basin 47	4.3	2.557	1.743	0.449	15.805
Basin 48	4.3	3.909	0.391	0.094	12.748
Basin 49	4.3	2.49	1.81	0.469	25.816
Basin 50	4.3	3.558	0.742	0.145	8.949
Basin 51	4.3	3.393	0.907	0.195	9.658
Basin 52	4.3	3.37	0.93	0.198	14.003
Basin 53	4.3	2.978	1.322	0.314	49
Basin 54	4.3	2.691	1.609	0.409	13.3
Basin 55	4.3	2.691	1.609	0.409	20.285
Basin 56	4.3	2.182	2.118	0.557	8.433
Basin 57	4.3	2.242	2.058	0.54	10.385
Basin 58	4.3	2.76	1.54	0.388	9.757
Basin 59	4.3	2.49	1.81	0.469	14.047
Basin 60	4.3	2.066	2.234	0.608	16.008
Basin 61	4.3	2.301	1.999	0.523	8.787
Basin 62	4.3	2.364	1.936	0.506	16.812
Basin 63	4.3	2.69	1.61	0.409	12.916
Basin 64	4.3	2.065	2.235	0.589	4.115
Basin 65	4.3	2.558	1.742	0.449	7.071
Basin 66	4.3	2.759	1.541	0.388	14.905
Basin 67	4.3	2.066	2.234	0.589	44.758
Basin 68	4.3	2.243	2.057	0.54	4.903
Basin 69	4.3	2.181	2.119	0.557	1.926
Basin 70	4.3	1.953	2.347	0.619	11.886
Basin 71	4.3	2.365	1.935	0.506	7.529
Basin 72	4.3	2.365	1.935	0.506	6.538
Basin 73	4.3	1.846	2.454	0.648	36.571
Basin 74	4.3	1.592	2.708	0.716	31.571
Basin 75	4.3	2.243	2.057	0.54	33.881
Basin 76	4.3	2.631	1.669	0.429	9.158
Basin 77	4.3	2.832	1.468	0.366	4.468
Basin 78	4.3	3.052	1.248	0.297	5.363
Basin 79	4.3	2.491	1.809	0.469	14.883

Subcatchment Results

50-year Storm Event: 4.3 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 80	4.3	2.905	1.395	0.344	6.51
Basin 81	4.3	2.762	1.538	0.388	2.178
Basin 82	4.3	3.129	1.171	0.273	27.567
Basin 83	4.3	3.899	0.401	0.094	1.802
Basin 84	4.3	3.13	1.17	0.273	7.002
Basin 85	4.3	2.556	1.744	0.449	28.341
Basin 86	4.3	2.623	1.677	0.429	12.244
Basin 87	4.3	2.425	1.875	0.487	6.579
Basin 88	4.3	2.76	1.54	0.388	14.909
Basin 89	4.3	3.714	0.586	0.102	10.888
Basin 90	4.3	3.212	1.088	0.249	5.702
Basin 91	4.3	3.368	0.932	0.198	1.977
Basin 92	4.3	2.906	1.394	0.344	19.32
Basin 93	4.3	2.623	1.677	0.429	9.873
Basin 94	4.3	3.129	1.171	0.273	9.684

Subcatchment Results

100-year Storm Event: 4.4 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 01	4.4	3.223	1.177	0.273	7.226
Basin 02	4.4	2.709	1.691	0.432	7.833
Basin 03	4.4	3.145	1.255	0.297	5.035
Basin 04	4.4	3.726	0.674	0.122	14.711
Basin 05	4.4	2.509	1.891	0.491	1.451
Basin 06	4.4	3.221	1.179	0.273	3.683
Basin 07	4.4	2.994	1.406	0.344	3.793
Basin 08	4.4	3.069	1.331	0.321	13.232
Basin 09	4.4	2.921	1.479	0.367	6.683
Basin 10	4.4	2.709	1.691	0.432	8.68
Basin 11	4.4	2.993	1.407	0.344	6.857
Basin 12	4.4	2.711	1.689	0.432	5.192
Basin 13	4.4	2.575	1.825	0.472	2.435
Basin 14	4.4	2.921	1.479	0.367	22.496
Basin 15	4.4	3.069	1.331	0.321	5.641
Basin 16	4.4	3.113	1.287	0.29	20.434
Basin 17	4.4	3.301	1.099	0.248	19.442
Basin 18	4.4	2.145	2.255	0.611	5.441
Basin 19	4.4	2.71	1.69	0.432	8.128
Basin 20	4.4	3.226	1.174	0.273	14.282
Basin 21	4.4	2.92	1.48	0.367	11.804
Basin 22	4.4	2.066	2.334	0.637	33.969
Basin 23	4.4	2.509	1.891	0.491	19.376
Basin 24	4.4	1.913	2.487	0.687	28.273
Basin 25	4.4	2.478	1.922	0.501	22.807
Basin 26	4.4	2.391	2.009	0.53	10.989
Basin 27	4.4	2.71	1.69	0.432	13.926
Basin 28	4.4	3.23	1.17	0.272	7.819
Basin 29	4.4	3.731	0.669	0.122	13.05
Basin 30.1	4.4	3.726	0.674	0.122	9.688
Basin 30.2	4.4	3.726	0.674	0.122	10.035
Basin 31	4.4	2.778	1.622	0.411	23.617
Basin 32	4.4	3.068	1.332	0.321	15.234
Basin 33	4.4	2.575	1.825	0.472	7.014
Basin 34	4.4	3.302	1.098	0.248	24.467
Basin 35	4.4	4.003	0.397	0.097	3.391
Basin 36	4.4	3.226	1.174	0.273	7.445
Basin 37	4.4	3.304	1.096	0.248	7.387
Basin 38	4.4	2.994	1.406	0.344	9.425
Basin 39	4.4	3.907	0.493	0.098	4.446

Subcatchment Results

100-year Storm Event: 4.4 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 40	4.4	3.904	0.496	0.098	9.107
Basin 41	4.4	3.069	1.331	0.321	5.405
Basin 42	4.4	3.466	0.934	0.198	10.152
Basin 43	4.4	2.643	1.757	0.452	2.452
Basin 44	4.4	2.994	1.406	0.344	13.372
Basin 45	4.4	1.657	2.743	0.725	2.162
Basin 46	4.4	3.069	1.331	0.321	5.518
Basin 47	4.4	2.642	1.758	0.452	16.375
Basin 48	4.4	4.008	0.392	0.097	13.066
Basin 49	4.4	2.574	1.826	0.472	26.76
Basin 50	4.4	3.655	0.745	0.144	9.196
Basin 51	4.4	3.489	0.911	0.194	9.937
Basin 52	4.4	3.466	0.934	0.198	14.411
Basin 53	4.4	3.071	1.329	0.314	50.603
Basin 54	4.4	2.779	1.621	0.411	13.761
Basin 55	4.4	2.779	1.621	0.411	20.993
Basin 56	4.4	2.26	2.14	0.562	8.762
Basin 57	4.4	2.322	2.078	0.545	10.786
Basin 58	4.4	2.849	1.551	0.389	10.09
Basin 59	4.4	2.574	1.826	0.472	14.56
Basin 60	4.4	2.147	2.253	0.611	16.755
Basin 61	4.4	2.381	2.019	0.528	9.122
Basin 62	4.4	2.445	1.955	0.51	17.446
Basin 63	4.4	2.777	1.623	0.411	13.366
Basin 64	4.4	2.141	2.259	0.595	4.28
Basin 65	4.4	2.644	1.756	0.452	7.326
Basin 66	4.4	2.848	1.552	0.389	15.416
Basin 67	4.4	2.142	2.258	0.595	46.556
Basin 68	4.4	2.323	2.077	0.545	5.092
Basin 69	4.4	2.259	2.141	0.562	2.002
Basin 70	4.4	2.026	2.374	0.626	12.375
Basin 71	4.4	2.447	1.953	0.51	7.813
Basin 72	4.4	2.446	1.954	0.51	6.784
Basin 73	4.4	1.917	2.483	0.655	38.114
Basin 74	4.4	1.656	2.744	0.725	32.982
Basin 75	4.4	2.323	2.077	0.545	35.193
Basin 76	4.4	2.718	1.682	0.432	9.482
Basin 77	4.4	2.921	1.479	0.367	4.619
Basin 78	4.4	3.145	1.255	0.297	5.533
Basin 79	4.4	2.575	1.825	0.472	15.428

Subcatchment Results

100-year Storm Event: 4.4 inches

Name	Total Rainfall (in)	Total Runoff Depth (in)	Total Infiltration (in)	Max Infil. Rate. (in/hr)	Max Flow (cfs)
Basin 80	4.4	2.996	1.404	0.344	6.726
Basin 81	4.4	2.851	1.549	0.389	2.253
Basin 82	4.4	3.223	1.177	0.273	28.424
Basin 83	4.4	3.998	0.402	0.097	1.847
Basin 84	4.4	3.223	1.177	0.273	7.221
Basin 85	4.4	2.641	1.759	0.452	29.365
Basin 86	4.4	2.71	1.69	0.432	12.679
Basin 87	4.4	2.508	1.892	0.491	6.823
Basin 88	4.4	2.849	1.551	0.389	15.421
Basin 89	4.4	3.813	0.587	0.104	11.174
Basin 90	4.4	3.307	1.093	0.248	5.876
Basin 91	4.4	3.464	0.936	0.198	2.034
Basin 92	4.4	2.997	1.403	0.344	19.961
Basin 93	4.4	2.709	1.691	0.432	10.223
Basin 94	4.4	3.223	1.177	0.273	9.987

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Appendix D

water quality data ▪ master plan

D.1 – TMDL Implementation Plan
D.2 – NPDES Minimum Control Measure Fact Sheets
D.3 – UIC Information
D.4 – DSL Wetland Compensatory Mitigation Facts
D.5 – Wetland Inventory
D.6 – Street Sweeping Technical Memorandum

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Appendix D

water quality data ▪ master plan

D.1 TMDL Implementation Plan

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CITY OF SILVERTON
OREGON'S GARDEN CITY

Public Works
306 S Water Street • Silverton OR 97381
www.silverton.or.us

June 26, 2010

Nancy Gramlich
Oregon DEQ
Western Region, Salem Office
750 Front Street NE, Ste. 120
Salem OR 97301-1039

RE: Molalla-Pudding Subbasin TMDL
City of Silverton Implementation Plan

Dear Ms Gramlich:

Enclosed with this correspondence you will find the City of Silverton Implementation Plan for the Molalla-Pudding Subbasin TMDL. I hope you will find the submittal to be timely and complete. I look forward to working with you as the City prepares for the first Implementation Plan annual report over the course of the next year.

If you have any questions, or need additional information, please feel free to contact me, at 503-873-5439.

Sincerely,

Steven E. Starner
Water Quality Supervisor

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City of Silverton, Oregon

Total Maximum Daily Loads Implementation Plan

June, 2010

***2006 Willamette River Basinwide**
Mercury

***2008 Silver Creek**
Bacteria, Temperature

***2008 Molalla-Pudding Subbasin**
DDT, Dieldrin, Iron

Final Draft
June 26, 2010

CITY OF SILVERTON
TMDL IMPLEMENTATION PLAN

TABLE OF CONTENTS

Section 1:	Introduction
Section 2:	Watershed Location
Section 3:	TMDL Pollutant Parameters Bacteria Temperature Mercury DDT, Dieldrin, Iron
Section 4:	Legal Authority
Section 5:	Stormwater Master Plan
Section 6:	Implementation Plan Review and Reporting
Section 7:	TMDL Implementation Tracking Matrix (described)
Section 8:	SPROUT
Section 9:	Last Word
Section 10:	Definitions
Appendix A:	TMDL Implementation Matrix
DEQ:	Molalla-Pudding Subbasin TMDL Order
DEQ:	Issuance of Molalla-Pudding Subbasin TMDL/WQMP

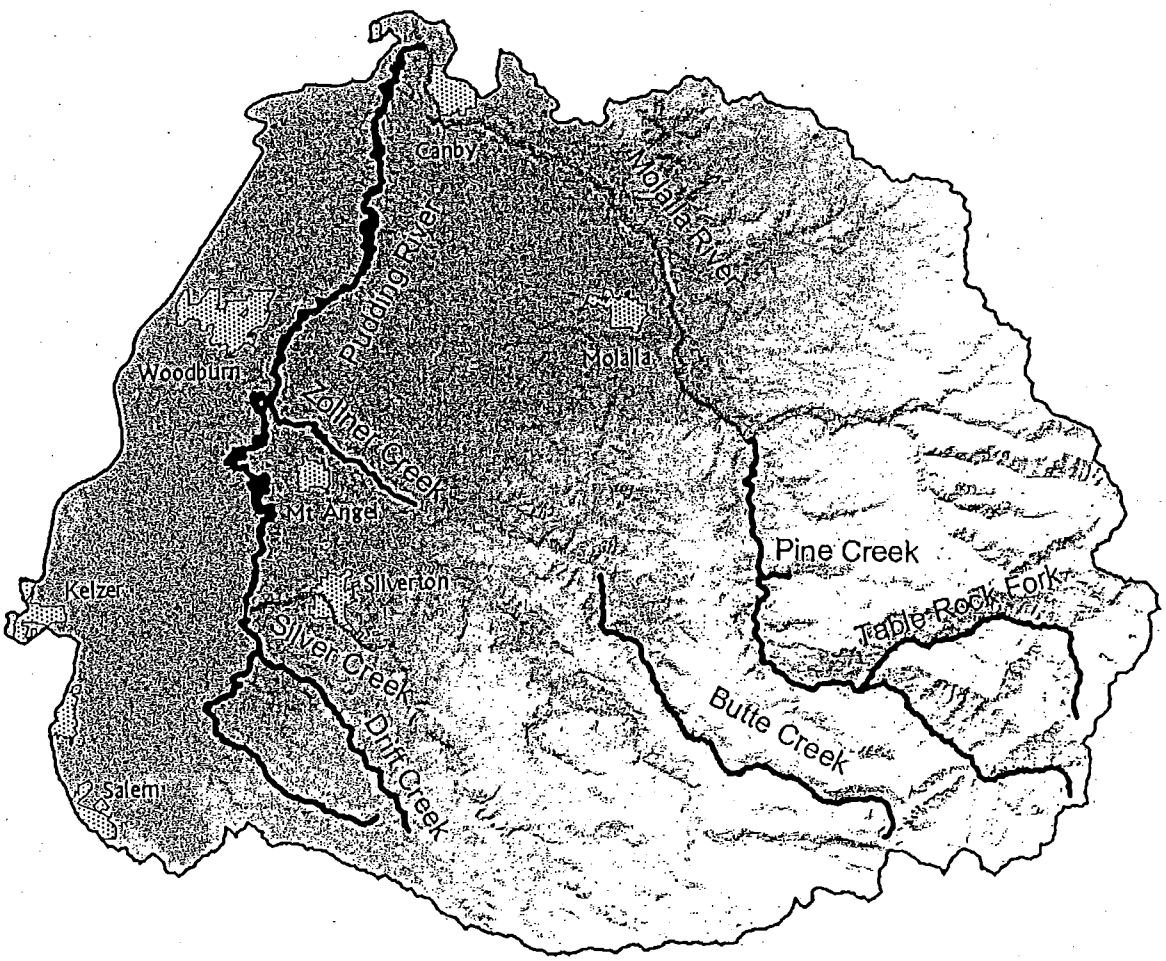
Section 1 – INTRODUCTION

The Willamette River and several tributaries from the Molalla-Pudding Watershed do not currently meet several water quality standards, including bacteria, mercury, temperature, DDT, Dieldrin, and Iron, as established by the federal Clean Water Act. These standards are intended to assure that beneficial uses of surface water, such as swimming, fish consumption, drinking water, and fish rearing, are protected. When water quality standards are not met, a Total Daily Maximum Load (TMDL) is required to be established. A TMDL determines how much pollution can be added to surface waters without exceeding water quality standards. A local TMDL Implementation Plan is a document describing the management strategies to be used by local agencies to restore and protect water quality.

This document is the TMDL Implementation Plan for the City of Silverton.

Section 2 – WATERSHED LOCATION

Silverton is located in Marion County, approximately 14 miles east of Salem on the western slope of the Cascade Mountains and the eastern edge of the Willamette Valley. The PSU Center for Population Research and Census has established the City's 2009 population as 9,585.



TOPOGRAPHY

Silverton is located on the level alluvial plain of Silver Creek between high ridges to the east and west. The general topography of the area slopes downward to the northwest. The elevation of the City is approximately 230 to 250 feet, whereas hills immediately to the southeast rise to nearly 900 feet. North of the City, the topography opens out from the ridges to a relatively flat area.

CLIMATE

Silverton's weather is characterized by wet, mild winters and warm, dry summers. The mean winter temperature is 41 degrees F and the mean summer temperature is 65 degrees F. Average annual rainfall is just under 50 inches with most of the precipitation occurring as rain from October to May. Prevailing winds are from the southwest in the winter and the north in the summer.

AIR QUALITY

Silverton is located on the eastern edge of the Willamette Valley air shed. Natural ventilation is restricted by the Cascade and Coast mountain ranges and is limited during periods of atmospheric stagnation in the late summer and early fall. No air quality monitoring has been performed in the City. There are no major pollution sources within the UGB, although severe short-term pollution events occur during the summer and early fall from smoke associated with agricultural field burning.

GEOLOGY AND SOILS

Silverton is located on relatively level alluvial deposits of the Sifton-Salem Association that occur on either side of Silver Creek. The level lands to the north and west of the City are comprised of Willamette Silts which are derived from the Columbia River Basalt. To the east and west of the City, the soils are comprised of weathered Columbia River Basalt and are relatively impermeable.

Nearly all soils in the area are classified as Class I-IV soils as defined by the US Soil Conservation Service. Classes I-IV soils are those suitable for agricultural use, irrigation, and rapid infiltration of water on a general basis.

WATER RESOURCES

The major water features of the area are Webb Lake, Silver Creek, Brush Creek, and Abiqua Creek. Silver and Abiqua Creek are tributary to the Pudding River, which flows northward to the Molalla River, which in turn discharges into the Willamette River at river mile 36. Brush Creek is tributary to Silver Creek, flowing out of Pettit Reservoir.

Silver Creek is the receiving water for most of the City's stormwater and the effluent from the City's wastewater treatment plant. Flow in Silver Creek varies throughout the

FISHERIES AND AQUATIC LIFE
The Oregon Department of Fish and Wildlife inventoried Silver Creek in July, 1993. The Department's conclusion was that the area near the wastewater treatment plant was a transition zone and did not support a significant number of game fish year-round. They further concluded that the lower two-mile stretch of Silver Creek is a migratory route for winter steelhead and cutthroat trout. Consequently, the stream is classified as "salmonid" with respect to DEQ's established water quality standards, and is protected for salmon and trout rearing and migration.

Section 3 – TMDL Pollutant Parameters
There are several programs that are either already in place or will be put in place to help ensure that the Molalla-Pudding TMDL waste load and load allocations will be implemented. Some of these are traditional regulatory programs such as specific requirements under National Pollution Discharge Elimination System (NPDES) Permits. Other programs address nonpoint sources through the authority of other state or federal agencies (for forested and agricultural lands) and voluntary efforts (like watershed councils).

BACTERIA, Point (NPDES Permit) Sources
The Silverton WWTP is located at approximately river mile 2.4 on Silver Creek, a tributary to the Pudding River. The wasteload allocation for bacteria will be met by the effluent limits for E. coli bacteria in the facility's discharge permit. The facility treats wastewater with an activated sludge process and ultraviolet disinfection.

The Silverton WTP is permitted to discharge filter backwash water and reservoir cleaning water to river mile 3.9 on Abiqua Creek, a tributary to the Pudding River. The TMDL has not identified a water quality standard violation for the bacteria parameter in Abiqua Creek, therefore the WTP discharge is not subject to a waste load allocation.

BACTERIA, Nonpoint (NP) Sources
The Molalla-Pudding Subbasin bacteria TMDL allocates "other appropriate measures", or surrogate measures, as provided under USEPA regulations. The surrogate measures translate load allocations into applicable measures of performance, or Best Management Practices (BMPs), rather than mass/time loads.

In Silverton, the BMPs to be implemented for reducing bacteria discharges include:

1. Identify and eliminate illicit connections and discharges to the storm sewer system.
2. Map local septic systems currently in use and ensure adequate maintenance is performed.
3. Educate pet owners about proper pet waste disposal and expand the current pet waste station program.
4. Inspect and enforce erosion control standards for new construction.
5. Establish a long-term operation and maintenance program for post-construction stormwater facilities.
6. Continue current program of regular street sweeping and catch basin cleaning.

TEMPERATURE, Point Sources

Between May and October, up to 75 percent of the treated effluent from the WWTP is pumped to several wetland cells in the Oregon Garden. The remainder flows by gravity to Silver Creek. Thermal load limits currently set in the pre-TMDL NPDES Permit are 5.2 million Kcal/day between May 16 and October 14 (summer), and 21 million Kcal/day from October 15 to May 15 (winter). The City continuously monitors effluent temperature for wastewater discharged to Silver Creek as well as that discharged to the Oregon Garden wetlands. The City also monitors temperature of the outflow from the Oregon Garden wetland to Brush Creek.

The TMDL allocates a heat load for the Silverton WWTP equivalent to a 0.2 degree C stream temperature increase when fully mixed with Silver Creek, applicable June1 through September 30. The excess thermal load is based on Silver Creek stream flows and is determined by the following calculation:

$$ETL = 0.20(Q_R + Q_e)C_F$$

where:

$ETL = \text{Excess Thermal Load}, \; kcal/day$

$0.20 = \text{allowed temperature increase}, \; ^oC$

$Q_R = \text{stream flow rate at gage Silver Creek at Silverton}, \; cfs$

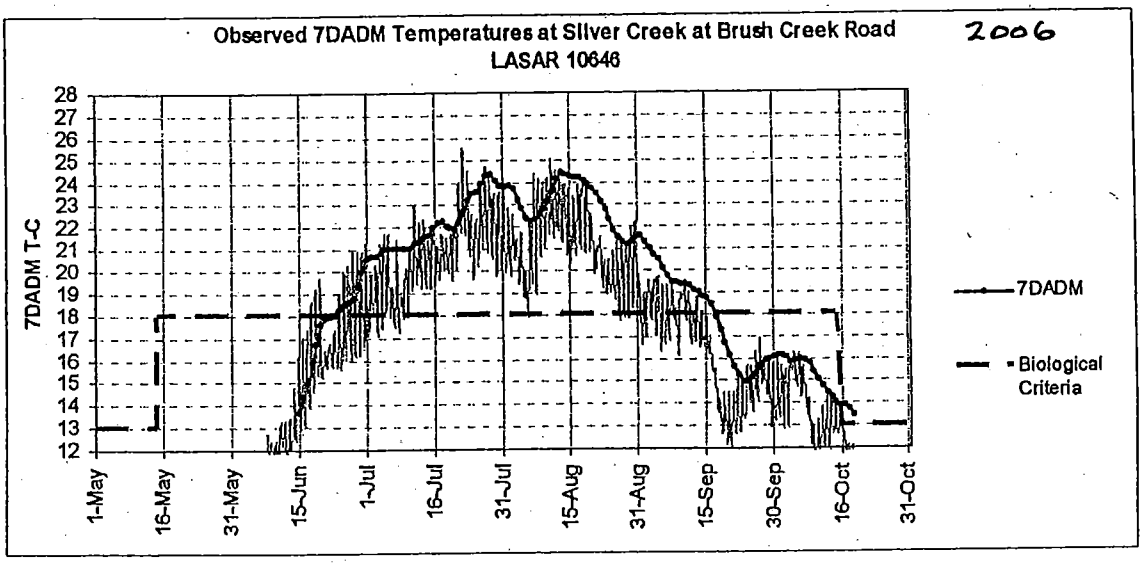
$Q_e = \text{City of Silverton WWTP effluent flow rate}, \; cfs$

$$C_F = 2{,}446{,}665 \frac{kcal \cdot s}{^oC \cdot ft^3 \cdot day}$$

Silverton WWTP Excess Thermal Load (ETL) allocations (million kcal/day) for various river and effluent flow combinations – June 1 to September 30.
Million kcal/day may be converted to MW-day/day by multiplying by 0.04846.

Silver Creek at Silverton flow rate (cfs):	≤3.5	5	7.5	10	12.5	15
Q_e (MGD)	ETL	ETL	ETL	ETL	ETL	ETL
0.1	1.79	2.52	3.75	4.97	6.19	7.42
0.2	1.86	2.60	3.82	5.04	6.27	7.49
0.3	1.94	2.67	3.90	5.12	6.34	7.57
0.4	2.02	2.75	3.97	5.20	6.42	7.64
0.5	2.09	2.83	4.05	5.27	6.50	7.72
0.7	2.24	2.98	4.20	5.42	6.65	7.87
1.0	2.47	3.20	4.43	5.65	6.87	8.10
1.5	2.85	3.58	4.81	6.03	7.25	8.48
2.0	3.23	3.96	5.18	6.41	7.63	8.85
2.5	3.61	4.34	5.56	6.79	8.01	9.23
3.0	3.98	4.72	5.94	7.16	8.39	9.61
4.0	4.74	5.47	6.70	7.92	9.14	10.37

Silver Creek at Silverton flow rate (cfs):	17.5	20	22.5	25	27.5	30
Q_e (MGD)	ETL	ETL	ETL	ETL	ETL	ETL
0.1	8.6	9.9	11.1	12.3	13.5	14.8
0.2	8.7	9.9	11.2	12.4	13.6	14.8
0.3	8.8	10.0	11.2	12.5	13.7	14.9
0.4	8.9	10.1	11.3	12.5	13.8	15.0
0.5	8.9	10.2	11.4	12.6	13.8	15.1
0.7	9.1	10.3	11.5	12.8	14.0	15.2
1.0	9.3	10.5	11.8	13.0	14.2	15.4



The City of Silverton WTP is the only point source on Abiqua Creek. Filter backwash water first enters the municipal storm sewer system, daylights in a drainage ditch (Olson's Ditch) through a partially developed industrial area, and flows into a constructed pond (Webb Pond) of approximately 20 acres and 10 feet in depth. The pond acts as a settling basin. Overflow from the pond enters a drainage ditch which eventually discharges to Abiqua Creek. Residual chlorine, pH, and settleable solids are regulated by the NPDES Permit. The WTP is allowed a 0.2 degree C temperature increase, applicable June 1 through September 30. Since impacts are not cumulative, the 0.2 degree C allowed need not be reduced for stream flow rates greater that the lowest (7Q10) flow rate. The excess thermal load for the WTP is calculated with the following equation, based on the 7Q10 flow for Abiqua Creek and a facility backwash discharge of 0.095 MGD:

$$ETL = 0.20(Q_R + Q_e)C_F$$

where:

ETL = Excess Thermal Load, $kcal/day$

0.20 = allowed temperature increase, ^oC

Q_R = estimated 7Q10 stream flow rate of Abiqua Creek d/s from Silverton DWP cfs

Q_e = City of Silverton DWP effluent flow rate, 0.147 cfs

$$C_F = 2{,}446{,}665 \frac{kcal \cdot s}{^oC \cdot ft^3 \cdot day}$$

Excess Thermal Load allocated to Silverton Drinking Water Treatment Plant.

Allocated ΔT (°C)	Stream Flow (7Q10) (cfs)	Effluent Flow (design flow) (cfs)	ETL (million kcal/day)	ETL (MW)
0.2	5	0.095	2.493	0.12

The current NPDES Permit requires a 30:1 dilution ratio in the receiving stream during periods of backwash discharge. Since the maximum reported discharge (0.147 cfs) and the 7Q10 flow in Abiqua Creek (5 cfs) would meet the dilution requirement, no operational changes appear to be necessary for the facility to meet the waste load allocation. However, the TMDL has been established without any temperature data related to the WTP backwash or the Webb Lake outfall. The City will be voluntarily collecting daily maximum temperature (degrees C) and 7-day maximum average temperature at the Webb Lake outfall, June 1 through September 30, for at least the first five years of TMDL implementation.

TEMPERATURE – Nonpoint Sources

Radiant heating of local streams that have lost much of their natural riparian cover is a major source of heat throughout the watershed. Because heat load from nonpoint sources is relatively difficult to determine, the TMDL uses a surrogate measure for temperature reduction. The surrogate is effective shade which is used to translate solar radiation loads into streamside vegetation objectives. Effective shade targets are established for each reach of a stream based on soil type and stream aspect. This means shade targets are greater on the south and west banks of any particular stream than on the east or north banks.

DEQ has created graphs that describe the effective shade target for any stream in the basin based on the geomorphic unit, channel width, stream aspect, and vegetation type. Using these graphs, individual steam reaches can be evaluated to determine the percent effective shade target and corresponding solar load allocation. The City of Silverton has been working with the Willamette Partnership, formed in 2004, to develop a process to allow land managers and regulated entities in the Willamette Basin to participate in a market for one ecosystem service – water temperature – through planting and maintaining riparian shade according to standards and processes generally described above. The Partnership is developing a "Trading Temperature Credits From Riparian Shade" handbook to address a unit of exchange (a temperature credit) for participating in riparian shade restoration, wetland restoration, floodplain restoration, stream flow augmentation, and wastewater reclamation/reuse.

The City of Silverton will continue to capitalize on the strong relationships established with the Pudding River Watershed Council, Marion County Soil and Water Conservation District, and other Designated Management Agencies (DMAs) in the watershed to identify suitable restoration projects and participate in project implementation. In general, milestone activities may be described as:

1. Conduct a survey and assessment of current riparian conditions in the City (Silver Creek) and the watershed.
2. Prioritize stream reaches based on need for effective shade and potential to impact steam temperature.
3. Conduct outreach to private land owners where effective shade is low.
4. Develop a planting plan and budget for revegetation projects.
5. Monitor plant survivability for two to three years after planting.
6. Develop a riparian reassessment plan for five to ten years after planting to measure changes in percent effective shade.

Another nonpoint source of heat is stormwater runoff from impervious surfaces, especially during summer storm events. It is anticipated that the SWMP Project will identify opportunities to construct detention ponds, water quality inlets, vaults, and tanks, swales, and vegetative filter strips to prevent temperature laden stormwater from entering Silver Creek. Also, the City will continue the practice of requiring trees to be planted in new developments to provide shade for streets, sidewalks, and parking lots. Existing street trees will be maintained and replaced as needed.

MERCURY, Point Sources

In the 2006 Willamette Basin TMDL, point source mercury is treated differently than bacteria or temperature. DEQ intends to use this initial TMDL period to gather more data on mercury in the basin and tributary watersheds. DMAs are required to conduct additional sampling for mercury on a schedule that DEQ will provide. Anticipating a schedule in the next 12 months, the City has budgeted for clean metals sampling and testing for both mercury and methylmercury. Additionally, the City is required to develop a mercury reduction manual using DEQ requirements. The timeline and structure of the manual and the sampling program have yet to be established by DEQ, therefore the implementation schedule for point source mercury will be different than the other TMDL requirements. DEQ will provide notification of any required timeline for mercury sampling and submittal of the City's mercury reduction manual. The City's Implementation Plan will be updated as necessary when these requirements are provided.

MERCURY, Nonpoint Sources

The accumulation of mercury in fish is a well-recognized environmental problem throughout the United States. The primary way that humans are exposed to mercury is through the consumption of fish or seafood containing elevated levels of mercury. In Oregon, the Department of Human Services has issued fish consumption advisories for the Willamette River because the levels of mercury in bass and northern pike minnow exceed levels deemed to be safe for human consumption (0.35 ppm).

Mercury is a naturally occurring element found in soils throughout the Willamette Basin. Mercury is also found in trees and fossil fuels such as coal, natural gas, diesel, and heating oil. The mercury present in these fuels is released into the atmosphere upon combustion. This mercury can be transported great distances and can later be deposited on the land where storm water runoff can carry it into rivers and lakes. Mercury has been mined commercially in Oregon and used in many products including fluorescent lights, thermometers, automobile switches, and dental fillings. Preliminarily, DEQ has indicated that most of the mercury (96%) in the Willamette watershed comes from nonpoint sources such as the erosion of native soils containing mercury and the runoff of atmospherically-deposited mercury from urban and rural lands. A small amount (4%) of the mercury is discharged at low levels by some industrial facilities and domestic wastewater treatment facilities.

In Silverton, nonpoint source mercury will be addressed by the following means:

1. Especially for projects disturbing more than one acre (requiring a 1200C permit), ensure than erosion control measures are in place, are inspected regularly, and enforced.
2. Where natural erosion is occurring, support stream bank restoration projects.
3. Assist with a local Household Hazardous Waste Collection Event.
4. Educate the public about DEQ's Free Mercury Collection Program, locally through the permanent household hazardous waste facility in Marion County.
5. Continue street sweeping and catch basin cleaning program.
6. Enforce standards for ongoing erosion prevention and sediment control.

Silverton has surveyed and inspected each local dental office to ensure compliance with Senate Bill 704, requiring the installation of amalgam separators and biannual reporting of amalgam separator maintenance. However, effective July 1, 2010, due to a budgetary shortfall, DEQ will no longer offer free collection of mercury amalgam and mercury amalgam in traps. The Annual Oregon Dental Association Convention will continue to offer free waste mercury collection.

In May, 2010, Silverton High School submitted a Chemical Waste Disposal and Protocol Plan to the City. The plan included a zero discharge protocol for mercury. The school will use Mercury Waste Solutions, Inc. for recycling and disposal.

DDT, DIELDRIN, IRON – Point Sources
The Pudding River is water quality limited for DDT and Dieldrin. Since the collection system for the WWTP is likely to contain connections to surface water (infiltration/inflow), legacy pesticides such as DDT and Dieldrin could enter the wastewater being treated and discharged to Silver Creek and the Pudding River. Therefore, each point source has been allotted a DDT and Dieldrin wasteload allocation (WLA) that equals the facility's current conditions. The WLA requires that the facility cause no measurable increase in in-stream DDT and Dieldrin concentrations.

As a partial measure designed to meet total DDT water column targets and fish tissue action levels in the Pudding River, load allocations are expressed by a surrogate measure: total suspended solids (TSS) concentration targets. By compliance with the TSS limitation in the NPDES Permit, the WLA will be met.

The TMDL indicates that point source discharges do not contribute to excess loads of iron. The source of iron is likely natural, anthropogenic activities that promote stream bank erosion and storm runoff. At this time, each point source is allotted an iron WLA that equals the facility's current conditions. However, permitted sources will be required to monitor and submit sufficient data so that DEQ can conduct an effluent characterization for each facility. Eight sampling events for municipal sources will constitute sufficient data. Based on the data submitted, DEQ will evaluate the extent that each permitted source causes or contributes to iron water quality exceedences. If the evaluation indicates a measurable increase in receiving water iron concentrations from the permitted point source activities or processes, DEQ would calculate effluent limits at that time.

DDT, DIELDRIN, IRON – Nonpoint Sources
Much of the published data on pesticides and toxics in the Pudding River Watershed dates back to the early 1900's and some information may not reflect current pesticide practices. Pesticides with known risks to humans and aquatic organisms (ie. DDT, Dieldrin) have since been replaced with safer products. Also, pesticide applicators are likely more aware of the health risks of pesticides than they were several decades ago and actively do more to ensure their proper application. From a TMDL implementation standpoint, successful reductions of pollution in this water quality parameter are best measured by reductions in TSS from erosion control and public education and outreach.

Some of the educational activities to reduce the presence of toxics in Silverton stormwater runoff include:

1. Encourage the use of native vegetation.

Native plants require less water, chemical, and fertilizer use.

2. Don't kill all the vegetation.

If chemicals are being applied to keep vegetative growth down, use them sparingly and make sure some vegetation is maintained to stabilize slopes.

3. Follow application guidelines on all chemical products.

Do not apply chemicals near sensitive waterways, streams, or storm sewer inlets.

4. Properly contain and dispose of unused chemicals.

The means for providing public education and outreach include:

1. Silverton Community Area Network (SCAN-WAVE Broadband cable TV).
2. All Planning Commission and City Council meetings televised (SCAN).
3. Weekly local newspaper, Silverton Appeal.
4. Monthly local newspaper, Our Town.
5. Quarterly City newsletter in Our Town publication.
6. Annual water system Consumer Confidence Report (direct mail).
7. Regular public meetings, PRWC and MCSWCD.

(In order to determine compliance with the DDT, Dieldrin, Iron TMDL, TSS values are needed. A model which relates TSS to turbidity, an inexpensively measured field parameter, will be used as a tool for field water quality monitoring. The model is outlined in Appendix K of the Molalla-Pudding Subbasin TMDL document.)

Section 4 – LEGAL AUTHORITY

The City has adopted Ordinances, Plans and Standards which will allow this Implementation Plan to be legally executed, including:

Silverton Municipal Code

Section 8.04.040	Public health nuisances designated – abatement.
Section 8.04.080	Drainage of surface waters.
Section 8.04.090	Hazardous containers and conditions.
Section 8.05.060	Removal of dog waste.
Section 12.36.030	Permit required for (tree) trimming or removal.
Section 13.36.010	Installation of facilities required when.
Section 13.36.020	Privies, cesspools and septic tanks prohibited.
Section 13.36.030	Dumping excrement or other waste prohibited.
Section 13.36.040	Discharging wastes to watercourses prohibited.
Section 13.36.050	Use of public sewers required.
Section 13.36.060	Maintenance of facilities required.
Section 13.36.070	Installation of sewers required.
Section 13.36.080	Changing of facilities limited.
Section 13.40.050	Location, capacity and other specifications.

Section 13.40.060 Operation and maintenance.
Section 13.40.070 Public sewer connection requirements.
Section 13.44.080 Leaks and extraneous discharges-monitoring procedures.
Section 13.52.030 Storm sewer use requirements.
Section 13.60.010 Inspection and testing-authorized officials.
Section 13.60.030 Inspection and testing-right of entry.
Section 13.60.050 Violation-notice to correct.
Section 16.12.040 Streetscape (street trees required).
Section 16.16.130 Designated creek protection.

City of Silverton Development Code (March 1, 2010)
Section 2.6.160 Re-vegetation standards.
Section 2.6.180 Grading and erosion control (including maint. and penalties).
Section 2.6.190 Storm drainage.
Section 2.6.220 Tree conservation, protection and removal.
Chapter 2.7 Wetlands and Riparian Overlay District

City of Silverton Comprehensive Plan (Revised August 2002)
The Oregon land use planning system provides a unique opportunity for local jurisdictions to address water quality protection and enhancement. Many of the goals have a direct connection to water quality, particularly Goal 5 (Natural Resources), Goal 6 (Air, Water, and Land Resources Quality), and Goal 7 (Areas subject to natural hazards). In the case of Goal 5, there is a specific rule that requires local jurisdictions to protect significant riparian areas and wetlands from development (see Silverton Development Code, Chapter 2.7).

Section 5 – STORMWATER MASTER PLAN
This will be the first Stormwater Master Plan for Silverton and the project deserves special recognition for several reasons. First, for a small community, a $99,770 planning effort is a major undertaking. The City's primary source of funding for stormwater maintenance and improvements comes from the State gas tax. The City also collects a Stormwater System Development Charge (SDC) on new development. $1,462 per single family dwelling unit, and 68 cents per square foot of impervious surface of commercial and industrial development. Funding inadequacies require City staff to be creative and efficient. The annual maintenance budget allows for emergency services related to Silver Creek flood events, street sweeping operations, and contract (Vactor truck) catch basin cleaning. A number of detention structures are maintained privately through Home Owner's Associations.

Second, this project will be completed during the first year of the TMDL Implementation Plan. It is anticipated that the detail of conditions of the existing system will result in prioritized improvements and maintenance strategies that will result in revisions to the initial draft of the Plan.

The Master Plan scope of work will include the following elements:

1. Data collection and existing facility conditions evaluation.
2. Geographic Information System (GIS) and mapping support.
3. Recommended revisions to storm water design standards.
4. Hydraulic model development.
5. Future condition analysis (based on storm event detention).
6. Assess City liability (potential flooding locations).
7. Financial plan (including development of a storm water utility fee).
8. Recommended Code revisions
9. Stormwater quality and wetlands evaluation.

The water quality portion of the Master Plan will be prepared in close coordination with Silverton's TMDL Implementation Plan, and will establish a staged sequential plan to meet TMDL WLAs. As the Master Plan project moves forward, there will be several meetings with the public (Technical Advisory Committee) and public reviews with the Planning Commission and City Council.

Section 6 – IMPLEMENTATION PLAN REVIEW AND REPORTING

The ultimate success of TMDL implementation activities will be measured by reaching the reduction level goals as they have been outlined in the Molalla-Pudding Subbasin TMDL document, for each pollutant parameter. For some strategies, such as planting trees for shade along waterways, it may take several years to reap the anticipated heat load reduction benefits. Progress towards lowering pollutant loads will be best measured by tracking accomplishments towards implementing the strategies identified in the Plan.

The City of Silverton will annually review the Implementation Plan and report on the activity associated with each strategy. Each year, the City will provide DEQ with a written report documenting efforts and tracking implementation activities. The report will contain a summary of accomplishments and any changes within the city that may influence how water quality management should be addressed. If there are strategies not completed within the targeted time frame, an explanation will be provided and a new time frame established. Every five years, a more comprehensive review of the Plan will occur, and changes to the will be made, if necessary. This review will include DEQ's re-evaluation of the Subbasin TMDL.

Section 7 – TMDL IMPLEMENTATION TRACKING MATRIX

The Implementation Tracking Matrix details the strategies that will be implemented within the next five years (see Appendix A). The strategies requiring grants and donations will be pursued when funding allows. The strategies related to community projects will occur when and where there is community interest, involvement, and funds. The matrix displays the pollutant being addressed, the strategy to address it, when that strategy will be implemented, and how to measure progress and successful implementation. This matrix will also serve as a tracking tool for annual reporting to DEQ.

Section 8 – SPROUT

The City of Silverton in collaboration with Marion County and The Oregon Garden developed a botanical garden that uses Silverton's secondary treated WWTP effluent as an economic, environmental, and aesthetic resource. A research and education program was developed along with the physical project. SPROUT – the Sustainable Plant Research and Outreach Center – acts as a bridge for communication, technology transfer, and project collaboration between growers, researchers, end users, educators, and policy makers in the field of phytotechnology. SPROUT's mission of "putting plants to work" is the strategic use of plants to provide ecosystem services in managed landscapes including wetlands, wastewater treatment, green roofs, raingardens, stormwater management, living machines, phytoremediation, and riparian buffers. The annual report for the Implementation Plan will include a summary of SPROUT's ongoing education and outreach efforts, including demonstration projects in the public display garden, hands-on workshops, and academic conferences.

Section 9 – LAST WORD

"I love the show on the Discovery Channel or NatGeo or wherever it is that predicts what will happen to Earth when it is finally relieved of the scourge commonly known as the human race. Anyone with half a brain should have figured out by now that we are nothing but an evolutionary flash in the cosmic skillet that is a tiny part of an infinite universe we are never going to come close to understanding. Whether it is caused by some giant flaming asteroid, or some giant flaming religious fundamentalist fruitcake, we are out of here, people, and frankly, I believe the planet will be a perfect place without us." - David Feherty

Section 10 – DEFINITIONS

TMDL means Total Maximum Daily Load.
NPDES means National Pollution Discharge Elimination System.
USEPA means United States Environmental Protection Agency.
NP means Nonpoint.
BMP means Best Management Practice.
ETL means Excess Thermal Load.
DMA means Designated Management Agency.
SWMP means Stormwater Master Plan.
PRWC means Pudding River Watershed Council.
MCSWCD means Marion County Soil and Water Conservation District.
DEQ means Department of Environmental Quality.
WLA means Waste Load Allocation.
7DADM means Seven Day Average Daily Maximum
ppm means parts per million
WWTP means Wastewater Treatment Plant
WTP means Water Treatment Plant

Appendix A: Silverton TMDL Implementation Matrix

Pollutant: Bacteria

City of Silverton, Oregon

SOURCE	STRATEGY	ACTION	REQUIRED RESOURCES	PERFORMANCE MEASURE	TIMELINE	MILESTONE	STATUS
Illicit Connections	Track storm sewer outfall E.coli	Sample outfalls for E.coli Concentrations	Existing staff-approx. 2hr/wk	Publish bacteria source tracking study	July 2010-June 2012	Inventory outfalls and sample locations (by Jan. 2011)	study protocol outlined
Failing Septic Systems	Investigate status of local septic systems	Inventory and map problem areas	Existing staff	Increase frequency of septic system service	Ongoing		Ongoing
Stormwater Run-off	Identify problems and solutions for municipal system	Develop a Storm Water Master Plan	$99,770 from Stormwater Improvement SDC fund	Complete storm sewer system evaluation - develop CIP	June 2010-June 2011	5 public advisory meetings and 2 City Council meetings	City Council approved contract June 2010
Pet/Animal Waste	Inventory pet waste station and recommend improvements	Educate pet/animal owners by local newspapers and quarterly city newsletter	Existing staff	Increase public awareness and reduce E.coli in outfalls	Ongoing	Pet waste stations installed	Ongoing
Erosion	Track construction and post-construction site run-off	Educate contractors	Existing staff	Reduce storm event turbidity at outfalls	Ongoing	1200 C permits issued and inspections conducted	Ongoing
Street and Catch Basin Maintenance	Establish regular schedules	Educate staff	$1,500 disposal costs-Street Maintenance fund	Catch basins emptied – streets swept regularly	Ongoing	Maintenance program documented	Budget adopted 2010-2011

Appendix A: Silverton TMDL Implementation Matrix

Pollutant: Temperature

City of Silverton, Oregon

SOURCE	STRATEGY	ACTION	REQUIRED RESOURCES	PERFORMANCE MEASURE	TIMELINE	MILESTONE	STATUS
Solar Radiation	Protect local riparian zones	Review current Overlay Protection Zone-rec. imp.	Existing staff	Field inspections conducted	June 2010-June 2011	Current Protection Zone reviewed	Riparian preservation ordinance adopted
	Remove non-native plant species	Identify projects through PRWC & MCSWCD	Provide maps, meeting space, & staff support	Projects planned and completed	Ongoing	Project identified	PRWC meetings attended
	Protect trees and plant trees in watershed	Identify projects through PRWC & MCSWCD	Provide maps, meeting space, & staff support	Projects planned and completed	Ongoing	Project(s) identified	PRWC meetings attended
	Impervious surface runoff control	Implement Storm Water Master Plan standards for NPS control measures	Stormwater SDCs and utility fee	Public Works standards modified	June 2010-June 2013	Public advisory meetings and City Council reviews held	Engineering contract signed June 2010
	Street tree maintenance program	Routine pruning and inspection to preserve street tree life	$5,000-Street Maintenance fund	Pruning conducted	June 2010-June 2011	Tree maintenance documented	Budget approved 2010-2011
Illicit Discharges	Boiler blowdown, air compressor and condensate tower discharge managed	Inspect commercial and industrial sites for heat-related discharges	Existing staff	Inspections conducted	June 2010-June 2012	Inspection sites inventoried	One industry site inspection conducted

Appendix A: Silverton TMDL Implementation Matrix

Pollutant: Mercury

City of Silverton, Oregon

SOURCE	STRATEGY	ACTION	REQUIRED RESOURCES	PERFORMANCE MEASURE	TIMELINE	MILESTONE	STATUS
Soil and Rock Erosion	Enforce erosion control requirements	Educate contractors	Existing staff	Reduce turbidity at outfalls	Ongoing	1200 C permits issued	Ongoing
	Support stream bank restoration projects	Identify projects through PRWC and MCSWCD	Provide maps, meeting space, and staff support	Projects planned and completed	Ongoing	Meetings attended	ongoing
NPS Discharges	Conduct WHW collection event	Coordinate with Allied Waste, Fire District, and Marion County	Existing staff, collection site	Project planned	June 2010-June 2011	Collection event date established	Not yet started
WWTP Discharge	Effluent sampling	Budget for analysis	$850 per sample	Report analysis results to DEQ	June 2010-June 2011	Staff trained on clean sampling techniques	Budget adopted 2010-2011
	Dental office BMP program	Follow-up survey and inspect 5 offices	Existing staff/2 hr per office	Offices surveyed and inspected	June 2010-June 2011	Mercury collection documented	Initial survey and inspection completed
	"Mercury in Schools" program	Establish school relationship	Existing staff	Conduct follow-up site visit	June 2010-June 2011	Meeting attended	Chemical High School Disposal Waste Plan submitted May 2010

Appendix A: Silverton TMDL Implementation Matrix

Pollutant: DDT, Dieldrih, Iron

City of Silverton, Oregon

SOURCE	STRATEGY	ACTION	REQUIRED RESOURCES	PERFORMANCE MEASURE	TIMELINE	MILESTONE	STATUS
NPS Discharges	Conduct HHW Collection Event	Coordinate with Allied Waste, Fire District, and Marion Co.	Existing staff Collection Site	Project planned	June 2010-June 2011	Collection event date established	Not yet started
	Public education and outreach	Develop plan for catch basin monitoring	Existing staff	Plan documented	June 2010-June 2011	Marking project scheduled	Not yet started
	Public notice and participation	SWMP public meetings held	Engineering consultant and existing staff	Meetings held	June 2010-June 2011	Meetings scheduled and public invited	$99,770 contract signed and schedule established
	Illicit discharge detection and elimination	Confirm status of local commercial and industrial 1200Z permit compliance	Existing staff	Illicit discharges detected and plan to eliminate documented	June 2010-June 2012	Current 1200Z permit status inventoried	Not yet started
	Construction site run off	Improve site inspection and enforcement	Existing staff	Improve BMP requirements	June 2010-June 2011	1200 C permits issued	Permits issued
	Post-construction run off managed	Ensure maintenance & operation of BMPs	Existing staff	Long-term maintenance program developed	June 2010-June 20-12	Current BMP status documented	Not yet started
WWTP Discharges	Incorporate iron analysis into sampling program	Conduct 8 sampling events	Existing staff and $160 lab test cost	Sampling event completed-report to DEQ	June 2010-June 2011	Sampling schedule established	Budget adopted 2010-2011

State of Oregon
Department of Environmental Quality

Memorandum

To: Molalla-Pudding Subbasin TMDL File **Date:** December 8, 2008

NJM

From: Neil Mullane, WQ Administrator

Subject: Molalla-Pudding Subbasin TMDL Order

On December 8, 2008, the Molalla-Pudding Subbasin Total Maximum Daily Load (TMDL) was issued as an order by the Oregon Department of Environmental Quality (ODEQ). The area covered by the Molalla-Pudding Subbasin corresponds to hydrologic unit codes (HUCs) 170900901, 170900902, 170900903, 170900904, 170900905, and170900906. The Molalla-Pudding Subbasin encompasses an area of approximately 878 square miles located in the Middle Willamette Basin. The TMDLs addressed are temperature, bacteria, DDT, dieldrin, chlordane, iron, and nitrate. The TMDLs are applicable to all perennial and intermittent waters as follows:

TMDL Parameter	Applicable Hydrologic Unit Codes
Temperature	1709000901, 1709000902, 1709000903, 1709000904, 1709000905, and 1709000906
Bacteria	1709000901, 1709000902, 1709000903, 1709000904, 1709000905, and 1709000906.
DDT	1709000902, 1709000903, 1709000904, and 6th field HUCs 170900090108, 170900090109 and 170900090110
Dieldrin	1709000902, 1709000903, 1709000904, and 6th field HUCs 170900090108, 170900090109 and 170900090110
Chlordane	Zollner Creek watershed within 5th field HUC 1709000902
Iron	1709000902, 1709000903, 1709000904, and 6th field HUCs 170900090108, 170900090109 and 170900090110
Nitrate	Zollner Creek watershed within 5th field HUC 1709000902

The allocations are applicable to sources and land uses in the relevant hydrologic unit codes as follows:

TMDL Allocation for	Applicable Sources and Land Uses
Temperature	All sources and land uses
Bacteria	All sources and all land uses except forestry
DDT	Point sources: wastewater treatment plants that discharge into listed reach of Pudding River. All non-point sources on all land uses.
Dieldrin	Point sources: wastewater treatment plants that discharge into listed reach of Pudding River. All non-point sources on all land uses.
Chlordane	All non-point sources on all land uses.
Iron	Point sources: sources that discharge into listed reach of Pudding River or a tributary that enters listed reach of Pudding River. All non-point sources on all land uses.
Nitrate	All non-point sources on all land uses.

This final Molalla-Pudding Subbasin TMDL, developed under §303(d) of the Clean Water Act, has been submitted for U.S. Environmental Protection Agency (USEPA) approval. The document, when approved, will be an update to Oregon's Continuous Planning Process per §303(e) of the Clean Water Act (CWA). Oregon's WQMP is also being submitted to USEPA, although it does not need to be approved or disapproved as specified under the terms of the February 1, 2000 Memorandum of Agreement between USEPA and ODEQ regarding the implementation of §303(d) of the CWA. Should USEPA modify or disapprove this TMDL, such actions will be made public.

Watershed analyses and draft TMDLs were presented to and discussed with a review committee that consisted of a variety of stakeholders and interests including: City of Woodburn, City of Hubbard, City of Molalla, City of Silverton, City of Canby, Canby Utility/Veolia Water North America, BLM, Marion County, Clackamas County, Pudding River Watershed Council, Molalla River Watch, Native Fish Society, Molalla River Improvement District, East Valley Water District, JLR, LLC/Bruce Pac, Norpac, and private landowners and citizens in the subbasin. The intent was to get informal review and comment while DEQ was completing the development of the draft TMDLs.

The public comment period on the draft Molalla-Pudding Subbasin TMDL was opened on August 29, 2008 and closed on October 31, 2008. Informational meetings to present background on the technical and modeling components of the draft TMDLs were provided preceding a formal public hearing on October 15, 2008. Copies of the document were made available at various locations within the subbasin including the libraries; Marion SWCD office, Salem and Portland DEQ offices as well as through the internet and direct mailings. ODEQ received comments on the draft TMDLs from 14 parties including: EPA, City of Woodburn, City of Salem, City of Molalla, City of Silverton, City of Keizer, City of Wilsonville, Clackamas County Water Environment Services, Native Fish Society, East Valley Irrigation District, Lake Labish Water Control District, U.S. Bureau of Land Management, Oregon Department of Geology and Mineral Industries, and Oregon Department of Forestry.

DEQ has summarized the issues raised, prepared responses and made revisions to the draft TMDL and WQMP.

This memo and the related public notification represent the beginning of the 60-day appeal period on this ODEQ action. The Oregon Administrative Rules (OAR) allow for the following:

(1) Any person who participated in establishing a TMDL, including those who submitted comments, and any other person entitled to seek judicial review of an order issuing a TMDL may request reconsideration by the Director in accordance with OAR 137-004-0080.
(2) A person may file a petition for judicial review of a final TMDL order as allowed by ORS 183.484.

This TMDL/WQMP and Response to Comments documents can be found at the following website: http://www.deq.state.or.us/wq/tmdls/willamette.htm or can be viewed at the following locations: ODEQ Headquarters, 811 SW Sixth Avenue, Portland, OR 97204 or ODEQ Northwest Regional Office, 2020 SW 4th Avenue, Suite 400, Portland, OR 97201. Once USEPA has approved this TMDL, this document will be made available via a CD electronic file or paper copy.

Should you have any questions about this TMDL, please contact Karen Font Williams at 503-229-6254.

Issued by:

Neil Mullane

Neil Mullane
Water Quality Administrator

Date: 12/8/08

Attachments

Oregon
Theodore R. Kulongoski, Governor

Department of Environmental Quality
Northwest Region Portland Office
2020 SW 4th Avenue, Suite 400
Portland, OR 97201-4987
(503) 229-5263
Fax: (503) 229-6945
TTY: (503) 229-5471

December 29, 2008

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Steve Starner
Water Quality Division Supervisor
City of Silverton
400 Schemmel Lane
Silverton, OR 97381

Re: Issuance of Molalla-Pudding Subbasin TMDL / WQMP

Dear Mr. Starner:

I would like to thank you for the comments that you submitted to ODEQ on the draft Molalla-Pudding Subbasin Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP) during the recent public comment period. ODEQ strongly supports the public process and believes that it serves to strengthen the final product. ODEQ has reviewed all of the comments in detail and has prepared a document that summarizes our responses. Adjustments, as appropriate, were made to the draft TMDL/WQMP based on these reviews. We believe the documents represent a fair and honest analysis of water quality conditions and appropriate allocations of pollutants that, when achieved, will protect beneficial uses.

The Pudding and Molalla Rivers and numerous tributaries do not currently meet one or more water quality criteria for the following parameters: temperature, bacteria, some pesticides, iron, and nitrate. These water quality criteria assure that beneficial uses of the rivers, such as swimming, fishing and fish rearing, are protected. When water quality standards are not met, the federal Clean Water Act requires a TMDL to be established. A TMDL determines how much pollution can be added to the river without exceeding water quality standards.

This letter is intended to provide you with notification that the TMDL has been issued as an order and that the summary of responses to comments is available as directed under OAR 340-042-0050 to 0070. Copies of the final TMDL, WQMP and Response to Comments are available on the ODEQ Website at http://www.deq.state.or.us/wq/tmdls/willamette.htm. We have limited hard copies and CDs available upon request at this time.

Also included with this letter is a memo to our files concerning issuance of the Molalla-Pudding Subbasin TMDL. The Oregon Administrative Rules (OARs) allow for the following:

1) Any person who participated in establishing a TMDL, including those who submitted comments and any other person entitled to seek judicial review of and order issuing a TMDL, may request reconsideration by the Director in accordance with OAR 137-004-0080.
2) A person may file a petition for judicial review of a final TMDL order as allowed by ORS 183.484.

ODEQ will now initiate the next round of implementation in conjunction with the land management agencies. This will include modification/development of more detailed management plans based on the allocations in the TMDL and as detailed in the WQMP. We will continue to work in partnership with sources, land management and resource agencies, soil and water conservation districts, watershed groups and others.

Once again, we appreciate your interest and look forward to your assistance in the next steps of implementation in order to improve water quality in the Molalla-Pudding Subbasin. If you have any questions or would like to request a copy/CD of the TMDL/WQMP, please call Karen Williams in our Northwest Region office at 503-229-6254.

Sincerely,

Sally Puent for Nina DeConcini

Nina DeConcini
Northwest Region Division Administrator

Encl.

Appendix D

water quality data ▪ master plan

D.2 NPDES Minimum Control Measure Fact Sheets

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United States Environmental Protection Agency
Office of Water (4203)
EPA 833-F00-005
January 2000 (revised December 2005)
Fact Sheet 2.3

Stormwater Phase II Final Rule

Public Education and Outreach Minimum Control Measure

Stormwater Phase II Final Rule Fact Sheet Series

Overview

1.0 – Stormwater Phase II Final Rule: An Overview

Small MS4 Program

2.0 – Small MS4 Stormwater Program Overview

2.1 – Who's Covered? Designation and Waivers of Regulated Small MS4s

2.2 – Urbanized Areas: Definition and Description

Minimum Control Measures

2.3 – Public Education and Outreach

2.4 – Public Participation/ Involvement

2.5 – Illicit Discharge Detection and Elimination

2.6 – Construction Site Runoff Control

2.7 – Post-Construction Runoff Control

2.8 – Pollution Prevention/Good Housekeeping

2.9 – Permitting and Reporting: The Process and Requirements

2.10 – Federal and State-Operated MS4s: Program Implementation

Construction Program

3.0 – Construction Program Overview

3.1 – Construction Rainfall Erosivity Waiver

Industrial "No Exposure"

4.0 – Conditional No Exposure Exclusion for Industrial Activity

This fact sheet profiles the Public Education and Outreach minimum control measure, one of six measures an operator of a Phase II-regulated small municipal separate storm sewer system (MS4) is required to include in its stormwater management program to meet the conditions of its National Pollutant Discharge Elimination System (NPDES) stormwater permit. This fact sheet outlines the Phase II Final Rule requirements and offers some general guidance on how to satisfy them. It is important to keep in mind that the regulated small MS4 operator has a great deal of flexibility in choosing exactly how to satisfy the minimum control measure requirements.

Why Is Public Education and Outreach Necessary?

An informed and knowledgeable community is crucial to the success of a stormwater management program since it helps to ensure the following:

- ***Greater support*** for the program as the public gains a greater understanding of the reasons why it is necessary and important. Public support is particularly beneficial when operators of small MS4s attempt to institute new funding initiatives for the program or seek volunteers to help implement the program; and

- ***Greater compliance*** with the program as the public becomes aware of the personal responsibilities expected of them and others in the community, including the individual actions they can take to protect or improve the quality of area waters.

What Is Required?

To satisfy this minimum control measure, the operator of a regulated small MS4 needs to:

- ❑ Implement a public education program to distribute educational materials to the community, or conduct equivalent outreach activities about the impacts of stormwater discharges on local waterbodies and the steps that can be taken to reduce stormwater pollution; and

- ❑ Determine the appropriate best management practices (BMPs) and measurable goals for this minimum control measure. Some program implementation approaches, BMPs (i.e., the program actions/activities), and measurable goals are suggested below.

What Are Some Guidelines for Developing and Implementing This Measure?

Three main action areas are important for successful implementation of a public education and outreach program:

❶ ***Forming Partnerships***

Operators of regulated small MS4s are encouraged to utilize partnerships with other governmental entities to fulfill this minimum control measure's requirements. It is generally more cost-effective to use an existing program, or to develop a new regional or state-wide education program, than to have numerous operators developing their own local programs. Operators also are encouraged to seek assistance from non-governmental organizations (e.g., environmental, civic, and industrial organizations), since many already have educational materials and perform outreach activities.

❷ ***Using Educational Materials and Strategies***

Operators of regulated small MS4s may use stormwater educational information provided by their State, Tribe, EPA Region, or environmental, public interest, or trade organizations instead of developing their own materials. Operators should strive to make their materials and activities relevant to local situations and issues, and incorporate a variety of strategies to ensure maximum coverage. Some examples include:

- ***Brochures or fact sheets*** for general public and specific audiences;
- ***Recreational guides*** to educate groups such as golfers, hikers, paddlers, climbers, fishermen, and campers;
- ***Alternative information sources,*** such as web sites, bumper stickers, refrigerator magnets, posters for bus and subway stops, and restaurant placemats;
- ***A library of educational materials*** for community and school groups;
- ***Volunteer citizen educators*** to staff a ***public education task force;***
- ***Event participation*** with educational displays at home shows and community festivals;
- ***Educational programs*** for school-age children;
- ***Storm drain stenciling*** of storm drains with messages such as "Do Not Dump - Drains Directly to Lake;"
- ***Stormwater hotlines*** for information and for citizen reporting of polluters;
- ***Economic incentives*** to citizens and businesses (e.g., rebates to homeowners purchasing mulching lawnmowers or biodegradable lawn products);and
- ***Tributary signage*** to increase public awareness of local water resources.

❸ ***Reaching Diverse Audiences***

The public education program should use a mix of appropriate local strategies to address the viewpoints and concerns of a variety of audiences and communities, including minority and disadvantaged communities, as well as children. Printing posters and brochures in more than one language or posting large warning signs (e.g., cautioning against fishing or swimming) near storm sewer outfalls are methods that can be used to reach audiences less likely to read standard materials. Directing materials or outreach programs toward specific groups of commercial, industrial, and institutional entities likely to have significant stormwater impacts is also recommended. For example, information could be provided to restaurants on the effects of grease clogging storm drains and to auto garages on the effects of dumping used oil into storm drains.

What Are Appropriate Measurable Goals?

Measurable goals, which are required for each minimum control measure, are intended to gauge permit compliance and program effectiveness. The measurable goals, as well as the BMPs, should reflect the needs and characteristics of the operator and the area served by its small MS4. Furthermore, they should be chosen using an integrated approach that fully addresses the requirements and intent of the minimum control measure. Finally, they should allow the MS4 to make improvements to its program over each 5-year permit term by providing data on program successes and shortfalls.

EPA has developed a Measurable Goals Guidance for Phase II MS4s that is designed to help program managers comply with the requirement to develop measurable goals. The guidance presents an approach for MS4 operators to develop measurable goals as part of their stormwater management plan. For example, an MS4 could develop a stormwater public education campaign for radio and television. The goal of the campaign might be to increase the number of dog owners who pick up after their pets. To measure the program's progress towards this goal, the program manager might perform a stormwater public awareness survey at the beginning, during, and at the end of the permit term to gauge any change is pet owner behavior over time. As another example, an MS4 might want to encourage "do-it-yourselfers" to recycle used motor oil by establishing and advertising a municipal drop-off center. The MS4 could measure progress toward this goal by tracking the amount of motor oil collected and correlating those data to the timing of public service announcements and other advertisements to see if their message is being received.

For Additional Information

Contacts

☞ U.S. EPA Office of Wastewater Management
http://www.epa.gov/npdes/stormwater
Phone: 202-564-9545

☞ Your NPDES Permitting Authority. Most States and Territories are authorized to administer the NPDES Program, except the following, for which EPA is the permitting authority:

Alaska	Guam
District of Columbia	Johnston Atoll
Idaho	Midway and Wake Islands
Massachusetts	Northern Mariana Islands
New Hampshire	Puerto Rico
New Mexico	Trust Territories
American Samoa	

☞ A list of names and telephone numbers for each EPA Region and State is located at http://www.epa.gov/npdes/stormwater (click on "Contacts").

Reference Documents

☞ EPA's Stormwater Web Site
http://www.epa.gov/npdes/stormwater
- Stormwater Phase II Final Rule Fact Sheet Series
- Stormwater Phase II Final Rule (64 *FR* 68722)
- National Menu of Best Management Practices for Stormwater Phase II
- Measurable Goals Guidance for Phase II Small MS4s
- Stormwater Case Studies
- Stormwater Month Materials
- And many others

☞ Getting In Step
http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf

United States Environmental Protection Agency
Office of Water (4203)
EPA 833-F-00-006
January 2000 (revised December 2005)
Fact Sheet 2.4

Stormwater Phase II Final Rule

Public Participation/ Involvement Minimum Control Measure

Stormwater Phase II Final Rule Fact Sheet Series

Overview

1.0 – Stormwater Phase II Final Rule: An Overview

Small MS4 Program

2.0 – Small MS4 Stormwater Program Overview

2.1 – Who's Covered? Designation and Waivers of Regulated Small MS4s

2.2 – Urbanized Areas: Definition and Description

Minimum Control Measures

2.3 – Public Education and Outreach

2.4 – Public Participation/ Involvement

2.5 – Illicit Discharge Detection and Elimination

2.6 – Construction Site Runoff Control

2.7 – Post-Construction Runoff Control Minimum Control Measure

2.8 – Pollution Prevention/Good Housekeeping

2.9 – Permitting and Reporting: The Process and Requirements

2.10 – Federal and State-Operated MS4s: Program Implementation

Construction Program

3.0 – Construction Program Overview

3.1 – Construction Rainfall Erosivity Waiver

Industrial "No Exposure"

4.0 – Conditional No Exposure Exclusion for Industrial Activity

This fact sheet profiles the Public Participation/Involvement minimum control measure, one of six measures the operator of a Phase II regulated small municipal separate storm sewer system (MS4) is required to include in its stormwater management program to meet the conditions of its National Pollutant Discharge Elimination System (NPDES) permit. This fact sheet outlines the Phase II Final Rule requirements and offers some general guidance on how to satisfy them. It is important to keep in mind that the small MS4 operator has a great deal of flexibility in determining how to satisfy the minimum control measure requirements.

Why Is Public Participation and Involvement Necessary?

EPA believes that the public can provide valuable input and assistance to a regulated small MS4's municipal stormwater management program and, therefore, suggests that the public be given opportunities to play an active role in both the development and implementation of the program. An active and involved community is crucial to the success of a stormwater management program because it allows for:

- ***Broader public support*** since citizens who participate in the development and decision making process are partially responsible for the program and, therefore, may be less likely to raise legal challenges to the program and more likely to take an active role in its implementation;
- ***Shorter implementation schedules*** due to fewer obstacles in the form of public and legal challenges and increased sources in the form of citizen volunteers;
- ***A broader base of expertise*** and ***economic benefits*** since the community can be a valuable, and free, intellectual resource; and
- ***A conduit to other programs*** as citizens involved in the stormwater program development process provide important cross-connections and relationships with other community and government programs. This benefit is particularly valuable when trying to implement a stormwater program on a watershed basis, as encouraged by EPA.

What Is Required?

To satisfy this minimum control measure, the operator of a regulated small MS4 must:

- ❑ Comply with applicable State, Tribal, and local public notice requirements; and
- ❑ Determine the appropriate best management practices (BMPs) and measurable goals for this minimum control measure. Possible implementation approaches, BMPs (i.e., the program actions and activities), and measurable goals are described below.

What Are Some Guidelines for Developing and Implementing This Measure?

Operators of regulated small MS4s should include the public in developing, implementing, updating, and reviewing their stormwater management programs. The public participation program should make every effort to reach out and engage all economic and ethnic groups. EPA recognizes that there are challenges associated with public involvement. Nevertheless, EPA strongly believes that these challenges can be addressed through an aggressive and inclusive program. Challenges and example practices that can help ensure successful participation are discussed below.

Implementation Challenges

The best way to handle common notification and recruitment challenges is to know the audience and think creatively about how to gain its attention and interest. Traditional methods of soliciting public input are not always successful in generating interest, and subsequent involvement, in all sectors of the community. For example, municipalities often rely solely on advertising in local newspapers to announce public meetings and other opportunities for public involvement. Since there may be large sectors of the population who do not read the local press, the audience reached may be limited. Therefore, alternative advertising methods should be used whenever possible, including radio or television spots, postings at bus or subway stops, announcements in neighborhood newsletters, announcements at civic organization meetings, distribution of flyers, mass mailings, door-to-door visits, telephone notifications, and multilingual announcements. These efforts, of course, are tied closely to the efforts for the public education and outreach minimum control measure (see Fact Sheet 2.3).

In addition, advertising and soliciting help should be targeted at specific population sectors, including ethnic, minority, and low-income communities; academia and educational institutions; neighborhood and community groups; outdoor recreation groups; and business and industry. The goal is to involve a diverse cross-section of people who can offer a multitude of concerns, ideas, and connections during the program development process.

Possible BMPs

There are a variety of practices that could be incorporated into a public participation and involvement program, such as:

- ***Public meetings/citizen panels*** allow citizens to discuss various viewpoints and provide input concerning appropriate stormwater management policies and BMPs;
- ***Volunteer water quality monitoring*** gives citizens first-hand knowledge of the quality of local water bodies and provides a cost-effective means of collecting water quality data;
- ***Volunteer educators/speakers*** who can conduct workshops, encourage public participation, and staff special events;
- ***Storm drain stenciling*** is an important and simple activity that concerned citizens, especially students, can do;
- ***Community clean-ups*** along local waterways, beaches, and around storm drains;
- ***Citizen watch groups*** can aid local enforcement authorities in the identification of polluters; and
- ***"Adopt A Storm Drain" programs*** encourage individuals or groups to keep storm drains free of debris and to monitor what is entering local waterways through storm drains.

What Are Appropriate Measurable Goals?

Measurable goals, which are required for each minimum control measure, are intended to gauge permit compliance and program effectiveness. The measurable goals, as well as the BMPs, greatly depend on the needs and characteristics of the operator and the area served by the small MS4. Furthermore, they should be chosen using an integrated approach that fully addresses the requirements and intent of the minimum control measure.

EPA has developed a Measurable Goals Guidance for Phase II MS4s that is designed to help program managers comply with the requirement to develop measurable goals. The guidance presents an approach for MS4 operators to develop measurable goals as part of their stormwater management plan. For example, an MS4 could conclude as part of its Illicit Discharge Detection and Elimination program that a certain section of town has a high incidence of used motor oil dumping. The watershed has numerous automotive businesses including small repair shops, large auto dealerships, gas stations, and body shops. In addition, there are several large apartment complexes with areas that could be used as "do-it-yourself" oil change areas. The MS4 organizes a public meeting in the watershed to not only educate residents about stormwater issues and permit requirements, but also to ask for input regarding possible dumping areas and to determine if the community needs an oil recycling facility or some other way to safely dispose of used motor oil. In this way, the MS4 might better understand who the target audience is for illegal dumping control while implementing a valuable service for the watershed community.

For Additional Information

Contacts

- ☞ U.S. EPA Office of Wastewater Management
  http://www.epa.gov/npdes/stormwater
  Phone: 202-564-9545

- ☞ Your NPDES Permitting Authority. Most States and Territories are authorized to administer the NPDES Program, except the following, for which EPA is the permitting authority:

Alaska	Guam
District of Columbia	Johnston Atoll
Idaho	Midway and Wake Islands
Massachusetts	Northern Mariana Islands
New Hampshire	Puerto Rico
New Mexico	Trust Territories
American Samoa	

- ☞ A list of names and telephone numbers for each EPA Region and State is located at http://www.epa.gov/npdes/stormwater (click on "Contacts").

Reference Documents

- ☞ EPA's Stormwater Web Site
  http://www.epa.gov/npdes/stormwater
  - Stormwater Phase II Final Rule Fact Sheet Series
  - Stormwater Phase II Final Rule (64 *FR* 68722)
  - National Menu of Best Management Practices for Stormwater Phase II
  - Measurable Goals Guidance for Phase II Small MS4s
  - Stormwater Case Studies
  - And many others

United States Environmental Protection Agency
Office of Water (4203)
EPA 833-F-00-007
January 2000 (revised December 2005)
Fact Sheet 2.5

Stormwater Phase II Final Rule

Illicit Discharge Detection and Elimination Minimum Control Measure

Stormwater Phase II Final Rule Fact Sheet Series

Overview

1.0 – Stormwater Phase II Final Rule: An Overview

Small MS4 Program

2.0 – Small MS4 Stormwater Program Overview

2.1 – Who's Covered? Designation and Waivers of Regulated Small MS4s

2.2 – Urbanized Areas: Definition and Description

Minimum Control Measures

2.3 – Public Education and Outreach

2.4 – Public Participation/ Involvement

2.5 – Illicit Discharge Detection and Elimination

2.6 – Construction Site Runoff Control

2.7 – Post-Construction Runoff Control

2.8 – Pollution Prevention/Good Housekeeping

2.9 – Permitting and Reporting: The Process and Requirements

2.10 – Federal and State-Operated MS4s: Program Implementation

Construction Program

3.0 – Construction Program Overview

3.1 – Construction Rainfall Erosivity Waiver

Industrial "No Exposure"

4.0 – Conditional No Exposure Exclusion for Industrial Activity

This fact sheet profiles the Illicit Discharge Detection and Elimination minimum control measure, one of six measures the operator of a Phase II regulated small municipal separate storm sewer system (MS4) is required to include in its stormwater management program to meet the conditions of its National Pollutant Discharge Elimination System (NPDES) permit. This fact sheet outlines the Phase II Final Rule requirements and offers some general guidance on how to satisfy them. It is important to keep in mind that the small MS4 operator has a great deal of flexibility in choosing exactly how to satisfy the minimum control measure requirements.

What Is An "Illicit Discharge"?

Federal regulations define an illicit discharge as "...any discharge to an MS4 that is not composed entirely of stormwater..." with some exceptions. These exceptions include discharges from NPDES-permitted industrial sources and discharges from fire-fighting activities. Illicit discharges (see Table 1) are considered "illicit" because MS4s are not designed to accept, process, or discharge such non-stormwater wastes.

Table 1

Sources of Illicit Discharges
Sanitary wastewater
Effluent from septic tanks
Car wash wastewaters
Improper oil disposal
Radiator flushing disposal
Laundry wastewaters
Spills from roadway accidents
Improper disposal of auto and household toxics

Why Are Illicit Discharge Detection and Elimination Efforts Necessary?

Discharges from MS4s often include wastes and wastewater from non-stormwater sources. A study conducted in 1987 in Sacramento, California, found that almost one-half of the water discharged from a local MS4 was not directly attributable to precipitation runoff. A significant portion of these dry weather flows were from illicit and/or inappropriate discharges and connections to the MS4.

Illicit discharges enter the system through either direct connections (e.g., wastewater piping either mistakenly or deliberately connected to the storm drains) or indirect connections (e.g., infiltration into the MS4 from cracked sanitary systems, spills collected by drain outlets, or paint or used oil dumped directly into a drain). The result is untreated discharges that contribute high levels of pollutants, including heavy metals, toxics, oil and grease, solvents, nutrients, viruses, and bacteria to receiving waterbodies. Pollutant levels from these illicit discharges have been shown in EPA studies to be high enough to significantly degrade receiving water quality and threaten aquatic, wildlife, and human health.

What Is Required?

Recognizing the adverse effects illicit discharges can have on receiving waters, the Phase II Final Rule requires an operator of a regulated small MS4 to develop, implement and enforce an illicit discharge detection and elimination program. This program must include the following:

- ❑ A storm sewer system map, showing the location of all outfalls and the names and location of all waters of the United States that receive discharges from those outfalls;
- ❑ Through an ordinance, or other regulatory mechanism, a prohibition (to the extent allowable under State, Tribal, or local law) on non-stormwater discharges into the MS4, and appropriate enforcement procedures and actions;
- ❑ A plan to detect and address non-stormwater discharges, including illegal dumping, into the MS4;
- ❑ The education of public employees, businesses, and the general public about the hazards associated with illegal discharges and improper disposal of waste; and
- ❑ The determination of appropriate best management practices (BMPs) and measurable goals for this minimum control measure. Some program implementation approaches, BMPs (i.e., the program actions/activities), and measurable goals are suggested below.

Does This Measure Need to Address All Illicit Discharges?

No. The illicit discharge detection and elimination program does not need to address the following categories of non-stormwater discharges or flows unless the operator of the regulated small MS4 identifies them as significant contributors of pollutants to its MS4:

- ❑ Water line flushing;
- ❑ Landscape irrigation;
- ❑ Diverted stream flows;
- ❑ Rising ground waters;
- ❑ Uncontaminated ground water infiltration;
- ❑ Uncontaminated pumped ground water;
- ❑ Discharges from potable water sources;
- ❑ Foundation drains;
- ❑ Air conditioning condensation;
- ❑ Irrigation water;
- ❑ Springs;
- ❑ Water from crawl space pumps;
- ❑ Footing drains;
- ❑ Lawn watering;
- ❑ Individual residential car washing;
- ❑ Flows from riparian habitats and wetlands;
- ❑ Dechlorinated swimming pool discharges; and
- ❑ Street wash water.

What Are Some Guidelines for Developing and Implementing This Measure?

The objective of the illicit discharge detection and elimination minimum control measure is to have regulated small MS4 operators gain a thorough awareness of their systems. This awareness allows them to determine the types and sources of illicit discharges entering their system; and establish the legal, technical, and educational means needed to eliminate these discharges. Permittees could meet these objectives in a variety of ways depending on their individual needs and abilities, but some general guidance for each requirement is provided below.

The Map

The storm sewer system map is meant to demonstrate a basic awareness of the intake and discharge areas of the system. It is needed to help determine the extent of discharged dry weather flows, the possible sources of the dry weather flows, and the particular waterbodies these flows may be affecting. An existing map, such as a topographical map, on which the location of major pipes and outfalls can be clearly presented demonstrates such awareness.

EPA recommends collecting all existing information on outfall locations (e.g., review city records, drainage maps, storm drain maps), and then conducting field surveys to verify locations. It probably will be necessary to walk (i.e., wade through small receiving waters or use a boat for larger waters) the streambanks and shorelines for visual observation. More than one trip may be needed to locate all outfalls.

Legal Prohibition and Enforcement

EPA recognizes that some permittees may have limited authority under State, Tribal or local law to establish and enforce an ordinance or other regulatory mechanism prohibiting illicit discharges. In such a case, the permittee is encouraged to obtain the necessary authority, if possible.

The Plan

The plan to detect and address illicit discharges is the central component of this minimum control measure. The plan is dependant upon several factors, including the permittee's available resources, size of staff, and degree and character of its illicit discharges. As guidance only, the four steps of a recommended plan are outlined below:

❶ **Locate Problem Areas**
EPA recommends that priority areas be identified for detailed screening of the system based on the likelihood of illicit connections (e.g., areas with older sanitary sewer lines). Methods that can locate problem areas include: visual screening; water sampling from manholes and outfalls during dry weather; the use of infrared and thermal photography, cross-training field staff to detect illicit discharges, and public complaints.

❷ **Find the Source**
Once a problem area or discharge is found, additional efforts usually are necessary to determine the source of the problem. Methods that can find the source of the illicit discharge include: dye-testing buildings in problem areas; dye- or smoke-testing buildings at the time of sale; tracing the discharge upstream in the storm sewer; employing a certification program that shows that buildings have been checked for illicit connections; implementing an inspection program of existing septic systems; and using video to inspect the storm sewers.

❸ **Remove/Correct Illicit Connections**
Once the source is identified, the offending discharger should be notified and directed to correct the problem. Education efforts and working with the discharger can be effective in resolving the problem before taking legal action.

❹ **Document Actions Taken**
As a final step, all actions taken under the plan should be documented. This illustrates that progress is being made to eliminate illicit connections and discharges. Documented actions should be included in annual reports and include information such as: the number of outfalls screened; any complaints received and corrected; the number of discharges and quantities of flow eliminated; and the number of dye or smoke tests conducted.

Educational Outreach

The Center for Watershed Protection and Robert Pitt (2004) researched the most cost-effective and efficient techniques that can be employed to identify and correct inappropriate discharges. Data from Montgomery County, Maryland, was analyzed and it was determined that staff identify and correct about six inappropriate discharges per year as a result of regular screening. By contrast, over 185 inappropriate discharges are corrected each year in Montgomery County as a direct result of citizen complaints and calls to a storm water compliant hotline. Public education and labeling of outfalls and other storm drain infrastructure is an important element of establishing a successful citizen hotline. Outreach to public employees, businesses, property owners, the general public, and elected officials regarding ways to detect and eliminate illicit discharges is an integral part of this minimum measure.

Suggested educational outreach efforts include:

- Developing ***informative brochures, and guidances*** for specific audiences (e.g., carpet cleaning businesses) and school curricula;
- Designing a program to ***publicize and facilitate public reporting*** of illicit discharges;
- ***Coordinating volunteers*** for locating, and visually inspecting, outfalls or to stencil storm drains; and
- Initiating ***recycling programs*** for commonly dumped wastes, such as motor oil, antifreeze, and pesticides.

What Are Appropriate Measurable Goals?

Measurable goals, which are required for each minimum control measure, are intended to gauge permit compliance and program effectiveness. The measurable goals, as well as the BMPs, should reflect the needs and characteristics of the operator and the area served by its small MS4. Furthermore, they should be chosen using an integrated approach that fully addresses the requirements and intent of the minimum control measure.

EPA has developed a Measurable Goals Guidance for Phase II MS4s that is designed to help program managers comply with the requirement to develop measurable goals. The guidance presents an approach for MS4 operators to develop measurable goals as part of their stormwater management plan. For example, an MS4 could establish a measurable goal of responding to all complaints received by the citizen complaint hotline within 24 hours to minimize water quality impacts or recurrent dumping. A complaint tracking system could be used to log response and enforcement activity.

The educational outreach measurable goals for this minimum control measure could be combined with the measurable goals for the Public Education and Outreach minimum control measure (see Fact Sheet 2.3).

Sources

Center for Watershed Protection and R. Pitt. 2004. Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments. Center for Watershed Protection, Ellicott City, MD, and University of Alabama, Birmingham, AL.

Maryland Department of the Environment, Water Management Administration. 1997. *Dry Weather Flow and Illicit Discharges in Maryland Storm Drain Systems*. Baltimore, Maryland.

U.S. EPA Office of Water. 1993. *Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems: A User's Guide*. EPA/600/R-92/238. Washington, D.C.

Wayne County Rouge River National Wet Weather Demonstration Project. 1997. *Guidance for Preparing a Program for the Elimination of Illicit Discharges*. Wayne County, Michigan.

For Additional Information

Contacts

☞ U.S. EPA Office of Wastewater Management
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Phone: 202-564-9545

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Reference Documents

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- Stormwater Phase II Final Rule (64 *FR* 68722)
- National Menu of Best Management Practices for Stormwater Phase II
- Measurable Goals Guidance for Phase II Small MS4s
- Stormwater Case Studies
- And many others

☞ Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments
http://www.cwp.org/idde_verify.htm

United State Environmental Protection Agency
Office of Water (4203)
EPA 833-F-00-008
January 2000 (revised December 2005)
Fact Sheet 2.6

Stormwater Phase II Final Rule

Construction Site Runoff Control Minimum Control Measure

Stormwater Phase II Final Rule Fact Sheet Series

Overview

1.0 – Stormwater Phase II Final Rule: An Overview

Small MS4 Program

2.0 – Small MS4 Stormwater Program Overview

2.1 – Who's Covered? Designation and Waivers of Regulated Small MS4s

2.2 – Urbanized Areas: Definition and Description

Minimum Control Measures

2.3 – Public Education and Outreach

2.4 – Public Participation/ Involvement

2.5 – Illicit Discharge Detection and Elimination

2.6 – Construction Site Runoff Control

2.7 – Post-Construction Runoff Control

2.8 – Pollution Prevention/Good Housekeeping

2.9 – Permitting and Reporting: The Process and Requirements

2.10 – Federal and State-Operated MS4s: Program Implementation

Construction Program

3.0 – Construction Program Overview

3.1 – Construction Rainfall Erosivity Waiver

Industrial "No Exposure"

4.0 – Conditional No Exposure Exclusion for Industrial Activity

This fact sheet profiles the Construction Site Runoff Control minimum control measure, one of six measures that the operator of a Phase II regulated small municipal separate storm sewer system (MS4) is required to include in its stormwater management program to meet the conditions of its National Pollutant Discharge Elimination System (NPDES) permit. This fact sheet outlines the Phase II Final Rule requirements and offers some general guidance on how to satisfy them. It is important to keep in mind that the small MS4 operator has a great deal of flexibility in choosing exactly how to satisfy the minimum control measure requirements.

Why Is The Control of Construction Site Runoff Necessary?

Polluted stormwater runoff from construction sites often flows to MS4s and ultimately is discharged into local rivers and streams. Of the pollutants listed in Table 1, sediment is usually the main pollutant of concern. According to the 2000 National Water Quality Inventory, States and Tribes report that sedimentation is one of the most widespread pollutants affecting assessed rivers and streams, second only to pathogens (bacteria). Sedimentation impairs 84,503 river and stream miles (12% of the assessed river and stream miles and 31% of the impaired river and stream miles). Sources of sedimentation include agriculture, urban runoff, construction, and forestry. Sediment runoff rates from construction sites, however, are typically 10 to 20 times greater than those of agricultural lands, and 1,000 to 2,000 times greater than those of forest lands. During a short period of time, construction sites can contribute more sediment to streams than can be deposited naturally during several decades. The resulting siltation, and the contribution of other pollutants from construction sites, can cause physical, chemical, and biological harm to our nation's waters. For example, excess sediment can quickly fill rivers and lakes, requiring dredging and destroying aquatic habitats.

Table 1

Pollutants Commonly Discharged From Construction Sites
Sediment
Solid and sanitary wastes
Phosphorous (fertilizer)
Nitrogen (fertilizer)
Pesticides
Oil and grease
Concrete truck washout
Construction chemicals
Construction debris

What Is Required?

The Phase II Final Rule requires an operator of a regulated small MS4 to develop, implement, and enforce a program to reduce pollutants in stormwater runoff to their MS4 from construction activities that result in a land disturbance of greater than or equal to one acre. The small MS4 operator is required to:

- ❑ Have an ordinance or other regulatory mechanism requiring the implementation of proper erosion and sediment controls, and controls for other wastes, on applicable construction sites;
- ❑ Have procedures for site plan review of construction plans that consider potential water quality impacts;

- ❑ Have procedures for site inspection and enforcement of control measures;
- ❑ Have sanctions to ensure compliance (established in the ordinance or other regulatory mechanism);
- ❑ Establish procedures for the receipt and consideration of information submitted by the public; and
- ❑ Determine the appropriate best management practices (BMPs) and measurable goals for this minimum control measure. Suggested BMPs (i.e., the program actions/activities) and measurable goals are presented below.

What Are Some Guidelines for Developing and Implementing This Measure?

Further explanation and guidance for each component of a regulated small MS4's construction program is provided below.

Regulatory Mechanism

Through the development of an ordinance or other regulatory mechanism, the small MS4 operator must establish a construction program that controls polluted runoff from construction sites with a land disturbance of greater than or equal to one acre. Because there may be limitations on regulatory legal authority, the small MS4 operator is required to satisfy this minimum control measure only to the maximum extent practicable and allowable under State, Tribal, or local law.

Site Plan Review

The small MS4 operator must include in its construction program requirements for the implementation of appropriate BMPs on construction sites to control erosion and sediment and other waste at the site. To determine if a construction site is in compliance with such provisions, the small MS4 operator should review the site plans submitted by the construction site operator before ground is broken.

Site plan review aids in compliance and enforcement efforts since it alerts the small MS4 operator early in the process to the planned use or non-use of proper BMPs and provides a way to track new construction activities. The tracking of sites is useful not only for the small MS4 operator's recordkeeping and reporting purposes, which are required under their NPDES stormwater permit (see Fact Sheet 2.9), but also for members of the public interested in ensuring that the sites are in compliance.

Inspections and Penalties

Once construction commences, BMPs should be in place and the small MS4 operator's enforcement activities should begin. To ensure that the BMPs are properly installed, the small MS4 operator is required to develop procedures for site inspection and enforcement of control measures to deter infractions. Procedures could include steps to identify priority sites for inspection and enforcement based on the nature and extent of the construction activity, topography, and the characteristics of soils and receiving water quality. Inspections give the MS4 operator an opportunity to provide additional guidance and education, issue warnings, or assess penalties. In early 2002, EPA's Office of Compliance established a national workgroup to address issues related to the construction industry. The workgroup has developed a construction industry compliance assistance Web site as a tool for builders and developers (www.cicacenter.org). Inspectors can use the Web site to find plain language explanations of the major environmental laws affecting the construction industry as well as guidance that can be distributed developers and construction site operators.

To conserve staff resources, one possible option for small MS4 operators is to have inspections performed by the same inspector that visits the sites to check compliance with health and safety building codes.

Information Submitted by the Public

A final requirement of the small MS4 program for construction activity is the development of procedures for the receipt and consideration of public inquiries, concerns, and information submitted regarding local construction activities. This provision is intended to further reinforce the public participation component of the regulated small MS4 stormwater program (see Fact Sheet 2.4) and to recognize the crucial role that the public can play in identifying instances of noncompliance.

The small MS4 operator is required only to *consider* the information submitted, and may not need to follow-up and respond to every complaint or concern. Although some form of enforcement action or reply is not required, the small MS4 operator is required to demonstrate acknowledgment and consideration of the information submitted. A simple tracking process in which submitted public information, both written and verbal, is recorded and then given to the construction site inspector for possible follow-up will suffice.

What Are Appropriate Measurable Goals?

Measurable goals, which are required for each minimum control measure, are intended to gauge permit compliance and program effectiveness. The measurable goals, as well as the BMPs, should reflect the needs and characteristics of the operator and the area served by its small MS4. Furthermore, they should be chosen using an integrated approach that fully addresses the requirements and intent of the minimum control measure.

EPA has developed a Measurable Goals Guidance for Phase II MS4s that is designed to help program managers comply with the requirement to develop measurable goals. The guidance presents an approach for MS4 operators to develop measurable goals as part of their stormwater management plan. For example, an MS4 program goal might be to educate at least 80 percent of all construction site operators and contractors about proper selection, installation, inspection, and maintenance of BMPs by the end of the permit term, which will help to ensure compliance with erosion and sediment control requirements. This goal could be tracked by documenting attendance at local, State, or Federal training programs. Attendance can be encouraged by decreasing permitting fees for those contractors who have been trained and provide proof of attendance when applying for permits.

Are Construction Sites Covered Under the NPDES Stormwater Program?

Yes. On March 10, 2003, Phase II NPDES regulations came into effect that extended coverage to construction sites that disturb one to five acres in size, including smaller sites that are part of a larger common plan of development or sale (see Fact Sheet 3.0 for information on the Phase II construction program). Sites disturbing five acres or more were regulated previously. Most states have been authorized to implement the NPDES stormwater program and have issued, or are developing state-specific construction general permits. EPA remains the permitting authority in a few states, territories, and on most land in Indian Country, however. For construction (and other land disturbing activities) in areas where EPA is the permitting authority, operators must meet the requirements of the EPA Construction General Permit (CGP). Permitting authority information can be found in Appendix B of the CGP. CGP permit requirements include the submission of a Notice of Intent and the development of a stormwater pollution prevention plan (SWPPP). The SWPPP must include a site description and measures and controls to prevent or minimize pollutants in stormwater discharges.

Even though all construction sites that disturb more than one acre are covered by national NPDES regulations, the construction site runoff control minimum measure for the small MS4 program is needed to induce more localized site regulation and enforcement efforts, and to enable operators of regulated small MS4s to more effectively control construction site discharges into their MS4s.

To aid operators of regulated construction sites in their efforts to comply with both local requirements and their NPDES permit, the Phase II Final Rule includes a provision that allows the NPDES permitting authority to reference a "qualifying State, Tribal or local program" in the NPDES general permit for construction. This means that if a construction site is located in an area covered by a qualifying local program, then the construction site operator's compliance with the local program constitutes compliance with their NPDES permit. A regulated small MS4's stormwater program for construction could be a "qualifying program" if the MS4 operator requires a SWPPP, in addition to the requirements summarized in this fact sheet.

The ability to reference other programs in the NPDES permit is intended to reduce confusion between overlapping and similar local and NPDES permitting authority requirements, while still providing for both local and national regulatory coverage of the construction site. The provision allowing NPDES permitting authorities to reference other programs has no impact on, or direct relation to, the small MS4 operator's responsibilities under the construction site runoff control minimum measure profiled here.

Is a Small MS4 Required to Regulate Construction Sites that the Permitting Authority has Waived from the NPDES Construction Program?

No. If the NPDES permitting authority waives requirements for stormwater discharges associated with small construction activity (see 40 CFR § 122.26(b)(15)(i)), the small MS4 operator is not required to develop, implement, and/or enforce a program to reduce pollutant discharges from such construction sites.

For Additional Information

Contacts

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http://www.epa.gov/npdes/stormwater
Phone: 202-564-9545

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- National Menu of Best Management Practices for Stormwater Phase II
- Measurable Goals Guidance for Phase II Small MS4s
- Stormwater Case Studies
- And many others
- EPA Construction General Permit and Fact Sheet www.epa.gov/npdes/stormwater/cgp
- EPA Stormwater Management for Construction Activities and Best Management Practices: Developing Pollution Prevention Plans Guidance

☞ Construction Industry Compliance Assistance Center. http://www.cicacenter.org/

United States Environmental Protection Agency
Office of Water (4203)
EPA 833-F-00-009
January 2000 (revised December 2005)
Fact Sheet 2.7

Stormwater Phase II Final Rule

Post-Construction Runoff Control Minimum Control Measure

Stormwater Phase II Final Rule Fact Sheet Series

Overview

1.0 – Stormwater Phase II Final Rule: An Overview

Small MS4 Program

2.0 – Small MS4 Stormwater Program Overview

2.1 – Who's Covered? Designation and Waivers of Regulated Small MS4s

2.2 – Urbanized Areas: Definition and Description

Minimum Control Measures

2.3 – Public Education and Outreach

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2.7 – Post-Construction Runoff Control

2.8 – Pollution Prevention/Good Housekeeping

2.9 – Permitting and Reporting: The Process and Requirements

2.10 – Federal and State-Operated MS4s: Program Implementation

Construction Program

3.0 – Construction Program Overview

3.1 – Construction Rainfall Erosivity Waiver

Industrial "No Exposure"

4.0 – Conditional No Exposure Exclusion for Industrial Activity

This fact sheet profiles the Post-Construction Runoff Control minimum control measure, one of six measures that the operator of a Phase II regulated small municipal separate storm sewer system (MS4) is required to include in its stormwater management program in order to meet the conditions of its National Pollutant Discharge Elimination System (NPDES) permit. This fact sheet outlines the Phase II Final Rule requirements for post-construction runoff control and offers some general guidance on how to satisfy those requirements. It is important to keep in mind that the small MS4 operator has a great deal of flexibility in choosing exactly how to satisfy the minimum control measure requirements.

Why Is The Control of Post-Construction Runoff Necessary?

Post-construction stormwater management in areas undergoing new development or redevelopment is necessary because runoff from these areas has been shown to significantly affect receiving waterbodies. Many studies indicate that prior planning and design for the minimization of pollutants in post-construction stormwater discharges is the most cost-effective approach to stormwater quality management.

There are generally two forms of substantial impacts of post-construction runoff. The first is caused by an increase in the type and quantity of pollutants in stormwater runoff. As runoff flows over areas altered by development, it picks up harmful sediment and chemicals such as oil and grease, pesticides, heavy metals, and nutrients (e.g., nitrogen and phosphorus). These pollutants often become suspended in runoff and are carried to receiving waters, such as lakes, ponds, and streams. Once deposited, these pollutants can enter the food chain through small aquatic life, eventually entering the tissues of fish and humans. The second kind of post-construction runoff impact occurs by increasing the quantity of water delivered to the waterbody during storms. Increased impervious surfaces (e.g., parking lots, driveways, and rooftops) interrupt the natural cycle of gradual percolation of water through vegetation and soil. Instead, water is collected from surfaces such as asphalt and concrete and routed to drainage systems where large volumes of runoff quickly flow to the nearest receiving water. The effects of this process include streambank scouring and downstream flooding, which often lead to a loss of aquatic life and damage to property.

What Is Required?

The Phase II Final Rule requires an operator of a regulated small MS4 to develop, implement, and enforce a program to reduce pollutants in post-construction runoff to their MS4 from new development and redevelopment projects that result in the land disturbance of greater than or equal to 1 acre. The small MS4 operator is required to:

- ❑ Develop and implement strategies which include a combination of structural and/or non-structural best management practices (BMPs);
- ❑ Have an ordinance or other regulatory mechanism requiring the implementation of post-construction runoff controls to the extent allowable under State, Tribal or local law;

- ❑ Ensure adequate long-term operation and maintenance of controls;
- ❑ Determine the appropriate best management practices and measurable goals for this minimum control measure.

What Is Considered a "Redevelopment" Project?

The Phase II Final Rule applies to "redevelopment" projects that alter the "footprint" of an existing site or building in such a way that there is a disturbance of equal to or greater than 1 acre of land. Redevelopment projects do not include such activities as exterior remodeling. Because redevelopment projects may have site constraints not found on new development sites, the Phase II Final Rule provides flexibility for implementing post-construction controls on redevelopment sites that consider these constraints.

What Are Some Guidelines for Developing and Implementing This Measure?

This section includes some non-structural and structural BMPs that could be used to satisfy the requirements of the post-construction runoff control minimum measure. It is important to recognize that many BMPs are climate-specific, and not all BMPs are appropriate in every geographic area. Because the requirements of this measure are closely tied to the requirements of the construction site runoff control minimum measure (see Fact Sheet 2.6), EPA recommends that small MS4 operators develop and implement these two measures in tandem.

❑ Non-Structural BMPs

- **Planning Procedures**. Runoff problems can be addressed efficiently with sound planning procedures. Local master plans, comprehensive plans, and zoning ordinances can promote improved water quality in many ways, such as guiding the growth of a community away from sensitive areas to areas that can support it without compromising water quality.
- **Site-Based BMPs**. These BMPs can include buffer strip and riparian zone preservation, minimization of disturbance and imperviousness, and maximization of open space.

❑ Structural BMPs

- **Stormwater Retention/Detention BMPs.** Retention or detention BMPs control stormwater by gathering runoff in wet ponds, dry basins, or multichamber catch basins and slowly releasing it to receiving waters or drainage systems. These practices can be designed to both control stormwater volume and settle out particulates for pollutant removal.
- **Infiltration BMPs**. Infiltration BMPs are designed to facilitate the percolation of runoff through the soil to ground water, and, thereby, result in reduced stormwater runoff quantity and reduced mobilization of pollutants. Examples include infiltration basins/trenches, dry wells, and porous pavement.
- **Vegetative BMPs**. Vegetative BMPs are landscaping features that, with optimal design and good soil conditions, remove pollutants, and facilitate percolation of runoff, thereby maintaining natural site hydrology, promoting healthier habitats, and increasing aesthetic appeal. Examples include grassy swales, filter strips, artificial wetlands, and rain gardens.

What Are Appropriate Measurable Goals?

Measurable goals, which are required for each minimum control measure, are intended to gauge permit compliance and program effectiveness. The measurable goals, as well as the BMPs, should reflect needs and characteristics of the operator and the area served by its small MS4. Furthermore, the measurable goals should be chosen using an integrated approach that fully addresses the requirements and intent of the minimum control measure.

EPA has developed a Measurable Goals Guidance for Phase II MS4s that is designed to help program managers comply with the requirement to develop measurable goals. The guidance presents an approach for MS4 operators to develop measurable goals as part of their stormwater management plan. For example, an MS4 program goal might be to reduce by 30 percent the road surface areas directly connected to storm sewer systems (using traditional curb and gutter infrastructure) in new developments and redevelopment areas over the course of the first permit term. Using "softer" stormwater conveyance approaches, such as grassy swales, will increase infiltration and decrease the volume and velocity of runoff leaving development sites. Progress toward the goal could be measured by tracking the linear feet of curb and gutter not installed in development projects that historically would have been used.

For Additional Information

Contacts

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- National Menu of Best Management Practices for Stormwater Phase II
- Measurable Goals Guidance for Phase II Small MS4s
- Stormwater Case Studies
- And many others

☞ Other EPA Web sites
- Ordinance Database
www.epa.gov/owow/nps/ordinance
- Urban Nonpoint Source Guidance
www.epa.gov/owow/nps/urbanmm/index.html
- Low Impact Development Web site
www.epa.gov/owow/nps/lid

United States Environmental Protection Agency
Office of Water (4203)
EPA 833-F-00-010
January 2000 (revised December 2005)
Fact Sheet 2.8

Stormwater Phase II Final Rule

Pollution Prevention/Good Housekeeping Minimum Control Measure

Stormwater Phase II Final Rule Fact Sheet Series

Overview

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Small MS4 Program

2.0 – Small MS4 Stormwater Program Overview

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Minimum Control Measures

2.3 – Public Education and Outreach

2.4 – Public Participation/ Involvement

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2.7 – Post-Construction Runoff Control

2.8 – Pollution Prevention/Good Housekeeping

2.9 – Permitting and Reporting: The Process and Requirements

2.10 – Federal and State-Operated MS4s: Program Implementation

Construction Program

3.0 – Construction Program Overview

3.1 – Construction Rainfall Erosivity Waiver

Industrial "No Exposure"

4.0 – Conditional No Exposure Exclusion for Industrial Activity

This fact sheet profiles the Pollution Prevention/Good Housekeeping for Municipal Operations minimum control measure, one of six measures the operator of a Phase II regulated small municipal separate storm sewer system (MS4) is required to include in its storm water management program to meet the conditions of its National Pollutant Discharge Elimination System (NPDES) permit. This fact sheet outlines the Phase II Final Rule requirements and offers some general guidance on how to satisfy them. It is important to keep in mind that the small MS4 operator has a great deal of flexibility in choosing exactly how to satisfy the minimum control measure requirements.

Why Is Pollution Prevention/Good Housekeeping Necessary?

The Pollution Prevention/Good Housekeeping for municipal operations minimum control measure is a key element of the small MS4 stormwater management program. This measure requires the small MS4 operator to examine and subsequently alter their own actions to help ensure a reduction in the amount and type of pollution that: (1) collects on streets, parking lots, open spaces, and storage and vehicle maintenance areas and is discharged into local waterways; and (2) results from actions such as environmentally damaging land development and flood management practices or poor maintenance of storm sewer systems.

While this measure is meant primarily to improve or protect receiving water quality by altering municipal or facility operations, it also can result in a cost savings for the small MS4 operator, since proper and timely maintenance of storm sewer systems can help avoid repair costs from damage caused by age and neglect.

What Is Required?

Recognizing the benefits of pollution prevention practices, the rule requires an operator of a regulated small MS4 to:

- ❑ Develop and implement an operation and maintenance program with the ultimate goal of preventing or reducing pollutant runoff from municipal operations into the storm sewer system;
- ❑ Include employee training on how to incorporate pollution prevention/good housekeeping techniques into municipal operations such as park and open space maintenance, fleet and building maintenance, new construction and land disturbances, and stormwater system maintenance. To minimize duplication of effort and conserve resources, the MS4 operator can use training materials that are available from EPA, their State or Tribe, or relevant organizations;
- ❑ Determine the appropriate best management practices (BMPs) and measurable goals for this minimum control measure. Some program implementation approaches, BMPs (i.e., the program actions/activities), and measurable goals are suggested below.

What Are Some Guidelines for Developing and Implementing This Measure?

The intent of this control measure is to ensure that existing municipal, State or Federal operations are performed in ways that will minimize contamination of stormwater discharges. EPA encourages the small MS4 operator to consider the following components when developing their program for this measure:

- ***Maintenance activities, maintenance schedules, and long-term inspection procedures*** for structural and non-structural controls to reduce floatables and other pollutants discharged from the separate storm sewers;

- ***Controls for reducing or eliminating the discharge of pollutants*** from areas such as roads and parking lots, maintenance and storage yards (including salt/sand storage and snow disposal areas), and waste transfer stations. These controls could include programs that promote recycling (to reduce litter), minimize pesticide use, and ensure the proper disposal of animal waste;

- ***Procedures for the proper disposal of waste*** removed from separate storm sewer systems and areas listed in the bullet above, including dredge spoil, accumulated sediments, floatables, and other debris; and

- ***Ways to ensure that new flood management projects assess the impacts on water quality*** and examine existing projects for incorporation of additional water quality protection devices or practices. EPA encourages coordination with flood control managers for the purpose of identifying and addressing environmental impacts from such projects.

The effective performance of this control measure hinges on the proper maintenance of the BMPs used, particularly for the first two bullets above. For example, structural controls, such as grates on outfalls to capture floatables, typically need regular cleaning, while non-structural controls, such as training materials and recycling programs, need periodic updating.

What Are Appropriate Measurable Goals?

Measurable goals, which are required for each minimum control measure, are meant to gauge permit compliance and program effectiveness. The measurable goals, as well as the BMPs, should consider the needs and characteristics of the operator and the area served by its small MS4. The measurable goals should be chosen using an integrated approach that fully addresses the requirements and intent of the minimum control measure.

EPA has developed a Measurable Goals Guidance for Phase II MS4s that is designed to help program managers comply with the requirement to develop measurable goals. The guidance presents an approach for MS4 operators to develop measurable goals as part of their stormwater management plan. For example, an MS4 program goal might be to incorporate the use of road salt alternatives for highway deicing and reduce traditional road salt use by 50 percent in the first year of the permit term.

For Additional Information

Contacts

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- Measurable Goals Guidance for Phase II Small MS4s
- Stormwater Case Studies
- And many others

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Appendix D

water quality data master plan

D.3 UIC Information

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Oregon Department of Environmental Quality

Underground Injection Control (UIC) Program - Search UIC Database

Results from Search Type: Organization = silverton

Number of UIC Wells	Type	Type Description	Status
2	5W32	Septic Systems (drainfield Disposal Method)	Active

UIC Number: 10616
Facility Name: City of Silverton (Owner: City of Silverton)
Facility Status: Registered & RA
Street/City: 306 S. Water Street, Silverton
County: Marion
Latitude/Longitude: Latitude (45.0091), Longitude (-122.7845)
DEQ Permits:

Permit Type	Permit Number
NPDES	101720

Choose Type of Search	Enter Search Criteria*	Enter Latitude and Longitude:	Minimum	Maximum
Organization Name Search		**Latitude** (42.0 to 46.5) **Longitude** (-116.5 to -124.5)		

Search Reset

**For best results enter a portion/unique portion of the search criteria (eg. Address Search: 12345 Suttle Ave., type in suttle or sut).*

Oregon Department of Environmental Quality

Underground Injection Control (UIC) Program - Search UIC Database

Results from Search Type: City = Silverton

No. of UIC Wells	Facility Status	UIC Number	Organization/Owner	Facility Name	City	County
1	Not Registered	10132	Engine Parts & Machine	Engine Parts & Machine	Silverton	Marion
1	Registered w/permit	10397	Christian Renewal Center	Christian Renewal Center	Silverton	Marion
2	Registered & RA	10616	City of Silverton	City of Silverton	Silverton	Marion
5	Registered & RA	10619	Silver Falls School District	Silverton High School	Silverton	Marion
2	Registered & RA	10643	Silver Falls School District	Victor Point Elementary	Silverton	Marion
3	Under Review	11331	Silver Falls School District	Bethany Elementary School	Silverton	Marion
2	Under Review	11476	Silver Falls School District	Silver Crest Elementary	Silverton	Marion
1	Registered & RA	11480	Silver Falls School District	Evergreen Elementary	Silverton	Marion
4	Under Review	11481	Silver Falls School District	Central Howell Elementary School	Silverton	Marion
1	Under Review	12820	Mark Dickman	Dickman Farms Inc.	Silverton	Marion
1	Registered & RA	13678	Silver Falls School District	Mark Twain Middle School	Silverton	Marion

Record count = 11

Choose Type of Search	Enter Search Criteria*	Enter Latitude and Longitude:	Minimum	Maximum
Organization Name Search		**Latitude** (42.0 to 46.5) **Longitude** (-116.5 to -124.5)		

Search Reset

**For best results enter a portion/unique portion of the search criteria (eg. Address Search: 12345 Suttle Ave., type in suttle or sut).*

Oregon DEQ UIC Program Information

Web Address: http://www.deq.state.or.us/wq/uic/uic.htm
Phone: (503) 229-5619

There is no grandfather clause for existing UIC systems. All systems must go through the registration process and either be permitted or rule authorized. Each UIC is evaluated on a case by case basis, and registration through the DEQ can take up 90 days.

Subsurface infiltration systems, such as drywells, are classified as Class V injection wells in the EPA's federal UIC program. The two requirements of the UIC program are as follows:

- A non-endangerment performance standard must be met, prohibiting discharges that allow movement of fluids containing contaminants into potential underground sources of drinking water.
- All UIC facility owners/operators must provide inventory information by registering the facilities.

Under the federal UIC regulations, the definition of an underground injection well is a bored, drilled, or driven shaft whose depth is greater than the largest surface dimension; a dug hole whose depth is greater than the largest surface dimension; an improved sinkhole; or a subsurface fluid distribution system that includes an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute fluids below the surface of the ground.

Examples of a UIC well or a subsurface infiltration system are drywells, drain fields, pipe or French drains, and other similar devices that discharge to ground. In addition to the non-endangerment standard, storm water injection systems will qualify as "rule authorized" only if no other disposal option is appropriate. Oregon Administrative Rules (OAR) 340-044-0030 specifically prohibits injection wells with depths greater than their largest surface dimension, if any other treatment or disposal method which "affords better protection of public health or water resources is reasonably available or possible."

All "rule authorized" systems must meet the *General Requirements* in RA 1101. Further provisions in *Basic Requirements* must be met by all injection systems except roof drains. Additional specific *Category Requirements* (per RA 1101) apply to the following categories:

- Municipal systems with 50 or more injection wells
- Municipal systems with less than 50 injection wells
- Industrial/commercial facilities with hazardous substances
- Industrial/commercial facilities without hazardous substances

- Large parking lots
- Small parking lots
- Residential systems included in the UIC Program (e.g. garage floor and driveway drains)

Owners of any category of "rule authorized" storm water injection systems (except residential) must prepare and implement a storm water management plan. The required elements of the plan vary depending on the size of the system. Certain elements – system assessment; Best Management Practices (BMPs) for source control and treatment; spill prevention and response; maintenance plan; employee and public education; and evaluation of plan effectiveness – are required for any size system. For municipal systems with 50 or more injection systems, storm water management plans must also have monitoring and record-keeping plans.

Department of Environmental Quality (DEQ) has developed recommendations for source control measures, spill response, storm water maintenance standards, education outreach, and monitoring. These are documented in "DEQ Underground Injection Control (UIC) Class V BMPs for Groundwater."

If an injection system does not qualify as "rule authorized", the Owner may be required to either: 1) modify the system so it meets the criteria for rule authorized; 2) close the injection system; 3) discharge to a municipal storm sewer, if available; or 4) apply for a Water Pollution Control Facility (WPCF) Permit (general or area wide).

Municipalities with over 50 injection systems need to develop a Decommissioning Plan for injection systems that do not meet the *Basic Requirements* (Oregon Administrative Rules (OAR) 340-044-0018). DEQ documents (Ref. 5 and 6) outline evaluation steps needed, and suggest closure standards for storm water injection systems. DEQ Storm water Management Guidelines outline different methods to remove pollutants from storm water prior to groundwater discharge, including alternatives to injection wells.

Municipalities also have the option to negotiate an area-wide permit or memorandum of agreement with DEQ for systems that fail to meet Rule Authorization requirements. (As of February 2012, only one area-wide WPCF/UIC permit has been issued, which is to the City of Portland.) An area-wide permit would need to include the following elements:

- Quarterly inventory reporting of new injection systems
- Use of DEQ database spread sheet
- GPS location data
- Monitoring and maintenance plans
- Maintenance schedule
- Storm water management

- Screening for hazardous areas
- Spill plans
- Closure and remediation requirements
- Inspection and enforcement options
- Information on existing land uses and any available data on unsuitable areas (soils)

In summary, any owner or operator of a Class V storm water system is required to:

- Register system prior to use, and provide inventory data to Department of Environmental Quality (DEQ).

- Meet “non-endangerment” performance standard to prevent contamination of groundwater by storm water.

- Submit a closure plan to DEQ, and then properly decommission a banned system or any system when it is no longer in use.

- Comply with other local, state and federal regulations (including requirements of the State Groundwater Act and the Safe Drinking Water Act Standards).

State of Oregon Department of Environmental Quality
Water Quality Division
Underground Injection Control Program
811 SW Sixth Avenue, Portland OR 97204

Underground Injection Control

Rule Authorized Storm Water Injection Requirements

Storm water injection is authorized by rule, and does not need a permit if **General**, **Basic**, and **Category** requirements are met.

Type of Storm Water	What is Required?	When is it required?	
		New Injection	Existing & Registered Injection
All rule authorized injection	**General Requirements** **340-044-0018(1)** **Must be** an allowable injection not specifically prohibited by rule **Must submit** inventory and registration information **Must not impact groundwater** above background or MCLs **Available** for specific types of injection – listed, storm water, case-by-case		
All rule authorized storm water injection EXCEPT roof drains	**Storm Water** **Basic Requirements** **340-044-0018(3)(a)** **Must submit certification** with inventory and registration information that: • No other waste is mixed with storm water • Storm water runoff is minimized • No other disposal option is appropriate • No domestic drinking water supply wells are present within 500 feet • No public drinking water supply wells are present within 500 feet or 2 year time-of-travel • No soil or groundwater contamination is present • Well is not deeper than 100 feet, does not discharge into groundwater or below highest seasonal groundwater level • Confinement barrier or filtration medium is present, <u>or</u> BMPs are used to prevent or treat storm water contamination • Design and operation prevents accidental or illicit disposal and temporary blocking is available **SEE ADDITIONAL REQUIREMENTS FOR SPECIFIC CATEGORIES**	Applies before construction	Review for compliance

UIC Rule Authorized Storm Water Injection Additional Requirements by Category

Storm Water Categories	Additional Requirements	When is it required?	
		New Injection	Existing & Registered Injection
Municipal **50 or more injection wells** **340-044-0018(3)(b)**	**Must submit** with inventory and registration: • Evaluation of impacts to groundwater ➢ Volume, quality, geology, density, land use • Decommissioning plan for wells that don't comply with basic requirements • Certification that storm water does not drain from hazardous substance use, handling, or storage areas <u>or</u> submit a permit application	Before construction Not applicable Before construction	12/19/01 12/19/01 7/1/02
	Must prepare and implement a *storm water management plan* with these required elements: • System assessment – well location, construction detail, land use, identification of areas with hazardous substance use • System controls ➢ BMPs for source control and treatment ➢ Prevent drainage from areas with hazardous substances ➢ Spill prevention and response ➢ Maintenance plan and schedule – visual inspection and physical maintenance ➢ Employee and public education ➢ Identify responsible personnel • Monitoring plan ➢ Identify representative locations for monitoring and sampling ➢ <u>Minimum</u> sampling – 2 times in first year, then annually at on-set of wet weather conditions ➢ Grab samples prior to injection ➢ Sample analysis – Use analytical methods with detection limits below MCLs. Analyze for contaminants identified in system assessment <u>plus</u> BTEX, benzo(a)pyrene, Pb, Cr, Cd, total nitrogen, fecal coliform bacteria • Record keeping plan	Before construction	7/1/02
	Must submit a summary report on *storm water management plan* implementation, monitoring, sampling, and assess effectiveness of BMPs	6/30/04	6/30/04
Municipal **Fewer than 50 injection wells** 340-044-0018(3)(c)	**Must submit** with inventory and registration: • Certification that storm water does not drain from hazardous substance use, handling, or storage areas <u>or</u> submit a permit application	Before construction	7/1/02
	Must prepare and implement a *storm water management plan* with these required elements: • System assessment • System controls – BMPs for source control and treatment • Spill prevention and response • Maintenance plan • Employee and public education • Evaluation of effectiveness of storm water management plan	Before construction	7/1/02

UIC Rule Authorized Storm Water Injection Additional Requirements by Category

Storm Water Categories	Additional Requirements	When is it required?	
		New Injection	Existing & Registered Injection
Industrial or Commercial Facility **With Hazardous Substances** **340-044-0018(3)(d)**	**Must submit** with inventory and registration: • Certification that storm water is not exposed to industrial activities or hazardous substance use, handling, or storage areas. Include: ➢ Site assessment – location and type of industrial activities, location of hazardous substances, location and description of all storm water discharges, methods to prevent exposure to industrial activities and hazardous substances ➢ Sample analysis – representative grab sample analyzed for priority pollutants, total nitrogen, fecal coliform bacteria, and other potential contaminants ➢ Site control measures and BMPs ➢ List and date of all accidents, spills, or releases of hazardous substances • **Must re-certify** every 5 years. May modify required sample analysis	Before construction	3/19/02
	Must prepare and implement a *storm water management plan* with these required elements: • Site assessment – well location, construction detail, activities and use in areas exposed to storm water, identification and location of areas where hazardous substance used, handle, stored • Site controls – BMPs for source control and treatment ➢ Segregate areas with hazardous substance use from storm water run-off or run-on ➢ Spill prevention and response ➢ Maintenance plan and schedule – <u>minimum</u> monthly visual inspection and semi-annual physical maintenance ➢ Employee education ➢ Identify responsible personnel • Monitoring plan ➢ Identify locations for monitoring ➢ <u>Minimum</u> sampling – 2 times in first year, then annually at on-set of wet weather conditions in first 30 minutes of discharge from storm > 0.1 inches after 72 hours dry weather • Grab samples prior to injection ➢ Sample analysis – Use analytical methods with detection limits below MCLs. Analyze for contaminants identified in site assessment and all contaminants detected in certification analysis ➢ Use MCLs as reference levels ➢ Review BMPs and implement corrective measures if reference levels exceeded ➢ Record keeping and reporting plan – report results that exceed reference levels	Before construction	3/19/02

UIC Rule Authorized Storm Water Injection Additional Requirements by Category

Storm Water Categories	Additional Requirements	When is it required?	
		New Injection	Existing & Registered Injection
Industrial or Commercial Facility **<u>No</u> Hazardous Substances** 340-044-0018(3)(e)	**Must submit** with inventory and registration: • Certification that hazardous substances not used, handled or stored at facility • **Must re-certify** every 5 years **Must prepare and implement** a *storm water management plan* with these required elements: • Site assessment • Site controls – BMPs for source control and treatment • Spill prevention and response • Maintenance plan • Employee education Evaluation of effectiveness of storm water management plan	Before construction Before construction	12/19/01 3/19/02
Large Parking Lots **1000 trips per day** **Industrial, commercial, municipal, residential** **340-044-0018(3)(f)**	**Must submit** with inventory and registration: • Certification that storm water is not exposed to industrial activities or areas where hazardous substance are used, handled, or stored • **Must re-certify** every 5 years **Must prepare and implement** a *storm water management plan* with these required elements: • Site assessment – well location, construction details, evaluation of use and activities, evaluation of risk for accidental or illicit waste disposal • Site controls – BMPs for source controls and treatment ➢ Prevent drainage from areas with high risk for accidental or illicit disposal ➢ Spill prevention and response ➢ Maintenance plan and schedule – <u>minimum</u> monthly visual inspection and semi-annual physical maintenance ➢ Employee and public education ➢ Identify responsible personnel • Monitoring plan ➢ Identify locations for monitoring ➢ <u>Minimum</u> sampling – 2 times in first year, then annually at on-set of wet weather conditions in first 30 minutes of discharge from storm > 0.1 inches after 72 hours dry weather ➢ Grab samples prior to injection ➢ Sample analysis – Use analytical methods with detection limits below MCLs. Analyze for contaminants identified in site assessment plus BTEX, benzo(a)pyrene, Pb, Cr, Cd, total nitrogen, fecal coliform bacteria ➢ Use MCLs as reference levels ➢ Review BMPs and implement corrective measures if reference levels exceeded Record keeping and reporting plan – report results that exceed reference levels	Before construction Before construction	12/19/01 3/19/02

UIC Rule Authorized Storm Water Injection Additional Requirements by Category

Storm Water Categories	Additional Requirements	When is it required?	
		New Injection	Existing & Registered Injection
Small Parking Lots **<1000 trips per day** **Industrial, commercial, municipal** **340-044-0018(3)(g)**	**Must submit** with inventory and registration: • Certification that storm water is not exposed to industrial activities or hazardous substance areas **Must prepare and implement** a *storm water management plan* with these required elements: • System assessment • System controls – BMPs for source control and treatment • Spill prevention and response • Maintenance plan • Employee and public education • Evaluation of effectiveness of storm water management plan	Before construction Before construction	12/19/01 3/19/02
Residential **340-044-0018(3)(h)**	**Must submit** inventory and registration information and certify basic requirements are met **Use** designs that prevent storm water contamination and remove pollutants **Use** BMPs to prevent and/or treat storm water contamination including maintenance with monthly visual inspection and semi-annual maintenance	Before construction	Required

Appendix D

water quality data ▪ master plan

D.4 DSL Wetland Compensatory Mitigation Facts

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JUST THE FACTS...

ABOUT COMPENSATORY MITIGATION FOR WETLAND IMPACTS

When people apply for a permit to place fill in a wetland, they discover immediately that they must follow a process to "mitigate" the impacts to the wetland. This fact sheet explains the mitigation process and the different compensatory mitigation options that may be available to the permit applicant. More detailed information and mitigation rules are available from the DSL Web site (see below) or from permit staff.

What Does Mitigation Mean?

The dictionary definition of mitigation is "to reduce the effect of an action." In wetland regulations, the term has the same meaning—to reduce the adverse effects of a proposed project. The main point to remember is that mitigation is a *process*. It starts with evaluating how a project might avoid wetland impacts. If the impact cannot be completely avoided, the next step is to look at ways to minimize "unavoidable" impacts. Only after a legitimate effort has been made to avoid and minimize adverse impacts does "compensatory mitigation" come into play. This sequential process is established in both state and federal law.

What Is Compensatory Mitigation?

Compensatory mitigation is creating, restoring, or enhancing wetlands to replace or "compensate" for the wetland area and functions lost through the permitted alteration. Constructing a wetland in an area that never supported wetlands historically is called *creation*. Wetland creation is often difficult because the upland soils are not good at retaining water. *Restoration* means re-establishing wetland hydrology and vegetation to a site that was historically wetland but has been dried out by diking, draining, or filling. *Enhancement* is improving an existing but badly degraded wetland by correcting the conditions that cause it to be degraded. This might include providing more water to the site and reestablishing native plant communities. The enhancement goal is to measurably improve the condition and functions of the wetland.

When Is Compensatory Mitigation Required?

Compensatory mitigation is required as a condition of any state permit to place fill or excavate in a wetland. When a permit application is received by DSL, the permit coordinator determines whether the applicant has adequately explored project alternatives that would avoid wetland impacts completely and also those that would minimize impacts. If there are practicable alternatives with no or minimal wetland impact, those alternatives must be pursued. Compensatory mitigation is required for the unavoidable impacts.

Basic Mitigation Process Steps

Steps taken before compensatory mitigation is considered

- Delineate wetland boundaries on the development site and obtain DSL concurrence.
- Analyze project development needs for the site.
- Determine whether the project can be completed without any direct impact (fill or excavation) in the wetlands.
- If not, identify project alternatives that will minimize wetland impacts.
- Finalize development/project plans that minimize wetland impacts.

Steps taken after alternatives are fully explored and impacts minimized

- Evaluate project impacts on wetland acreage and functions (conduct a wetland function assessment).
- Develop a compensatory mitigation plan that meets minimum ratios and replaces lost functions, or proposes purchase of mitigation bank credits or "payment to provide mitigation" (see reverse side of fact sheet).
- Obtain DSL approval of the mitigation plan (part of application review process).
- Construct mitigation project before or at the same time (same growing season) that the development project is constructed, unless otherwise authorized by DSL.
- Monitor mitigation project for required period of time (usually 5 years) and take corrective action to ensure project success, as necessary.

Must Wetlands Be Replaced On an Acre-for-Acre Basis?

DSL's rules set minimum ratios that vary by the type of compensatory mitigation proposed, as follows:

- Restoration ratio is 1:1 (1 acre restored for every 1 acre lost)
- Creation ratio is 1.5:1 (1.5 acres created for every 1 acre lost)
- Enhancement ratio is 3:1 (3 acres enhanced for every 1 acre lost)
- Enhancement of cropped wetlands is 2:1 (2 acres enhanced for every 1 acre lost)

The ratios reflect both the probability of mitigation project success and the state's mandate to maintain wetland acreage and functions.

Compensatory Mitigation Options

Onsite mitigation refers to conducting the compensatory mitigation project on the same parcel where the wetland impact will occur. This is frequently the easiest option and may be the best one for minimizing the adverse impacts of developments in a given area. For example, if localized flooding is a problem, it's important to maintain local flood storage capability. Sometimes, however, onsite mitigation is not practicable (e.g., for small wetland impacts) or is not the best option for replacing wetland functions.

Offsite mitigation is when the mitigation site is not part of the development site. Instead, the mitigation project is constructed at some other appropriate site.

Purchase credits from a mitigation bank—a mitigation bank is a large wetland mitigation project constructed by a public entity or private party to compensate for future wetland impacts. DSL has specific rules for how a mitigation bank will be developed, operated, and monitored. "Credits" are the units of exchange. They are usually based on acre units (one acre impact = one credit) and their value is determined by the actual cost of creating the credit in the bank. Private bank sponsors include all land and operation costs and will also figure in a margin of profit. DSL staff may approve purchase of credit from a bank if onsite mitigation options are not practicable or not environmentally preferable.

Payment to provide mitigation—as a last resort, applicants may be allowed to make a payment to DSL rather than construct the mitigation project themselves. If the development site is within the "service area" of a mitigation bank with credits available, the applicant must take that option before payment to provide is allowed. The payment to provide amount is based on the average cost of credits from all approved banks in Oregon. Money paid to DSL is used to fund restoration, creation, and/or enhancement of wetlands and other waters of the state.

How Well Does Compensatory Mitigation Work?

There have been many studies throughout the U.S. on how well compensatory mitigation is working. Most studies evaluate only very basic factors, such as whether plantings survived. However, the National Research Council conducted a nationwide study (in 2001) and made many recommendations for improving compensatory mitigation success.

The "success" of a mitigation project depends upon multiple factors including appropriate siting, adequate water source, and the site's ability to be self-maintaining. In general, restoration of former wetlands has a higher likelihood of success than wetland creation or enhancement. Because wetland enhancement sites are already wetland, this most common type of compensatory mitigation results in a loss of wetland area; therefore, it is very important that wetland functions are significantly improved. Mitigation banks can provide many practical and ecological benefits over small, onsite mitigation projects, but are not always the best choice for replacing localized wetland functions and values.

DSL studies of mitigation compliance with permit conditions have found that:

- Most compensatory mitigation projects required by a permit were completed.
- There were often significant differences in what was permitted and what was completed, resulting in a small net loss of wetland acreage.

There is limited data with which to evaluate the functional success of mitigation projects.

Appendix D

water quality data ▪ master plan

D.5 Wetland Inventory

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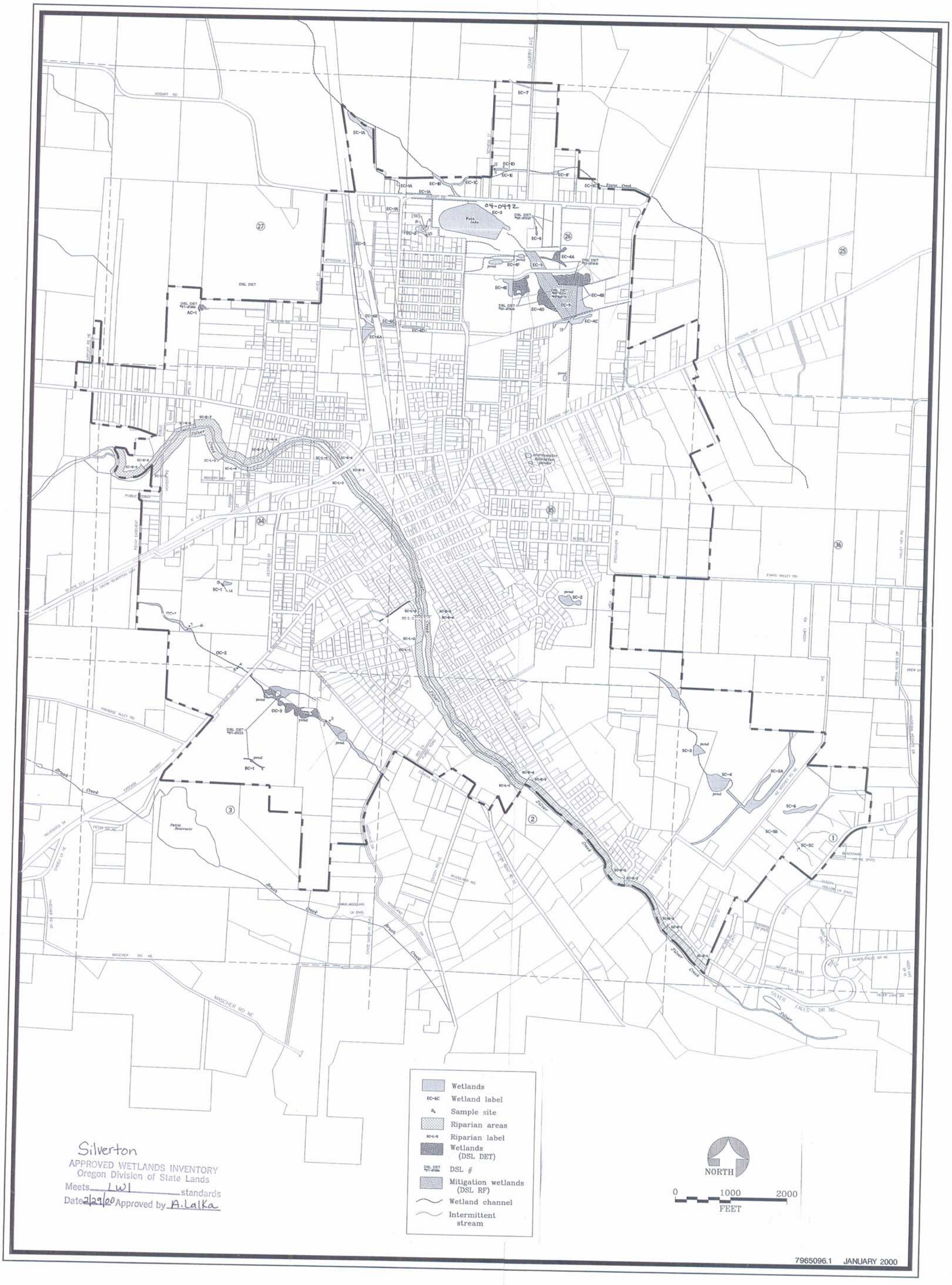
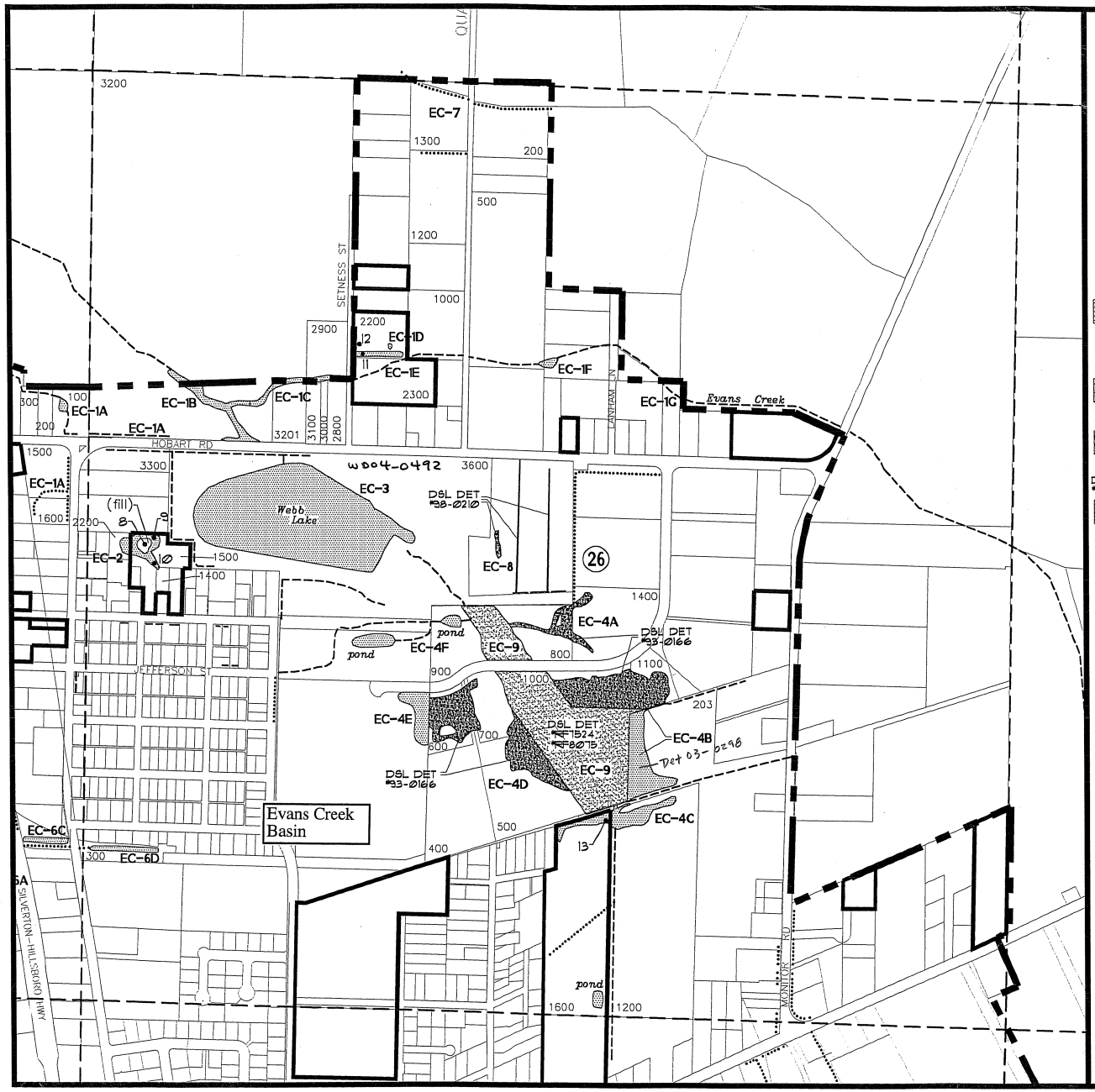

Wetlands
Wetland label
Sample site
Riparian areas
Riparian label
Wetlands (DSL DET)
DSL #
Mitigation wetlands (DSL RF)
Wetland channel
Intermittent stream
NORTH
0
1000
2000
FEET
Silverton
APPROVED WETLANDS INVENTORY
Oregon Division of State Lands
Meets LWI standards
Date 2/29/00 Approved by A. Lalka
04-0492
7965096.1 JANUARY 2000



T 6S R 1W Section 26

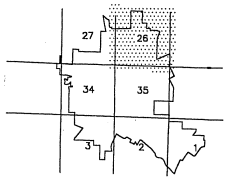
CITY OF SILVERTON LOCAL WETLAND INVENTORY

LEGEND

- Wetlands
- EC-6C Wetland label
- Sample site
- Riparian areas
- SC-L-5 Riparian label
- Wetlands (DSL DET)
- DSL DET #97-0186 DSL #
- Mitigation wetlands (DSL RF)
- Site access granted
- 1600 Parcel number
- Section line
- Urban Growth Boundary
- Wetland channel
- Intermittent stream

Wetland acreage

1 acre
1/2 acre
1/10th acre



NORTH

0 600 1200
FEET

JANUARY 2000

WETLAND INFORMATION IS SUBJECT TO CHANGE

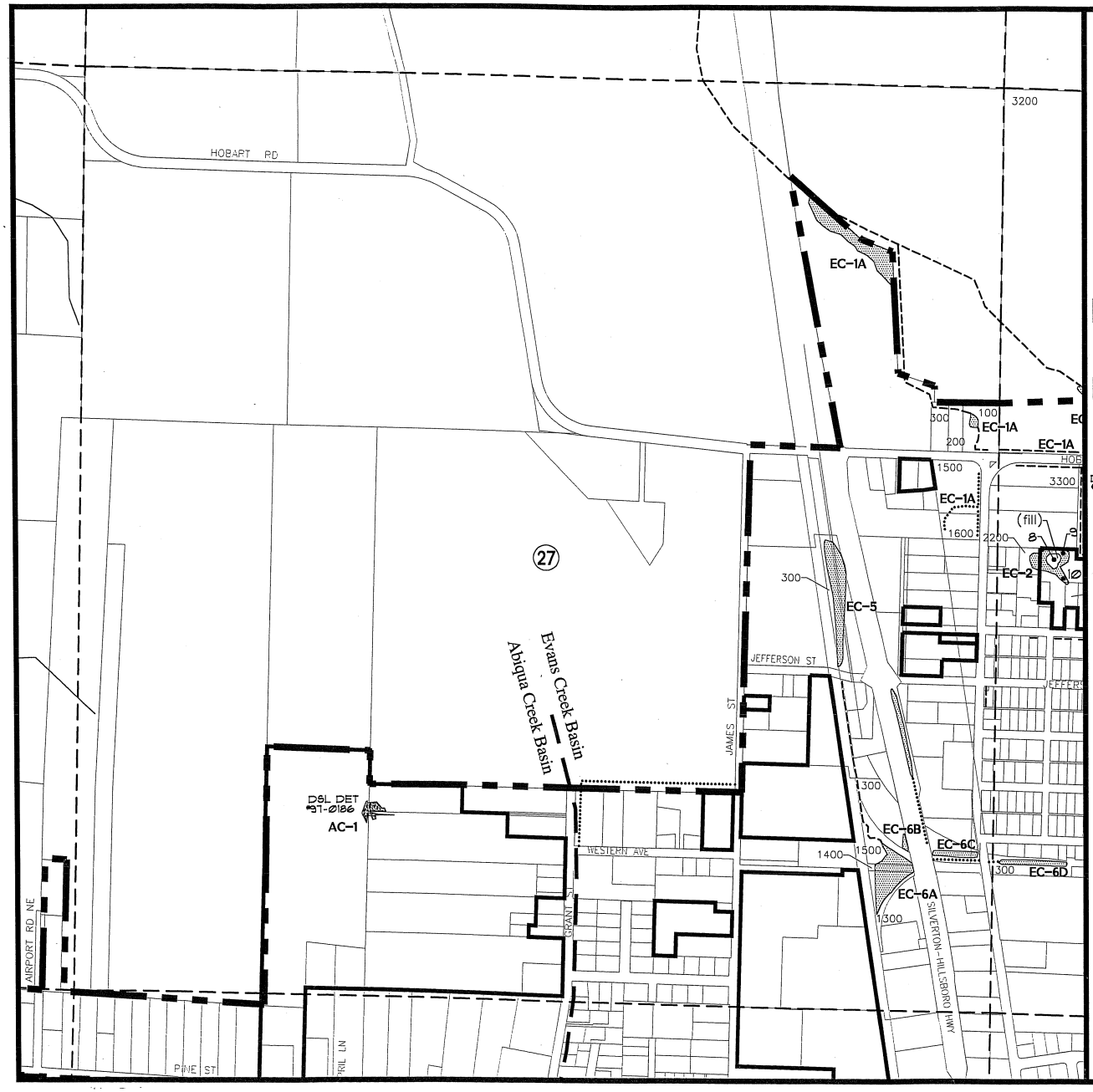
This map is for planning purposes only. Mapped wetland boundaries and riparian study areas were not flagged or surveyed (unless noted as a delineation study). There may be exceptions or unmapped wetlands subject to regulation. In all cases, actual field conditions determined wetland boundaries. All wetland boundaries were mapped in the field on aerial photographs at a scale of 1"=200'. On-site verified (site access granted) wetland boundaries were mapped accurately to within 25' on the aerial photographs. If site alteration work is proposed, you are advised to contact the Oregon Division of State Lands or the U.S. Army Corps of Engineers with regulatory questions. This study was funded by a wetlands planning assistance grant from the U.S. Environmental Protection Agency Region X, administered by the Oregon Division of State Lands

City of Silverton

306 S. Water Street
Silverton, Oregon 97381

SHAPIRO & ASSOCIATES, INC.

Oregon Division of State Lands
Meets Lwl standards
Date 2/29/00 Approved by A. Lalka



T 6S R 1W Section 27

CITY OF SILVERTON LOCAL WETLAND INVENTORY

LEGEND

- Wetlands
- EC-6C Wetland label
- Sample site
- Riparian areas
- SC-L-5 Riparian label
- Wetlands (DSL DET)
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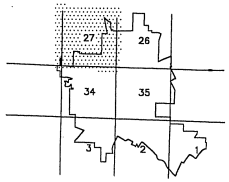
Wetland acreage

1 acre
1/2 acre
1/10th acre



NORTH

0 600 1200
FEET

JANUARY 2000

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City of Silverton

306 S. Water Street
Silverton, Oregon 97381

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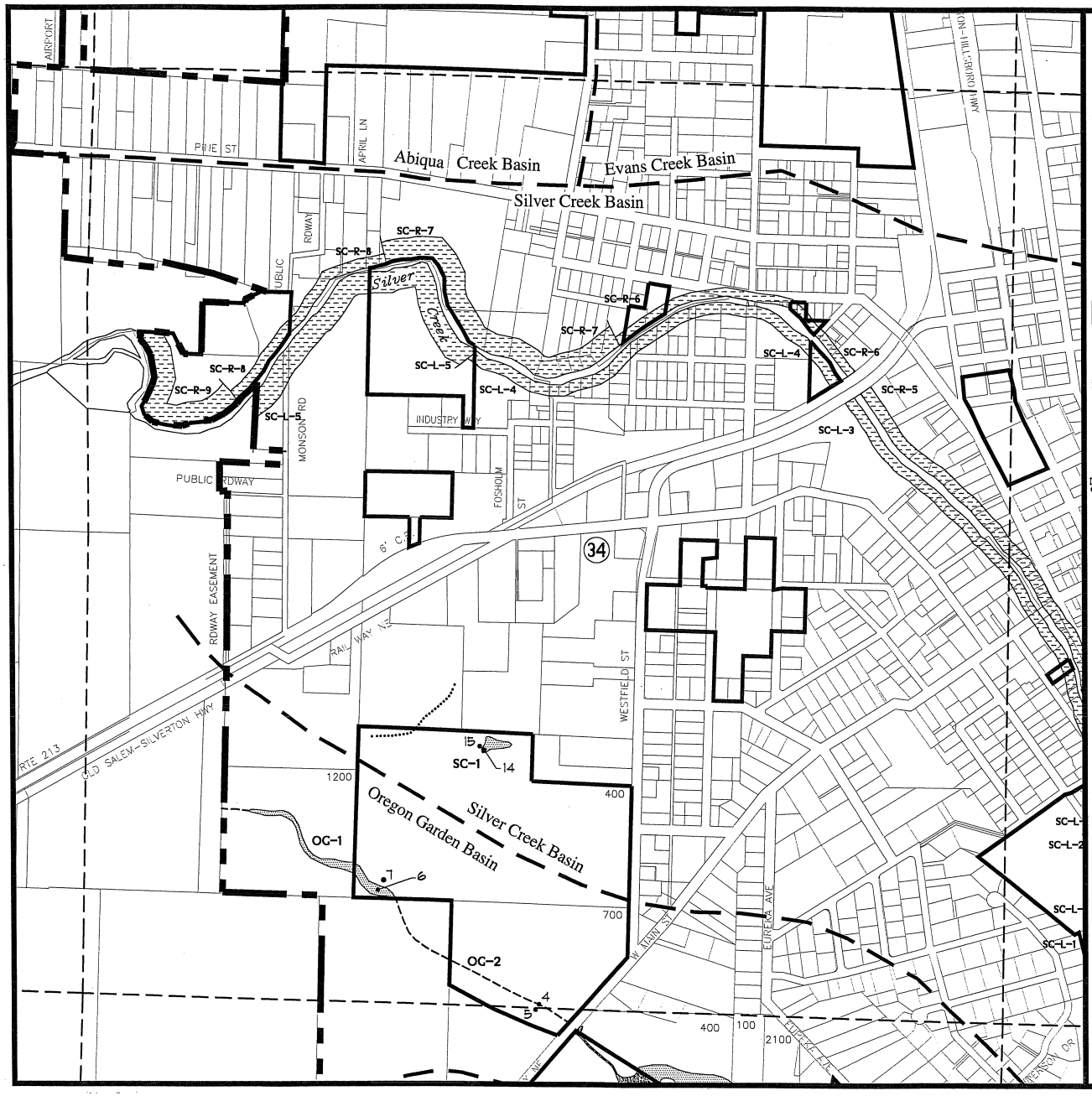
APPROVED WETLANDS INVENTORY
Oregon Division of State Lands
Meets LWI standard
Date 2/22/00 Approved by A. Laika



T 6S R 1W Section 34

CITY OF SILVERTON LOCAL WETLAND INVENTORY

LEGEND

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- Sample site
- Riparian areas
- SC-L-5 Riparian label
- Wetlands (DSL DET)
- DSL DET 97-0186 DSL #
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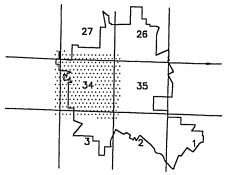
- Intermittent stream

Wetland acreage

1 acre
1/2 acre
1/10th acre



NORTH

0 600 1200
FEET

JANUARY 2000

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City of Silverton
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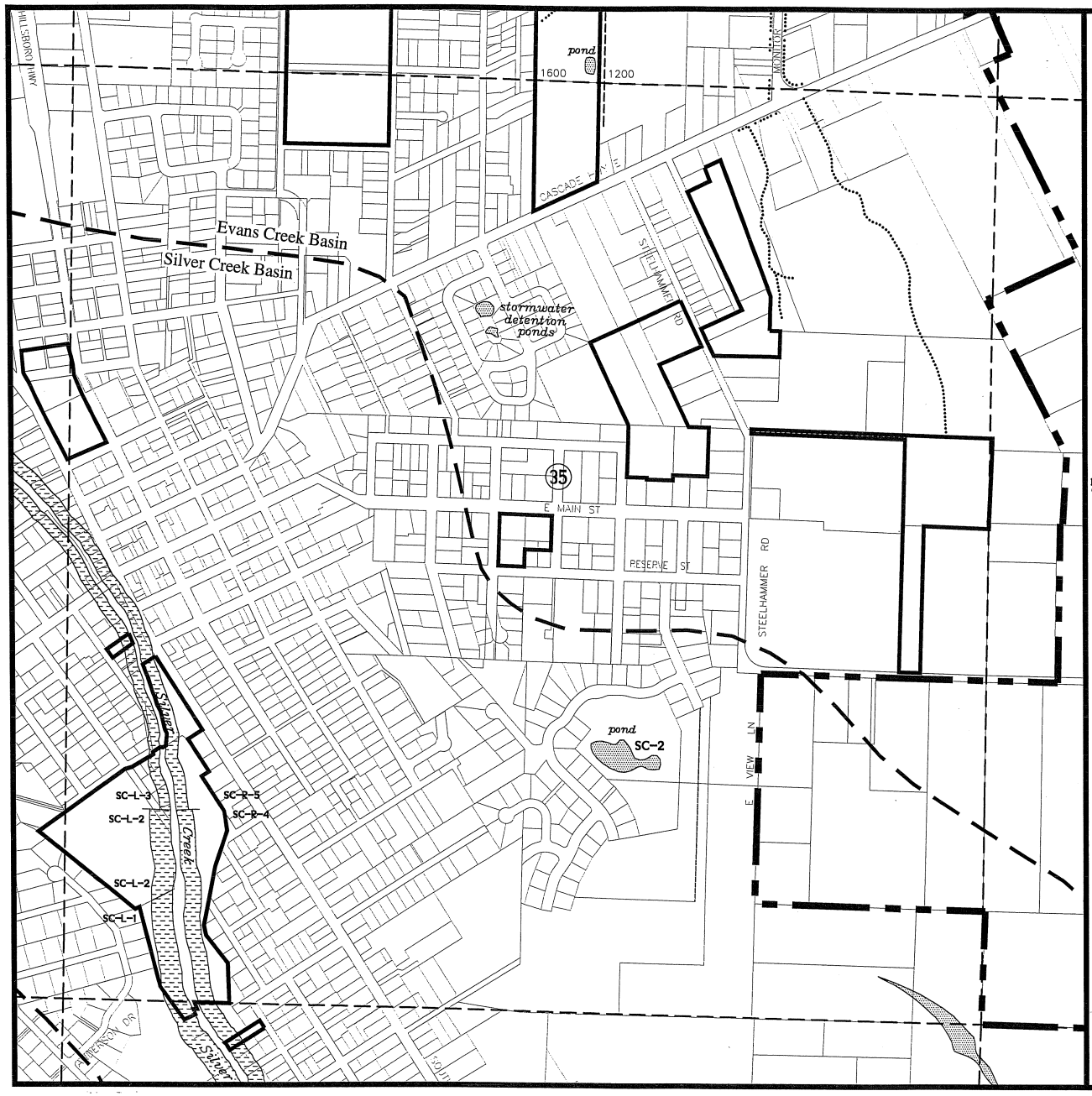
Meets LWI standards
Date 2/29/00 Approved by A. Laika



T 6S R 1W Section 35

CITY OF SILVERTON LOCAL WETLAND INVENTORY

LEGEND

- Wetlands
- EC-6C Wetland label
- Sample site
- Riparian areas
- SC-L-5 Riparian label
- Wetlands (DSL DET)
- DSL DET #97-0186 DSL #
- Mitigation wetlands (DSL RF)
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- 1600 Parcel number
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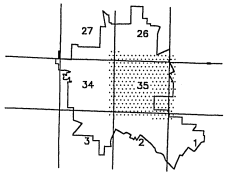
Wetland acreage

1 acre
1/2 acre
1/10th acre



NORTH

0 600 1200
FEET

JANUARY 2000

WETLAND INFORMATION IS SUBJECT TO CHANGE

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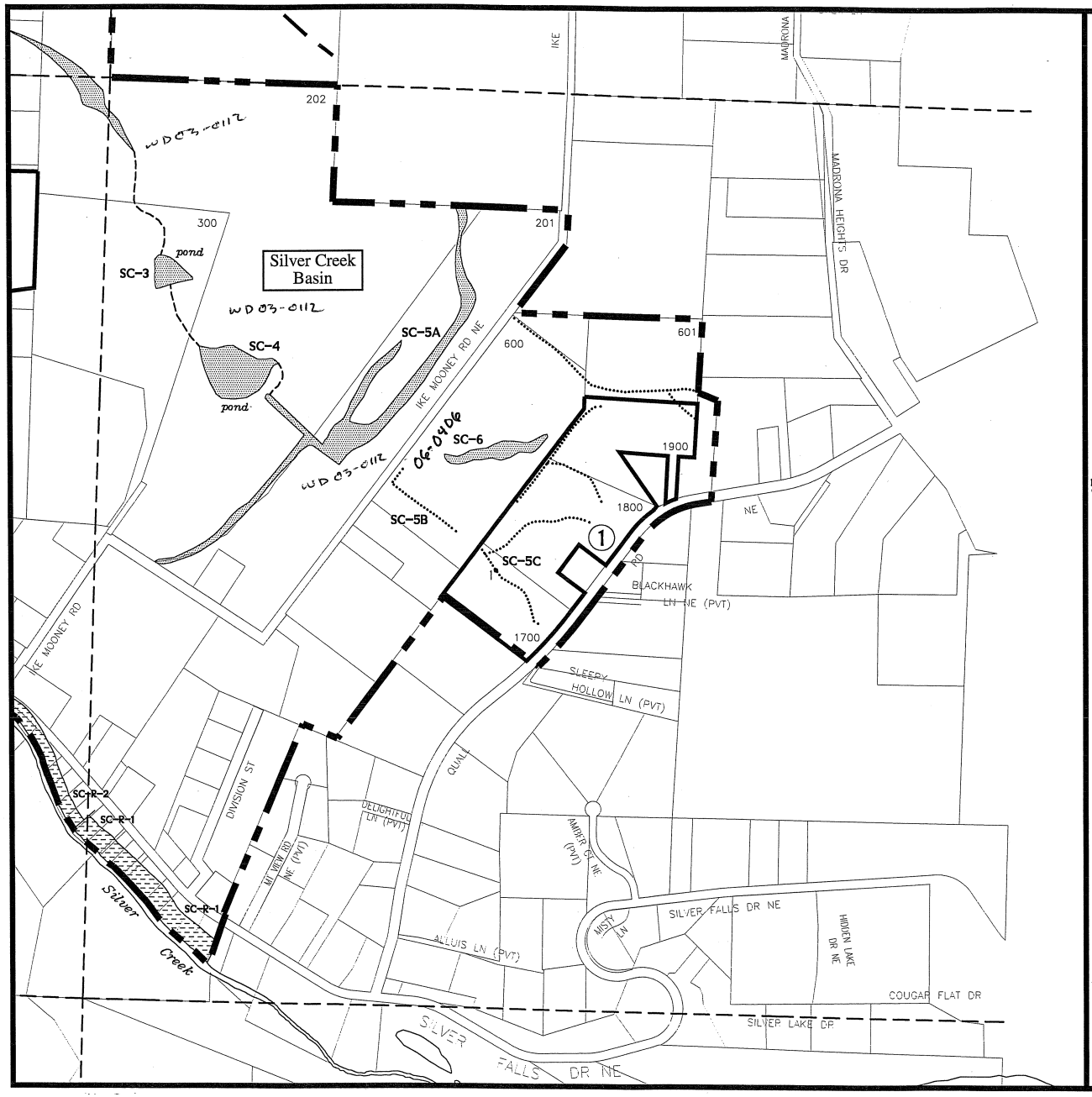
City of Silverton
306 S. Water Street
Silverton, Oregon 97381

SHAPIRO & ASSOCIATES, INC.

APPROVED WETLANDS INVENTORY
Oregon Division of State Lands
Meets LWI standards
Date 2/29/00 Approved by A. La Ika



T 7S R 1W Section 01

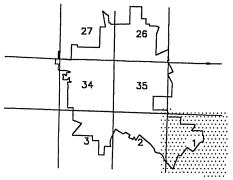
CITY OF SILVERTON LOCAL WETLAND INVENTORY

LEGEND

- Wetlands
- EC-6C Wetland label
- Sample site
- Riparian areas
- SC-L-5 Riparian label
- Wetlands (DSL DET)
- DSL DET #97-0186 DSL #
- Mitigation wetlands (DSL RF)
- Site access granted
- 1600 Parcel number
- Section line
- Urban Growth Boundary
- Wetland channel
- Intermittent stream

Wetland acreage

1 acre
1/2 acre
1/10th acre



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FEET

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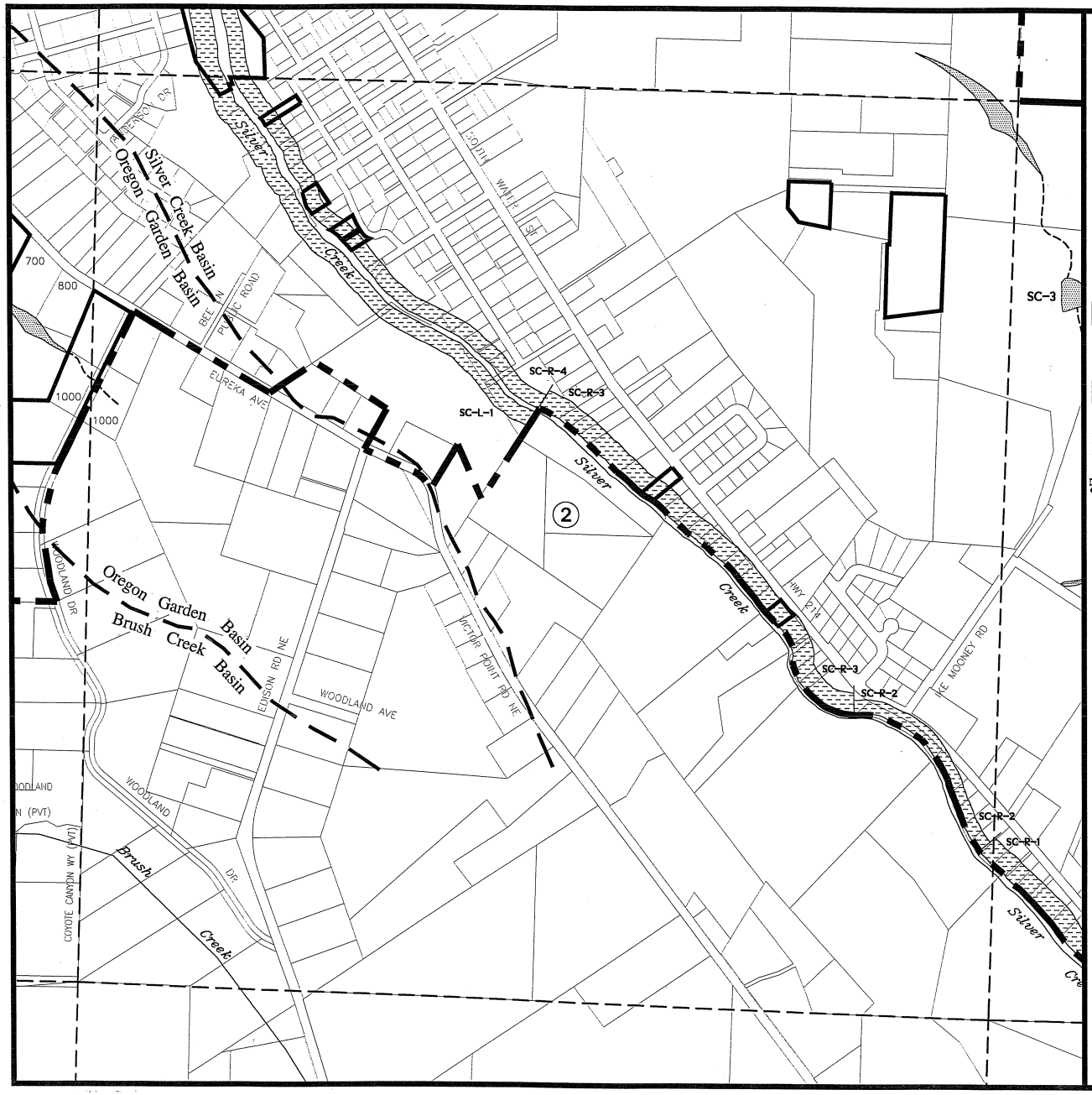


T 7S R 1W Section 02

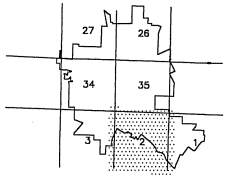
CITY OF SILVERTON LOCAL WETLAND INVENTORY

LEGEND

- Wetlands
- EC-6C Wetland label
- Sample site
- Riparian areas
- SC-L-5 Riparian label
- Wetlands (DSL DET)
- DSL DET #97-0186 DSL #
- Mitigation wetlands (DSL RF)
- Site access granted
- 1600 Parcel number
- Section line
- Urban Growth Boundary
- Wetland channel
- Intermittent stream

Wetland acreage

1 acre
1/2 acre
1/10th acre



NORTH

0 600 1200
FEET

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Oregon Division of State Lands
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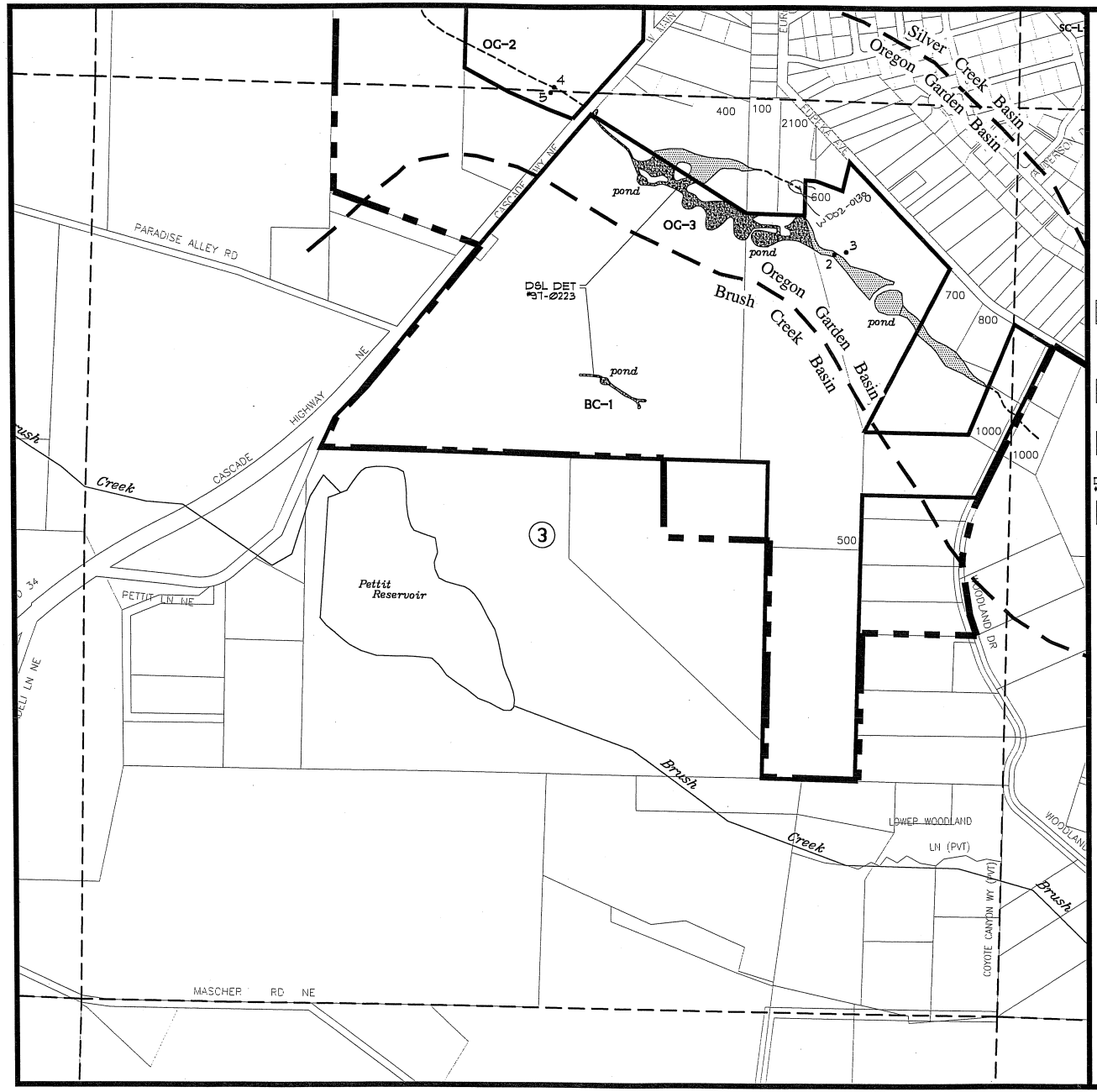

T 7S R 1W Section 03

CITY OF SILVERTON LOCAL WETLAND INVENTORY

LEGEND

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- EC-6C Wetland label
- Sample site
- Riparian areas
- SC-L-5 Riparian label
- Wetlands (DSL DET)
- DSL DET #97-0186 DSL #
- Mitigation wetlands (DSL RF)
- Site access granted
- 1600 Parcel number
- Section line
- Urban Growth Boundary
- Wetland channel
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Wetland acreage

1 acre
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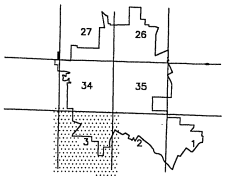
1/10th acre



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City of Silverton
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Oregon Division of State Lands
Meets Lwl standard
Date 2/29/00 Approved by A. Laika

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Appendix D

water quality data ▪ master plan

D.6 Street Sweeping Technical Memorandum

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TECHNICAL MEMORANDUM

To: Andy Peters
Maintenance Division Supervisor
City of Silverton, Public Works Department
From: Peter Olsen, PE
Keller Associates, Inc.
Date: April 2011
Re: Silverton Street Sweeping Evaluation

STATEMENT OF PURPOSE

The City of Silverton operates a street sweeping program for city streets. The program consists of sweeping with City-owned trucks operated by City maintenance staff, storing the collected debris at the maintenance yard where it is collected, screen, test, and dispose by hauling to the dump. As a part of the current Storm Water Master Plan, City staff has requested that Keller Associates evaluate the current procedures for storing, screening, testing, and disposing of the street sweeping debris for regulatory compliance and consistency with other street sweeping programs in the region.

The following list summarizes the specific concerns the City maintenance staff requested to be evaluated.

- Street sweeping frequency
- Storage facility requirements
    - Storage surface
    - Drainage collection and disposal
- Debris testing parameters
- Debris disposal

This document will discuss findings from researching the street sweeping programs for other communities in the region. Following these findings the City's existing procedures will be summarized, and recommendations for the City's street sweeping program are provided.

REGIONAL PRACTICES

Marion County:

Marion County sweeps the East Salem service area 3 times each year. According to the Coordinator for the East Salem service area, the East Salem service area is an area within the County that is most comparable to Silverton. The County performs additional sweeping in this service area for leaf pickup in the fall. Heavily polluted areas are swept more often. Catch basins are cleaned out with a vac truck every other year during summer months.

The debris is stockpiled on an uncovered concrete bunker area that drains to an oil separator. At one time, all debris was hauled to Brown's Island; however, the permit does not allow for disposal of the debris at Brown's Island unless it is debris from the fall leaf pickup. Currently, the remainder of the debris is disposed of in a permitted solid waste landfill.

Contact: Allen Volker, Coordinator and Crew Leader
Office 503.566.4148
Cell 503.931.1056

City of Salem:

The City of Salem has a highly defined sweeping program. Salem sweeps the arterials on a 3 to 4 week cycle during the summer months. The downtown and capitol mall areas are swept at least once per week throughout the year; however, it can be swept as many as 3 times per week during the summer months. The remaining streets in the City are classified into heavy, medium, and light pollution categories. Heavy areas are swept once per month. Medium areas are swept 8 times per year or about every 6 weeks. Light areas are swept 6 times each year or about every 2 months.

Previously, the City would store, test, screen, and use the collected debris as top soil for the construction debris landfill in the City. The City received a letter from DEQ stating that they could not dispose of the sweeping debris in the construction debris landfill, but must take it to a sanitary landfill because the street sweeping debris is itself designated as special waste.

The City now stages the debris on a gravel pad in a field. They have a working contract for loading and hauling, as well as a separate contract with the disposal location. Currently, the debris is hauled to the Riverbend landfill near McMinnville.

Contact: Cliff Bash
Office 503.588.6482
Cell 503.931.3596

City of Stayton:

From January to August the streets are swept once each month, with once per month hauling to the landfill. From September to December the streets are swept every week, filling a 30-cubic yard container for disposal every two weeks. Main Street and other areas are swept once each week throughout the year.

The City of Stayton has recently made some adjustments to how they handle the street sweeping debris. The City has plans to build a concrete pad with drainage that is collected and pumped to the headworks of the wastewater treatment plant. They are planning to line the edge of the concrete pad with jersey barriers. The debris will be tested every three years for total cadmium, chromium, lead, and benzene, toluene, ethylbenzene, and xylenes (BTEX) per landfill requirements. The City has contracted with Allied Waste for hauling the debris, and has contracted with Coffin Butte landfill for disposal.

Contact: Michael Bradley
503.871.7469

City of Woodburn:

The City of Woodburn currently operates under a contract with a sweeping company for the City street sweeping services. This alleviates the need to handle and dispose of the street sweeping debris. The contract for street sweeping began a few years ago. The City was divided into 5 areas that were each swept once per month. The downtown area was swept twice per month.

The sweeping debris was staged in drying beds at the wastewater treatment plant. Every year or two the debris would be screened to remove trash and then would be spread out on a nearby poplar plantation. The first year this practice began the City tested the debris and found no problem. It has not been tested any other time.

Contact: Dan Sherer

503.710.0466

Oregon Department of Transportation (ODOT):

Street sweeping performed by ODOT is not applicable in this case, and has not been included here. However, debris storage and disposal procedures are applicable. ODOT has various stockpile areas in Maintenance District 3. These stockpiles are tested every 2 to 3 years before and after screening. ODOT will recycle what they can from the screenings. Per the District 3 Section Supervisor, as long as the debris after screening is clean and less than 150 cubic yards then it can be used for clean fill. If the volume is greater than 150 cubic yards, an Oregon Department of State Lands (DSL) permit must be obtained before it can be used for clean fill. Please note that this contradicts the information obtained directly from DSL.

Contact: Jeff Sorenson, District 3 Section Supervisor
Office 503.986.2887
Cell 503.551.7166

REGULATORY AGENCIES

Oregon Department of State Lands (DSL)

The DSL is only involved if the City desires to use the debris as clean fill in wetlands. The other qualifier for DSL involvement is that the amount of fill to be placed in a designated wetland must exceed 50 cubic yards. The mitigation specialist mentioned that if fill is to be placed at or below normal water surface elevations, the U.S. Army Corps 404 permitting process must be followed as well.

Contact: Dana Field
Mitigation Specialist
503.986.5238

Oregon Department of Environmental Quality (DEQ)

DEQ does not provide specific guidance for how to handle street sweeping debris. Refer to the attached ODOT Policy and Procedures Manual for road waste. Also attached is a DEQ memorandum regarding "Clean Fill" and a letter to the City of Salem regarding disposal of their street sweeping debris. The ODOT Policy and Procedures Manual, DEQ letter to Salem, and DEQ memorandum regarding "Clean Fill" were all provided by Cathie Rhoades upon our request for any guidance on the City's handling of street sweeping debris.

DEQ requires that the City of Salem dispose of their street sweeping wastes into a lined solid waste landfill as permitted by DEQ, but has not specifically established this as a requirement for all cities.

Contact: Cathie Rhoades
Solid Waste Reduction Analyst
503.378.5089

TESTING AND DISPOSAL CONTACTS

This section lists a few testing and disposal contacts.

Testing

The testing required for disposal is prescribed by the respective landfill in which disposal is desired. The landfill should provide the parameters and acceptable limits to accept the debris at their landfill. The frequency of testing also depends on the location of disposal and the time of year. Winter requires more testing than summer. The price given to Keller Associates for testing requirements established by Coffin Butte is $200 per round of tests. Coffin Butte requires the testing of total cadmium, chromium and lead as well as total BTEX.

Contact: Nielson Research Corporation
Fay Fowler
541.771.5678

Disposal

Two possible options for disposal in a sanitary landfill for this area are Riverbend and Coffin Butte. The price provided to Keller Associates for disposal at Coffin Butte was $30/ton with a $7.50/load environmental fee.

Contact: Coffin Butte Landfill (Near Corvallis)
Joe Griffeth
1.800.204.4242 ext.7519

Riverbend Landfill
503-472-8788 ext. 27

EXISTING STREET SWEEPING PROCEDURE

Sweeping Frequency

The downtown area is swept every two weeks for the whole year. From January through September, the rest of the town is swept once each month. From October through December the streets are swept on a continual basis, covering the entire town every two to three weeks.

Debris Handling

The City maintenance staff currently stockpiles the collected debris in a designated location in the maintenance yard. The site currently drains to catch basins that convey the drainage to a shallow injection well at the west end of the yard. The shallow injection well is not registered with the DEQ Underground Injection Control (UIC) database. The pictures below present typical conditions at the maintenance yard.

The maintenance staff uses allocated budget to screen, test and dispose of the collected debris. Listed below are all the parameters that the fines (less than 3/4-inch) are tested for.

- Toxicity Characteristics Leaching Procedure (TCLP) Metals. This methodology estimates the mobility of specific inorganic and organic contaminates.
- Carcinogenic Polycyclic Aromatic Hydrocarbon (cPAH). This tests for pollutants that may cause cancer and birth defects
- Total petroleum as gasoline, diesel, and lube oils in the range C24-C40
- Volatile organics

If the test results show parameters below allowable limits, then the debris is added to the clean fill stockpile in the maintenance yard. The allowable limits were established results from research performed by the City maintenance supervisor. The process for handling material that is suspected to be hazardous includes isolating the pile from drainage, covering the pile, and lab testing for ignitability, corrosivity, metals, or other suspected hazardous materials. If tests indicate the material is hazardous, hazmat is contacted. If not hazardous, the debris is screened and tested again along with the other fine material in the fine material stockpile. If the street sweeping debris exceeds limitations for the tested parameters, it is combined with the large debris not suspected of hazardous material and disposed in a DEQ permitted landfill.

RECOMMENDATIONS

Sweeping Frequency

The current practice is consistent with other entities in the region and is reportedly sufficient for Silverton. Keller Associates recommends no change in frequency at this time. However, we recommend periodic monitoring of debris accumulation to ascertain if certain areas need to be swept more or less frequently.

Stockpiling and Disposal

Keller Associates recommends that the City establish a street sweeping debris (road waste) management plan. It is recommended that the City's street sweeping debris management plan include the following facilities:

- Stockpile bay consisting of a concrete pad and surrounding ecology blocks.
- Cover over stockpile bay.
- Drainage for concrete pad and drainage of surrounding area away from bay.
- Sand/grease separator for stockpile bay drainage.
- Discharge from sand/grease separator to City sanitary sewer system.

It is recommended that the City's street sweeping debris management plan include the following procedures:

- Testing of stockpile per requirements of receiving landfill.
- Haul to lined solid waste landfill that is permitted by DEQ.

These improvements should be phased in as maintenance facility budget is made available. The transportation of the debris to a lined solid waste landfill permitted by the DEQ should be incorporated as a standard practice immediately.

An analysis of the underground injection well is also recommended. This well should either be registered with the DEQ's UIC database or abandoned per DEQ standards. The analysis of the underground injection well should also include implementing BMPs for the maintenance yard site drainage to assure proper treatment and disposal of storm water drainage.

4.21 ROADWASTE

4.21.1 Purpose

This procedure is intended for the storing, using, and disposing of roadwaste. The procedure covers the management of various roadwaste generated from the day to day use and maintenance of highways. Roadwaste includes but is not limited to litter and trash; sweepings; cleanings from catch basins, sumps, or stormwater facilities; ditching materials; landslide debris; used sand and gravel; and asphalt grindings.

This procedure establishes management requirements for the disposal and management of roadwaste that protect Oregon natural resources, minimize waste generation, and encourage a safe and efficient work environment.

4.21.2 Regulating Agencies

EPA and DEQ regulate solid and hazardous waste disposal under the Resource Conservation and Recovery Act (RCRA). DEQ also issues guidance for reuse of waste and clean fill materials.

The Army Corps of Engineers (Corps) and the Division of State Lands (DSL) regulate waste management activities that impact wetlands, waterways, or fish habitat.

Local and regional public agencies regulate the management of waste materials within their jurisdictions. Local waste regulations take precedence over federal and state requirements if the local regulations are more stringent or protective of human health and the environment.

4.21.3 Alternatives And Pollution Prevention

- Reducing roadwaste can save disposal costs and conserve natural resources. Reduce roadwaste by reusing collected waste materials and/or by adjusting maintenance practices (e.g. using chemical deicer instead of sand and gravel to reduce street sweeping volumes).
- Waste regulators encourage the reuse of roadwaste as long as the material does not negatively impact human health or the environment. Available reuse options will depend on contamination levels (i.e. pollutants present in the roadwaste), difficulty of pollutant removal and management, and the local needs for the roadwaste material. Typically, roadwaste collected from highways and right-of-ways is not hazardous waste.
- In some cases, roadwaste can be reused as clean fill. The compaction required for specific projects should be considered prior to using roadwaste as a structural fill. Roadwaste with high organic content can make a poor structural fill.
- Roadwaste must be characterized for pollutant load prior to reuse. The presence of pollutants can eliminate or limit reuse options if reuse poses high risks to human health or the environment. Lead and polycyclic aromatic hydrocarbons (PAHs) are the most common pollutants of concern found in roadwaste.
- In some instances, it may be more cost effective to dispose of roadwaste rather than sort/clean it for reuse. Roadwaste collected from highly urbanized areas or high ADT roadways typically has a high contaminant level of trash and pollutants that make sorting and pollutant removal cost prohibitive.
- The State Attorney General's Office has discouraged give-away programs (e.g. giving away street sweepings to local residents who request the material for private use) because of liability risks.
- Frequent cleaning of sumps helps to lower pollutant levels in catch basin cleanings. Clay and fine soil are more likely to bind with chemical pollutants than coarse soil, sand, or gravel.

4.21.4 Roadwaste - Best Management Practices

- Employee safety and emergency procedures are located in the ODOT Safety & Health Manual and the Emergency Operations Plan, respectively. These documents reflect the ODOT expectations and rules in relation to safety, health, and emergency response activities.
- It is recommended that each District develop a Roadwaste Management Plan for specific roadwaste. These plans should identify how specific roadwaste will be managed on the local level so that negative impacts are minimized. Collected roadwaste should be characterized prior to developing the plans. Management priority should be given to roadwaste with potentially high pollutant levels and/or from high ADT roadways. ODOT technical staff (Office of Maintenance or Regional HazMat) and DEQ should be contacted for assistance with District specific plans.
- The local TMM, TMC, or their designee is responsible for the management of these products at ODOT Maintenance yards. Responsibility for hazardous waste disposal may be transferred to the District level at Districts where central hazardous waste management centers have been developed and implemented.

4.21.4.1 STORAGE OF ROADWASTE

- **Products should be stored in designated areas.** Products should be stored in an orderly manner. Refer to Section 3 - Good Housekeeping, for additional information.
- **Storage areas should be within the boundaries of the Maintenance yard, stockpile site, or at other locations with written permission of the owner (i.e. lease or other agreement).**
- **Locating storage piles away from stormdrains, stormwater conveyances, and waterbodies (including wetlands) is encouraged.** Erosion control, pollution reduction, and/or sediment reduction measures should be implemented where appropriate. The intent is to keep sediment and other potential pollutants out of stormwater systems and waterbodies. Refer to the ODOT Erosion Control Manual for additional guidance.
- **Roadwaste with known or suspected high levels of pollutants (e.g. contaminated soil) should be stored in a manner that protects the surrounding soil and waterbodies** (e.g. store material on plastic sheeting, paved surfaces, or under cover).
- **The use of trees or landscaping to screen roadwaste from the public and minimize impacts on adjacent landowners is recommended where available.**
- **Storage sites must meet local zoning and land use requirements.** Contact Region Environmental Services, Regional HazMat, or Office of Maintenance for assistance and/or review of roadwaste material storage sites and storage methods.
- **Storage sites that are continuously used to process roadwaste (i.e. separate waste materials from reusable materials) may require a DEQ permit.** Contact Office of Maintenance or the local DEQ office to determine if a permit is required for specific waste management operations.

4.21.4.2 HANDLING AND USE OF ROADWASTE

- **Roadwaste should be sorted and characterized for potential pollutants if it is being managed for reuse (e.g. fill, shoulder building).** At a minimum, the pollutant characterization should include testing for cadmium; copper; lead; zinc; gasoline; diesel and heavy oil; and PAHs. PAHs and metals are typically the chemical pollutants of highest concern. Contact Office of Maintenance or Regional HazMat for assistance with pollutant testing and waste characterization.
- **Litter and trash must be screened and removed within six months from the roadwaste stockpiles that are intended for disposal or recycling.**
- **Materials should be sorted and stored separately according to reuse or disposal option.** (e.g. brush intended for compost should be stored separately from sweepings intended for shoulder repairs.)

4.21.4.3 DISPOSAL OF ROADWASTE

- **Stockpiles of unmanaged roadwaste, roadwaste that will not be recycled, and roadwaste that will not be reused must be disposed of within six months.** Roadwaste that is sorted and managed for reuse may be stored for more than six months (e.g. used sanding material that is intended for shoulder repair or construction fill). If unmanaged roadwaste must be stored for longer than six months, a DEQ waste disposal permit or a waste transfer permit may be required. Contact Office of Maintenance for assistance with obtaining DEQ permits or approval.

4.21.4.3.1 Litter Including Abandoned Hazardous Waste

- **Litter and trash collected from the highway or right-of-way must be sorted and recycled or disposed of at a permitted solid waste management facility.** The following materials have been banned from solid waste disposal sites in Oregon and must be recycled: discarded or abandoned vehicles; large home or industrial appliances; used oil; tires; and lead-acid batteries.
- **Biologically hazardous waste (e.g. used syringe needles and urine containers) discovered along highway or right-of-way must be managed according to District and Safety and Health Policies** (refer to the ODOT Safety & Health Manual for additional guidance). This waste may contain bloodborne pathogens.
- **Abandoned hazardous waste must be managed by certified hazardous waste professionals.** Contact Regional HazMat to assist with the management of special hazardous roadwaste.

4.21.4.3.2 Street Sweepings

- **The reuse of street sweepings on special projects is strongly recommended where available.** Street sweepings must be screened to remove litter and organics and sampled for potential pollutants prior to reuse to ensure acceptable pollutant levels. Sweepings can not be placed in sensitive areas (e.g. wetlands, archeological sites, or historical sites). Examples of reuse opportunities include use in the construction of a rockfall safety berm, use to build out a steep shoulder along a highway, and incorporation into construction projects as fill. Reused materials must be managed protectively and according to environmental regulations.
- **Written DEQ approval (e.g. solid waste landfill permit or letter of authorization) must be obtained prior to reusing contaminated roadwaste as fill.** Street sweepings that contain lead and/or hydrocarbons are typically allowed to be used as fill. In some cases, sweepings may be stockpiled to allow time for natural breakdown of hydrocarbons.
- **Street sweepings that are not actively managed for reuse must be disposed of at permitted waste management facilities.** Typically, this means taking the material to a solid waste landfill. Local incinerators may be available that burn and process the waste materials to create clean construction fill.
- **If contamination is suspected, Office of Maintenance or Regional HazMat should be contacted to assist with analytical testing to determine if the material is hazardous waste.** Roadwaste collected from areas where chemical spills, roadway accidents, or illicit dumping has occurred may be hazardous.
- **Site-specific waste management protective BMPs should be included in the District Roadwaste Management Plan.** The BMPs should be developed and implemented with assistance from ODOT technical staff (Office of Maintenance or Regional HazMat).

4.21.4.3.3 Catch Basin and Culvert Cleanings

- **Partnering with local jurisdictions to dispose of catch basin and culvert cleanings is strongly recommended.** Partnerships could include cooperative construct of decant facilities or shared disposal contracts. Contaminated catch basin and culvert cleanings are primarily an urban issue. Local transportation agencies often share ODOT's need for waste management.

- **Catch basin and culvert cleanings must be separated into solid and liquid components prior to disposal.**
- **The reuse of catch basin and culvert cleanings on special projects is recommended, where available.** Cleanings can not be placed in sensitive areas (e.g. wetlands, archeological sites, or historical sites). Reused materials must be managed protectively and according to environmental regulations.
- **Written DEQ approval (e.g. solid waste landfill permit or letter of authorization) must be obtained prior to reusing contaminated roadwaste as fill.** Typically, roadwaste that is contaminated with lead or hydrocarbons may be authorized for use as fill in certain areas.
- **If contamination is suspected, Office of Maintenance or Regional HazMat should be contacted to assist with analytical testing to determine if the material is hazardous waste.** Roadwaste collected from areas where chemical spills, roadway accidents, or illicit dumping has occurred may be hazardous. In rare instances, roadwaste collected from neglected oil/water separators or drainage systems designed to treat or capture pollutants can also be hazardous. Contact ODOT technical staff, regulators, and/or waste management experts for assistance developing low cost methods and technologies for managing contaminated cleanings (e.g. evaporation ponds, pollutant filters, microbes, flocculents).
- **Catch basin and culvert cleanings that are not intended and actively managed for reuse must be disposed of at a permitted waste disposal facility.** Typically, this means taking the solid waste landfill and the liquid waste to a sewerage disposal facility. Local incinerators may be available that burn and process the waste materials to create clean construction fill.
- **Site-specific waste management protective BMPs should be included in the District Roadwaste Management Plan.** The BMPs should be developed and implemented with assistance from ODOT technical staff (Office of Maintenance or Regional HazMat).

4.21.4.3.4 Brush and Landscape Debris (green waste)

- **The use of green waste to manufacture compost or mulch is recommended where needed and/or available.** In some cases, street sweepings may suitable for use as compost additives. Many commercial compost manufacturers accept green waste materials. Large quantities of decomposing vegetation are associated with a number of pollutants (especially in water) including bacteria, nutrients, and low oxygen levels.
- **Brush and woody debris (including grass clippings) should be recycled where available.**
- **The placement of large woody debris in waterways for the creation of fish habitat is encouraged, where the opportunity is available.** Projects must be coordinated with Environmental Services and Oregon Department of Fish and Wildlife. Projects may require a permit from the Army Corps of Engineers.
- **Brush and landscape debris that is not intended and actively managed for reuse or recycling must be disposed of at a permitted waste disposal facility.** Organic wastes are regulated as potential health hazards (green waste, human waste, road kill, bacteria, vector control, etc.). Local county health departments usually regulate these wastes and many offer assistance with management of organic waste materials.
- **The disposal of brush and cuttings from suspected diseased plants and trees must be coordinated with Oregon Department of Agriculture, US Forest Service, or the Oregon Department of Forestry (ODF).**

4.21.4.3.5 Ditchings

- **The reuse of ditchings on special projects is strongly recommended where available.** Litter and organics must be removed and the material must be sampled prior to reuse to ensure acceptable pollutant levels. Ditchings can not be placed in sensitive areas (e.g. wetlands, archeological sites, or historical sites). Reused materials must be managed protectively and according to environmental regulations.
- **Written DEQ approval (e.g. solid waste landfill permit or letter of authorization) must be obtained prior to reusing contaminated roadwaste as fill.** Typically, contaminated street sweepings that are allowed for use as fill may contain lead or hydrocarbons. In some cases, sweepings may be stockpiled to allow time for natural breakdown of hydrocarbons.
- **If contamination is suspected, Office of Maintenance or Regional HazMat should be contacted to assist with analytical testing to determine if the material is hazardous waste.** Roadwaste collected from areas where chemical spills, roadway accidents, or illicit dumping has occurred may be hazardous. ODOT has found that contaminant levels vary widely in ditching material, regardless of whether the source is an urban or rural ditch.
- **Ditchings that are not actively managed for reuse must be disposed of at permitted waste management facilities.** Typically, this means taking the material to a solid waste landfill. Local incinerators may be available that burn and process the waste materials to create clean construction fill.
- **Site-specific waste management protective BMPs should be included in the District Roadwaste Management Plan.** The BMPs should be developed and implemented with assistance from ODOT technical staff (Office of Maintenance or Regional HazMat).

4.21.4.3.6 Used Sand and Gravel

- **The reuse of used sand and gravel from winter maintenance activities is strongly recommended.** Screening and/or washing may be needed prior to reuse. Quick pickup of used sand and gravel reduces the need for screening and washing.
- **The reuse of used sand and gravel on special projects is recommended where available.** Litter and organics must be removed and the material must be sampled prior to reuse to ensure acceptable pollutant levels. Materials can not be placed in sensitive areas (e.g. wetlands, archeological sites, or historical sites). Reused materials must be managed protectively and according to environmental regulations.
- **Used sand and gravel that is not actively managed for reuse must be disposed of at permitted waste management facilities.**

4.21.4.3.7 Slide Debris

- **The disposal of slide debris is site-specific.** Maintenance activities that dispose of slide debris must follow guidelines in the ODOT Blue Book.

4.21.4.3.8 Asphalt Grindings

- **Grinding from removal of highway striping paint must be characterized prior to disposal.** Striping grindings that are removed separately from asphalt paving may be hazardous waste because of the high lead levels used in old highway paints. If the paint origin or type is not known, laboratory testing must be conducted to determine if the grindings are hazardous waste. Striping grindings are not clean fill and must be disposed of as solid waste (landfill) or hazardous waste, depending on the test results.

- **The reuse of aged asphalt grinding (including grindings that may contain striping paint) on special projects is strongly recommended where available.** Aged asphalt is defined as clean fill by DEQ regulations. Asphalt grindings are typically used for highway and shoulder repair. However, use of aged asphalt is not appropriate in all locations (e.g. NOAA Fisheries will not allow use of concrete or asphalt for stream bank stabilization). Materials can not be placed in sensitive areas (e.g. wetlands, archeological sites, or historical sites). Aged asphalt must be free of oil to qualify for use as clean fill. To determine if the asphalt is free of oil DEQ recommends performing a "bucket test." The bucket test consists of soaking a sample of asphalt for 24 hours in a bucket of water. If free oil is present, an oily sheen will develop on the surface of the water. Reused materials must be managed protectively and according to environmental regulations.
- **Asphalt grindings that are not actively managed for reuse must be disposed of at permitted waste management facilities.**

4.21.5 Documentation

4.21.5.1 District Roadwaste Management Plans

Each District should develop a Roadwaste Management Plan. The plans should include reports, agreements, and/or contracts that show the roadwaste is being managed in a manner that minimizes negative impacts. Documentation could include lab reports for material testing, written management plans; DEQ letters of authorization, contracts or agreements from permitted disposal facilities, and letters of approval from local waste management agencies.

The plans should be unique and cover the District specific wastes and the activities used to manage them. Office of Maintenance or Regional HazMat can assist with preparing Roadwaste Management Plans (see Appendix G for a sample Roadwaste Management Plan).

Management of some roadwaste is problematic. Disposal of catch basin and culvert cleanings collected from urban and high traffic roadways has proved difficult for Districts that do not have access to waste decanting facilities that can separate waste slurries into liquid and solid wastes. For these problematic wastes, it is recommended that the Districts identify protective BMPs that address waste management concerns and document implementation of these BMPs in District Roadwaste Management Plans.

4.21.5.2 Other Documentation

- **Tracking the amount of roadwaste generated is recommended.** Knowledge of how much waste must be disposed of, how much sweeping material is stockpiled for reuse, or how much sweeping material must be disposed of, helps define waste management problems and is useful in negotiating waste disposal contracts.
- **Records of the generation and disposal of hazardous waste must be maintained for 3 years.** Solid waste must be determined hazardous or non-hazardous prior to disposal. Records of a how the waste was determined hazardous or non-hazardous must be kept for at least 3 years after the date the final shipment was sent offsite. A completed EMS Waste Profile, waste disposal analysis, and/or other waste determination may be used to document how the waste was determined hazardous or non-hazardous. Disposal records of non-hazardous materials that are identified as "excluded" on the EMS Waste Profile, records of universal waste disposal, and records of recycling should also be kept onsite. The EMS Waste Generation and Waste Disposal Logs should be used to document waste accumulation and disposal. Copies of the waste determination and tracking forms associated with this document are located in Appendix B. Additional information regarding the EMS Waste Profile and Waste Logs are located in Appendix D.
- **Documentation of pollutant characterization testing (required for reuse and/or disposal of some roadwaste) should be maintained onsite.** Contact the local waste disposal facilities to determine pollutant-testing requirements. Contact ODOT technical staff (Office of Maintenance or Regional HazMat) with questions regarding other waste disposal testing and documentation.

CLEAN FILL
What Can Be Landfilled Without A Permit?

State of Oregon
Department of Environmental Quality **Memorandum**

To: **Persons filling with "Clean Fill"**
From: **DEQ Solid Waste Program**
Subject: **Landfilling without a permit from DEQ**

The purpose of this memo is to assist contractors and landfill operators in understanding Oregon environmental law and regulation as it relates to operating a "clean fill" landfill. The Department does not regulate such landfills. If "solid waste" is accepted, the facility is then subject to permit requirements and possible enforcement action by the Department.

1. Materials which may be landfilled without a permit under Oregon solid waste rules.

Oregon Administrative Rules (OAR) 340-093 define "clean fill" as exempt from regulation as a solid waste. "Construction and Demolition Waste" is not exempt and must be disposed of in a Department permitted facility. Specific sections of the rules are quoted below for your information:

DEFINITIONS: OAR 340-093-0030

(10) "Clean Fill" means material consisting of soil, rock, concrete, brick, building block, tile or asphalt paving, which do not contain contaminants which could adversely impact the waters of the State or public health. This term does not include putrescible wastes, construction and demolition wastes and industrial solid wastes.

PERMIT REQUIRED: OAR 340-093-0040

(1) No person shall dispose of or authorize the disposal of solid waste except at a solid waste disposal site permitted by the Department to receive that waste, or at a class of disposal site specifically exempted by OAR 340-93-050(2) from the requirement to obtain a solid waste permit.

CLEAN FILL EXEMPTION: OAR 340-093-0050

(1) Except as provided by section (2) of this rule, no person shall establish, operate, maintain or substantially alter, expand, improve or close a disposal site, and no person shall change the method or type of disposal at a disposal site, until the person owning or controlling the disposal site obtains a permit therefor from the Department.

(2) Persons owning or controlling the following classes of disposal sites are specifically exempted from the above requirements to obtain a permit under OAR Chapter 340 Divisions 93 through 97, but shall comply with all other provisions of OAR Chapter 340 Divisions 93 through 97 and other applicable laws, rules, and regulations regarding solid waste disposal:

(c) A land disposal site used exclusively for the disposal of clean fill, unless the materials have been contaminated such that the Department determines that their nature, amount or location may create an adverse impact on groundwater, surface water or public health or safety;

Based on the above, solid waste rules allow you to landfill the following materials without a permit from DEQ:

* **Clean Soil,** but not soil contaminated by any hazardous constituent. Limited quantities of soil, which have been cleaned to Level I clean up standards and specifically approved by the Department for disposal at your site may be accepted.
* **Concrete,** including that which contains reinforcing bar or rod
* **Rock**
* **Brick**
* **Weathered and consolidated asphalt paving** which does not show evidence of fresh oil and which is not so broken as to expose numerous unweathered surfaces.

2. Asphalt.

While solid waste rules exempt some asphalt paving from a requirement to be disposed of in a permitted solid waste facility, that exemption does not apply to asphalt which has not been applied as paving and does not exempt asphalt paving which may pose a threat to the waters of the state or public health. Any asphalt which shows evidence of fresh oil or is not clearly weathered and consolidated does not qualify for the exemption and may not be placed as clean fill. Soil loads which contain fresh asphalt are not eligible for the clean fill exemption unless the asphalt is removed.

3. Other constraints.

Wetlands. It is possible that land proposed for filling with clean fill may be or have become wetlands. Before filling, you should obtain clearance from the Army Corps of Engineers or the Oregon Division of State Lands to ensure that you are not filling in a wetland.

Local Land Use Laws/Regulations. It is prudent to ensure that filling activities do not conflict with local regulations.

FOR MORE INFORMATION, CALL THE FOLLOWING DEQ NUMBERS:

Statewide General Number		**800 452-4011**
Eastern Region	**The Dalles**	**541/298-7255**
Northwestern Region	**Portland**	**503/229-5263**
Western Region	**Salem**	**503/378-5047**

Oregon
Theodore Kulongoski, Governor

Department of Environmental Quality
Western Region Salem Office
750 Front Street NE, Suite 120
Salem, OR 97301-1039
(503) 378-8240
FAX (503) 373-7944
TTY (503) 378-3684

September 2, 2008

Ken Roley, PE, Facilities Engineering Manager
City Of Salem, Public Works Field Office
1410 20th Street SE, Building #2
Salem, Oregon 97302-1200

Re: Salem Airport Disposal Site, SW Permit 136
Special Waste Management Plan-Street Sweepings
Marion County, SW Project 4169

Dear Mr. Roley:

The Department of Environmental Quality (DEQ) has completed its review for your special waste management plan, received on December 31, 2007, which requests disposal of the street sweeping wastes (road wastes) at your C&D landfill.

According to the Oregon Department of Transportation's report "Road Waste: Issues and Options," the levels of contamination normally observed in road waste highlight the need to limit human contact, prevent site or groundwater contamination and runoff to surface waters, and identify and separately manage potentially hot loads. Hydrocarbon and heavy metal levels in normal road waste do pose concerns, and the risks posed by human exposure should be minimized. Heavy metals and carcinogenic polycyclic aromatic hydrocarbons (CPAHs) are the main hazardous constituents driving action on road wastes. PAHs with up to three rings degrade in the presence of microorganisms found everywhere. Larger PAHs, including the CPAHs, are believed to persist in the environment. While some hydrocarbons in road wastes migrate readily in soil and in high concentrations have the potential to impact groundwater quality, CPAHs are largely immobile.

Based on the concerns as described above, DEQ requires that street sweeping wastes must be disposed into lined solid waste landfills as permitted by DEQ. No C&D landfills allow accepting street sweeping wastes in the State of Oregon, although your results of sampling data analysis for the collected street sweepings summarize that none of the sample results exceed accepted threshold levels for the hazardous materials.

As shown above, DEQ cannot therefore approve your request for disposal of the street sweeping wastes into your C&D landfill.

If you have any questions concerning this letter or if I can be of further assistance, please contact me at (503) 378-4977, or by email at gao.hu@deq.state.or.us.

Sincerely,

Hugh Gao, P.E., Senior Engineer
Western Region Hazardous and Solid Waste
Permitting and Compliance

cc: Bill Mason, DEQ-Eugene

X: \SOLIDWASTE\SWWRPermitFiles\0136SalemAirport\StreetSweepingWaste(9-08).doc

DEQ-DC1

Appendix E

storm water standards ▪ master plan

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SILVERTON MUNICIPAL CODE

Chapter 3.4
PUBLIC FACILITIES

3.4.400 Storm drainage and erosion control.

A. General Provisions. The city shall issue a development permit only where adequate provisions for stormwater runoff and erosion control have been made in conformance with the city of Silverton storm drainage master plan and public works design standards.

B. Accommodation of Upstream Drainage. Culverts and other drainage facilities shall be large enough to accommodate existing stormwater. Such facilities shall be subject to review and approval by the public works director.

C. Effect on Downstream Drainage. Where it is anticipated by the public works director that the additional runoff resulting from the development will overload an existing drainage facility, the city shall withhold approval of the development until provisions have been made for improvement of the potential condition or until provisions have been made for storage of additional runoff caused by the development. Stormwater detention and/or retention facilities, including water quality treatment, may be required in conformance with city standards.

D. Over-Sizing. The city may require as a condition of development approval that storm drainage systems serving new development be sized to accommodate future development within the area as projected by the applicable stormdrainage master plan. Over-sizing of facilities may be eligible for credit towards SDCs.

E. Existing Watercourse. Where a proposed development is traversed by a watercourse, drainage way, channel, or stream, there shall be provided a stormwater easement or drainage right-of-way conforming substantially to the lines of such watercourse and such further width as will be adequate for conveyance and maintenance to protect the public health and safety.

F. Erosion Control. Specific erosion control measures shall be designed, installed and monitored in conformance with the city's design standards. City-approved erosion control measures must be in place prior to, during and after construction activities for projects that disturb one or more acres of land over a period of time. A National Pollution Discharge Elimination System (NPDES) permit must be obtained from the Department of Environmental Quality prior to the issuance of a development permit or land use permit.

G. Detention. All required stormwater detention must provide for the 25-year storm event. Detention shall be located in underground facilities, or, if aboveground detention is utilized, it shall be with the review and approval of the public works director. (Ord. 08-06 § 3, 2008)

City of Silverton
STANDARD DESIGN REQUIREMENTS

General

1. Submit four (4) copies of detailed plans.
2. Submit all plans in a 24" X 36" or 22" X 34" format.
3. Submit plans in the following format:
   - Cover sheet with vicinity map, index, project name, 5-inch by 5-inch space for City stamps, owner's name, engineering firm, bench mark location and datum (NAVD 88).
   - General note and legend sheet.
   - Existing conditions plan.
   - Site plan. Include property line boundaries, sidewalk improvements, right-of-way (existing/proposed), easements (existing/proposed), and sidewalk and road connections to adjoining properties, addresses (Tax Lot number if no address available) for all properties next to site. Site plan may be placed on cover sheet provided view is easily readable.
   - Erosion control plan.
   - Grading plan.
   - Composite street and utility plan. Plan must use a letter designation for each continuous pipeline run. (Note: clearly show lettered pipeline on the utility plan, sheet index, and detailed plan sheets) Composite plan may be placed on cover sheet provided view is easily readable.
   - Detailed street plan, storm sewer/drainage plans, water and sanitary sewer utility plans scaled at 1"=20' or 1"=30'. Sheets shall include plan and profile views.
   - Detailed plan for stormwater detention facility, including water quality orifice diameter and manhole rim elevations. Provide plan and profile detail of inlet structure and energy dissipation device. Provide details of drain inlets, structures, and piping for outfall structure.
   - Striping, signage and pavement markings plan.
   - Street lighting and Illumination plans.
   - Landscape plans.

   All engineering plans shall be stamped by a Professional Engineer registered in the State of Oregon.
   - City Standard Detail drawings.
4. Provide for 12-foot wide public easements for all single public utilities and 20-foot wide for double line easements. Easements shall extend from street ROW to 6 feet past termination point of utility. Center single utilities within a 12-foot wide easement; combinations of utilities shall have easements extending 6 feet from centerline of outer utility.
5. Provide for 10-foot Public Utility Easement along all street frontages.
6. Provide City of Silverton Detail Drawings for all public improvements.
7. Scale drawings so that the information conveyed to the user is clear and unmistakable. Utilize 1" = 10' details at utility clusters.
8. Check for interference of utility lines with each other and structures.
9. Check and coordinate lot numbers, storm lines, and sanitary lines on all sheets.
10. Recalculate Engineer's Estimate. Show any other changes that have occurred.

Existing Conditions Plan

11. Show existing contours at 1-foot intervals.

12. Show existing natural features and trees. Label tree types and identifying numbers if inventoried.
13. Show existing wells and springs. Include information about state requirements for abandoning wells.

Erosion Control Plan

14. Show location of silt fencing, bio-bags, and treatment for slopes. Show location of first catch basins outside of project limits.
15. Show erosion control measures at all existing and proposed catch basins, culverts, and drain inlets.
16. Show construction access points and note required signage for movement of vehicles in and out of project site.

Grading Plan

17. Show existing and proposed grades in 1-foot intervals.
18. Show 100 year flood plain and identified wetlands, if applicable.
19. Show trees to be removed and saved. Show protective fencing around saved trees.
20. Show contours adjacent to site a minimum of 50 feet beyond project limits.

Street

21. Profile shall show stationing and elevations, with vertical data, including high points and low points, crown lines and transitions.
22. Provide cross-sections showing original ground at centerline. When ground varies more than 1.5 feet between existing and proposed grades to right-of-way, show ground at left and right of centerline.
23. Profile of original ground shall be projected a minimum of 300 feet beyond project limits of design centerline, with design grade extending at least 200 feet, and minimum 50 feet beyond right-of-way, unless otherwise directed by City's Authorized Representative.
24. Check centerline slope of streets; minimum 1%. Check slope transitions at intersections.
25. Centerline slope changes greater than 0.5% require vertical curves for transition.
26. Cross slope of streets not to exceed 2%.
27. Provide curb return plans with curb and gutter elevations. Check slope of gutters at intersection corners and verify that wheel chair ramps meet ADA requirements.
28. Provide access to structures and turning radii at intersections that meet Silverton Fire District requirements.
29. Where trees are located within 8 feet of public sidewalks, the sidewalks shall be protected from root intrusion with a root control barrier system designed by a Professional Landscape Architect registered in the state of Oregon, and approved by the City's authorized representative. Generally, the root control system should be installed a minimum of 12 inches deep, with a minimum 20-foot length centered on the root source. Installation of such systems shall be done so as to not disturb the sidewalk or base rock previously installed.

Storm

30. The City of Silverton requires that storm drains that collect runoff from two or more properties be public.

31. Stage construction such that the underground storm water detention and flow control is completed prior to construction of storm drainage system.
32. Show invert elevations at all storm line and sewer and water line crossings. Show all existing and proposed utilities in profile view. There shall be a minimum of 6 inches of clearance between lines.
33. Check for minimum cover over pipe.
34. Submit storm calculations. Indicate on storm water plan sheet the corresponding numbers to the manholes, catch basins, downspouts, contributing impervious surface areas, and connecting lines used for stormwater calculations.
35. Provide calculations for all stormwater pipe segments and outfall discharge velocity when discharging into drainage ditch or body of water.

ROCK PROTECTION

Discharge Velocity at Design Flow (fps)	Required Protection (Minimum Dimension)				
	Type	Thickness[2]	Width	Length	Height
0 to 5	ODOT Class 50 riprap[1]	1.5 ft	Diameter + 6 ft	8 ft or 4 x diameter, whichever greater	Crown + 1 ft
5 to 10	ODOT Class 200 riprap[1]	2.5 ft	Diameter + 6 ft or 3 x diameter, whichever greater	12 ft or 4 x diameter, whichever greater	Crown + 1 ft
Greater than 10	Designed system[3]	As required	As required	As required	Crown + 1 ft

[1]ODOT riprap class in English units.
[2]Riprap shall be grouted in place or on geotextile approved for in water use.
[3]For high-velocity outfalls, engineering calculations are to be submitted to the City's authorized representative for review and approval.

36. Those portions of the storm line and manholes that will be dedicated to the public or may be dedicated in the future need to be designed and constructed in conformance to City of Silverton Standards.
37. Connections to existing public storm lines or manholes shall be core drilled. City Inspector shall be present during connection (24-hr notification).
38. Tee connections may be used in street right-of-way only with approval of the City's authorized representative. The lateral shall be no larger than 50% the diameter of the main line, unless otherwise approved by the City's authorized representative. The connecting catch basin shall be oversized.
39. Storm laterals shall be provided with a cleanout installed at the public right-of-way or easement. Cleanouts shall not be installed in the sidewalk, unless approved by the City's authorized representative.
40. In public manholes, provide a minimum drop of 0.2 feet and a maximum drop of 1.5 feet between inlets and outlet.
41. All manhole inlets shall be at a minimum 90-degree angle in relation to the outlet, as measured from the center of the manhole base.
42. Manholes shall be provided at least every 500 feet.
43. All storm sheets: number all manholes, cleanouts, catch basins, outlets, and area drains for easier reference. Indicate type of catch basins to be installed
44. All weather access roads shall be provided to manholes located outside of the Public Right-of-way, unless otherwise approved by the City's authorized representative. At a minimum,

access shall be provided for maintenance and inspection to all portions of the facility. Access shall extend to within 10 feet of all control structures.

The following criteria are the minimum City requirements for access roads:

a. *Three inches of Class C AC; over 8 inches of ¾"-0"compacted crushed aggregate; over firm subgrade. Crushed aggregate and subgrade shall be compacted to 95% of maximum dry density, as determined by AASHTO T-180.*

   or

   The design engineer may submit a certified road design capable of supporting a 30-ton maintenance vehicle in all weather conditions.

b. *The plan shall include design of strengthened sidewalk sections where maintenance vehicles will cross.*

c. *Maximum grade: 15% with a maximum 3% cross-slope.*

d. *Minimum width: 15 feet on straight runs and curves. Curves shall be designed with a minimum 40-foot interior radius.*

e. *A 2-foot wide gravel shoulder shall be provided on each side of the access road.*

f. *Access shall extend to within 10 feet of all control structures, unless otherwise approved by the City's authorized representative.*

g. *If fencing is required for public safety or security reasons, the fence shall include a 12-foot-wide lockable gate for maintenance access.*

Sanitary

45. Check tie-in locations to public sanitary system.
46. Show invert elevations at all sanitary sewer lines and storm and water line crossings. Show all existing and proposed utilities in profile view. There shall be a minimum of 6 inches of clearance between sanitary sewer and storm lines and 18 inches of clearance between sanitary sewer and water lines. All sanitary lines shall be below water lines unless approved by City's authorized representative.
47. Minimum size for mains shall be 8-inch diameter. Minimum slope shall be S=0.0045 except for non-extendable or dead end lines with fewer than twelve (12) services shall be S=0.005.
48. All sanitary sewers (main line and laterals) shall have a minimum of 5 feet of cover over the top of the sewer pipe to finish grade. When such minimum cover is not possible, ductile iron pipe or AWWA C-900 shall be used. For laterals, approved material shall extend to cleanout at edge of right-of-way.
49. Connections to existing public sanitary lines or manholes shall be core drilled. City Inspector shall be present during connection (24-hr notification).
50. In public manholes, provide a minimum drop of 0.2 feet and a maximum drop of 1.5 feet between inlets and outlet.
51. All manhole inlets shall be at a minimum 90-degree angle in relation to the outlet, as measured from the center of the manhole base.
52. Manholes shall be provided at least every 500 feet.
53. All weather access roads shall be provided to manholes located outside of the Public Right-of-way, unless otherwise approved by the City's authorized representative. At a minimum, access shall be provided for maintenance and inspection to all portions of the facility. Access shall extend to within 10 feet of all control structures.

    The following criteria are the minimum City requirements for access roads:

    a. *Three inches of Class C AC; over 8 inches of ¾"-0"compacted crushed aggregate; over firm subgrade. Crushed aggregate and subgrade shall be compacted to 95% of maximum dry density, as determined by AASHTO T-180.*

       or

The design engineer may submit a certified road design capable of supporting a 30-ton maintenance vehicle in all weather conditions.

b. *The plan shall include design of strengthened sidewalk sections where maintenance vehicles will cross.*
c. *Maximum grade: 15% with a maximum 3% cross-slope.*
h. *Minimum width: 15 feet on straight runs and curves. Curves shall be designed with a minimum 40-foot interior radius.*
i. *A 2-foot wide gravel shoulder shall be provided on each side of the access road.*
j. *Access shall extend to within 10 feet of all control structures, unless otherwise approved by the City's authorized representative.*
k. *If fencing is required for public safety or security reasons, the fence shall include a 12-foot-wide lockable gate for maintenance access.*

54. All sanitary sheets: number all manholes and cleanouts for easier reference.
55. Sanitary laterals shall be provided with a cleanout installed at the public right-of-way. Cleanouts shall not be installed in the sidewalk, unless approved by the City's authorized representative.

Water

56. Check Straddle blocks. Straddle blocks shall be designed by engineer based on 200 psi water pressure. Soil bearing, steel size and spacing by engineer.
57. Automatic air and vacuum release valves with a bleed-off port shall be installed at all high points or locations in the pipeline where air pockets would be expected to accumulate. Valves shall be installed as indicated in City Detail Drawing.
58. Show invert elevations at all crossings between public water lines and storm/sanitary lines. Show all existing and proposed utilities in profile view. There shall be a minimum of six (6) inches of vertical clearance between water and other utility lines except sanitary sewer lines which shall be a minimum of eighteen (18) inches and below water line.
59. Check for 2.5 feet minimum cover over pipe.
60. Check location of water meters. Front edge must be in Right-of-way next to sidewalk, 18" off lot line, and not within driveways. Show all garden/irrigation meter locations.
61. Fire hydrants shall be located to provide a minimum clear distance of 24 inches between ports and face of curb and maximum distance of 15 feet from travel lane.
62. Fire hydrant locations shall be approved by Silverton Fire District and not to exceed 500 feet in distance from hydrant to hydrant.
63. Minimum water main line size shall be eight (8) inch diameter except for dead end lines that are less than 150 feet and do not supply a fire hydrant.

Signage and Striping

64. Show all signage and striping conforming to the Manual on Uniform Traffic Control Devices.
65. Show pedestrian cross-walks and signage along all arterial and collector streets.
66. Identify school zones, if applicable.

Lighting and Illumination

67. Show all street light and junction box locations.
68. Show connection point to PGE backbone power.
69. Show streetlight and junction box details per PGE and City of Silverton standards.
70. City Option B lighting standards for residential subdivisions:

- Luminaire (100 Watt):
  Size – 100 watt HPS 9500 Lumens (2039).
  Lens Type – Flat M-C-2 120/240V (factory wired).
  Model – General Electric Model # M2RC10S7N2GMC2017.
- Luminaire (150 Watt Special Case):
  Size – 150 watt HPS 16000 Lumens (2042).
  Lens Type – Flat M-C-2 120/240V (factory wired).
  Model – General Electric Model # M2RC15S7N2GMC2017.
- Lamps (100 Watt):
  Size – 100 watt HPS Non-cycling 9500 Lumens (39147).
  Model – Sylvania Lumalux Model # LU100/PLUS/ECO.
- Lamps (150 Watt Special Case):
  Size – 150 watt HPS Non-cycling 16000 Lumens (39145).
  Model – Sylvania Lumalux Model # LU150/55/PLUS/ECO.
- Photo Control (100-150 Watt):
  Specifications – Photoelectric control, Twistlock, Fail-On, Electronic, 105-300VAC, 60 HZ, per ANSI 136.10, Bronze Housing, 1.5 Lumen turn-on, Rated 1000 W Tungsten (1800VA Ballast), 1.15:1 Turn-off/Turn-on ratio, Solid Brass Plug Blades, Conformally Coated CDS Cell, 160 Joule MOV or explussion arrester, 2-4 sec Turn-off Delay (1986).
  Model – Fisher Pierce Model #FP7673C-MCBE or approved equal.
- Pole (100-150 Watt):
  Size & Type – 30 Foot, Direct bury.
  Mounting Height & Color – 25 Feet, Gray.
  Model – Shakespeare Model # BHT3099U5BL9901 (39356) (CU 1111) or approved equal.
- Mast Arms (100-150 Watt):
  Mast Arm – 6 Foot AL Finish (2026).
  Model – Shakespeare Model # OPAR-6.
- Streetlight Wire (Underground or In Pole)
  Streetlight Wire – #10 Cu 3-Conductor (36).
  Description – 310 AWG, 600 Volt, 3-conductor, Class B Stranding, Type TC, with Sunlight-Resistant 45-mil PVC Jacket. Suitable for direct burial installations. Insulation to be black, red,a dn green per NEMA WC-7 for NEC applications (TFN, THWN, THHN), with fillers or binding tape added to produce round outer jacket, rated 90 C dry and 75 C wet, 1,000 ft NR reels. Jacket to display sequential footage markings. 2 reel labels, one attached to the outside flange surface, one attached to the drum wrapping; each to detail total footage, inside or starting footage.
- Junction Box (13” X 24”):
  Synertech (Utility Vault) model # S1324HBB0A (LID) and FL-30-18 (BOX) or approved equal.

71. City Option B lighting standards for commercial/industrial areas:
    - Luminaire (200 Watt):
      Size – 200 watt HPS 22000 Lumens (2064).
      Lens Type – Flat M-C-2 240V.
      Model – General Electric Model # MSCL20S3N22FMC3.
    - Lamps (200 Watt):
      Size – 200 watt HPS Non-cycling 22000 Lumens (39144).
      Model – Sylvania Lumalux Model # LU200/PLUS/ECO.

- Photo Control (100-150 Watt):
  Specifications – Photoelectric control, Twistlock, Fail-On, Electronic, 105-300VAC, 60 HZ, per ANSI 136.10, Bronze Housing, 1.5 Lumen turn-on, Rated 1000 W Tungsten (1800VA Ballast), 1.15:1 Turn-off/Turn-on ratio, Solid Brass Plug Blades, Conformally Coated CDS Cell, 160 Joule MOV or explussion arrester, 2-4 sec Turn-off Delay (1986).
  Model – Fisher Pierce Model #FP7673C-MCBE or approved equal.
- Pole (200 Watt):
  Size & Type – 30 Foot, Direct bury.
  Mounting Height & Color – 25 Feet, Gray.
  Model – Shakespeare Model # BHT3099U5BL9901 (39356) (CU 1111) or approved equal
- Mast Arms (200 Watt):
  Mast Arm – 8 Foot AL Finish (39202).
  Model – Shakespeare Model # OPAR-8.
- Streetlight Wire (Underground or In Pole)
  Streetlight Wire – #10 Cu 3-Conductor (36).
  Description – 310 AWG, 600 Volt, 3-conductor, Class B Stranding, Type TC, with Sunlight-Resistant 45-mil PVC Jacket. Suitable for direct burial installations. Insulation to be black, red,a dn green per NEMA WC-7 for NEC applications (TFN, THWN, THHN), with fillers or binding tape added to produce round outer jacket, rated 90 C dry and 75 C wet, 1,000 ft NR reels. Jacket to display sequential footage markings. 2 reel labels, one attached to the outside flange surface, one attached to the drum wrapping; each to detail total footage, inside or starting footage.
- Junction Box (13" X 24"):
  Synertech (Utility Vault) model # S1730HBB0A (LID) and FL-36-18 (BOX) or approved equal

72. City Option B lighting standards for Downtown District:
    - Luminaire Post-top, Acorn (100 Watt):
      Size – 100 watt HPS 9500 Lumens.
      Lens Type – M-S-5.
      Model – Hadco S8539 (2035).
    - Lamps (100 Watt):
      Size – 100 watt HPS Non-cycling 9500 Lumens (39147).
      Model – Sylvania Lumalux Model # LU100/PLUS/ECO.
    - Lamps (150 Watt Special Case):
      Size – 150 watt HPS Non-cycling 16000 Lumens (39145).
      Model – Sylvania Lumalux Model # LU150/55/PLUS/ECO.
    - Photo Control (100-150 Watt):
      Specifications – Photoelectric control, Twistlock, Fail-On, Electronic, 105-300VAC, 60 HZ, per ANSI 136.10, Bronze Housing, 1.5 Lumen turn-on, Rated 1000 W Tungsten (1800VA Ballast), 1.15:1 Turn-off/Turn-on ratio, Solid Brass Plug Blades, Conformally Coated CDS Cell, 160 Joule MOV or explussion arrester, 2-4 sec Turn-off Delay (1986).
      Model – Fisher Pierce Model #FP7673C-MCBE or approved equal.
    - Pole Black, Fluted, Decorative Cast Aluminum with Shroud and Base (100-150 Watt):
      Size & Type – 16 Foot, Post-Top, Decorative, Anchor Base (1963) (CU 331).
      Model – Hadco P-2065-16-A.
      Accessories – 2 Banner brackets and 2 Flower basket hangers.

- Pole Footings (Concrete)
  Precast Concrete Base – For 16' Decorative Cast Aluminum (39083).
  Model – Utility Vault Model # 20R-LB-4-PGE.
- Streetlight Wire (Underground or In Pole)
  Streetlight Wire – #10 Cu 3-Conductor (36).
  Description – 310 AWG, 600 Volt, 3-conductor, Class B Stranding, Type TC, with Sunlight-Resistant 45-mil PVC Jacket. Suitable for direct burial installations. Insulation to be black, red,a dn green per NEMA WC-7 for NEC applications (TFN, THWN, THHN), with fillers or binding tape added to produce round outer jacket, rated 90 C dry and 75 C wet, 1,000 ft NR reels. Jacket to display sequential footage markings. 2 reel labels, one attached to the outside flange surface, one attached to the drum wrapping; each to detail total footage, inside or starting footage.
- Junction Box (13" X 24"):
  Synertech (Utility Vault) model # S1324HBB0A (LID) and FL-30-18 (BOX) or approved equal

73. Provide tables on illumination plan showing minimum maintained average values, uniformity ratio, and veiling luminance ratio for the following: streets, intersections, and walkways/bikeways.

Landscaping

74. Show all street tree locations, underground lateral crossings, meter boxes, fire hydrants, light poles and junction boxes, and any other surface or subsurface structure that may be in conflict with street tree location.
75. Show irrigation layout for public projects.

Storm Drainage Calculations

76. Storm drainage calculations shall provide a narrative including description of site, site map showing basins, design assumption, and summary sheet of peak flow and detention volume. Detailed drainage calculations shall include calculations for time of concentration, runoff for Zone 8 25-YR pre-developed and post-developed flows, detention volume required, and orifice sizing. Pre-developed flows are based on conditions prior to installation of structures, pavement, and any other impervious surfaces.

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GENERAL NOTES:

1. ALL WORK AND MATERIALS SHALL CONFORM TO THE RECENT EDITION OF THE OREGON CHAPTER APWA STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION EXCEPT AS MODIFIED BY THE CONSTRUCTION REQUIREMENTS OF THE CITY OF SILVERTON. ALL WORK WITHIN THE PUBLIC RIGHT-OF-WAY OR PUBLIC EASEMENTS REQUIRES A PUBLIC WORKS PERMIT.

2. THE CONTRACTOR IS RESPONSIBLE FOR THE PROCUREMENT OF ALL APPLICABLE PERMITS, LICENSES AND CERTIFICATES RELATIVE TO THE TRADES TO COMPLETE THE PROJECT AND FOR THE USE OF SUCH WORK WHEN COMPLETED. COMPLIANCE SHALL BE AT ALL LEVELS, FEDERAL, STATE, COUNTY, AND LOCAL, RELATING TO THE PERFORMANCE OF WORK

3. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO VERIFY ALL UTILITY LOCATIONS PRIOR TO CONSTRUCTION AND ARRANGE FOR THE RELOCATION OF ANY IN CONFLICT WITH THE PROPOSED CONSTRUCTION. THE LOCATIONS, DEPTH AND DESCRIPTION OF EXISTING UTILITIES SHOWN WERE COMPILED FROM AVAILABLE RECORDS AND/OR FIELD SURVEYS. THE ENGINEER OR UTILITY COMPANIES DO NOT GUARANTEE THE ACCURACY OR THE COMPLETENESS OF SUCH RECORDS. ADDITIONAL UTILITIES MAY EXIST WITHIN THE WORK AREA.

4. OREGON LAW REQUIRES THE CONTRACTOR TO FOLLOW RULES ADOPTED BY THE OREGON UTILITY NOTIFICATION CENTER. THOSE RULES ARE SET FORTH IN OAR 952-001-0010 THROUGH OAR 952-001-0090. THE CONTRACTOR MAY OBTAIN COPIES OF THE RULES FROM THE CENTER BY CALLING TOLL FREE TO (877) 668-4001 OR BY ACCESSING THE INTERNET AT WWW.CALLBEFOREYOUDIG.ORG. THE CONTRACTOR MUST NOTIFY THE CENTER AT LEAST TWO (2) BUSINESS DAYS, BUT NOT MORE THAN TEN (10) BUSINESS DAYS, BEFORE COMMENCING AN EXCAVATION. CALL TOLL FREE TO (800) 332-2344.

5. THE CONTRACTOR SHALL MAKE PROVISIONS TO KEEP ALL EXISTING UTILITIES (INCLUDING NON-LOCATABLE) IN SERVICE AND PROTECT THEM DURING CONSTRUCTION. CONTRACTOR SHALL BE RESPONSIBLE FOR THE IMMEDIATE NOTIFICATION OF DAMAGE TO UTILITIES AND THE REPAIR OR REPLACEMENT OF DAMAGED UTILITIES USING MATERIALS AND METHODS APPROVED BY THE UTILITY OWNER. NO SERVICE INTERRUPTIONS SHALL BE PERMITTED WITHOUT PRIOR WRITTEN AGREEMENT WITH THE UTILITY OWNER. NO SERVICE INTERRUPTIONS SHALL BE PERMITTED WITHOUT PRIOR WRITTEN AGREEMENT WITH THE UTILITY PROVIDER.

6. THE CONTRACTOR SHALL NOTIFY PROJECT ENGINEER AND CITY OF SILVERTON PUBLIC WORKS INSPECTOR FORTY-EIGHT (48) HOURS IN ADVANCE OF STARTING CONSTRUCTION AND TWENTY-FOUR (24) HOURS BEFORE RESUMING WORK AFTER SHUT DOWNS, EXCEPT FOR NORMAL RESUMPTION OF WORK FOLLOWING SATURDAYS, SUNDAYS OR HOLIDAYS.

7. THE CONTRACTOR SHALL REMOVE AND DISPOSE OF ALL TREES, STUMPS, ROOTS, TOPSOIL AND OTHER MATERIAL AND WHERE INDICATED ON THE PLANS. MATERIALS SHALL BE DISPOSED OF IN SUCH A MANNER AS TO MEET ALL APPLICABLE REGULATIONS.

8. ALL CONSTRUCTION VEHICLES SHALL PARK ON THE CONSTRUCTION SITE OR AT A LOCATION(S) INDICATED ON THE APPROVED PLAN. HOURS OF CONSTRUCTION FOR PUBLIC IMPROVEMENTS SHALL BE 7:00 AM TO 8:00 PM, MONDAY THROUGH FRIDAY. CONSTRUCTION OF PUBLIC IMPROVEMENTS IS PROHIBITED SATURDAY UNLESS AUTHORIZED IN ADVANCE BY THE CITY ENGINEER. NO WORK IS ALLOWED ON SUNDAY'S OR GOVERNMENT HOLIDAY'S. CONSTRUCTION ACTIVITIES INCLUDE ALL FIELD MAINTENANCE OF EQUIPMENT, REFUELING, AND PICK-UP OR DELIVERY OF EQUIPMENT AS WELL AS THE ACTUAL CONSTRUCTION ACTIVITY.

9. THE CONTRACTOR SHALL KEEP AN APPROVED SET OF PLANS ON THE PROJECT SITE AT ALL TIMES.

10. THE CONTRACTOR SHALL PERFORM ALL WORK NECESSARY TO COMPLETE THIS PROJECT IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS INCLUDING SUCH INCIDENTALS AS MAY BE NECESSARY TO MEET THE INTENT OF THE PROJECT CONTRACT DOCUMENTS AND APPLICABLE AGENCY REQUIREMENTS.

11. THE CONTRACTOR SHALL MAINTAIN AND COORDINATE ACCESS SATISFACTORY WITH THE NEEDS OF EMERGENCY SERVICE AGENCIES AND ALL AFFECTED PROPERTIES.

12. IF GROUND WATER SPRINGS OR TILED DRAINAGE SYSTEMS ARE ENCOUNTERED DURING CONSTRUCTION, THE CONTRACTOR SHALL IMMEDIATELY CONTACT THE PROJECT ENGINEER. THE PROJECT ENGINEER SHALL DIRECT THE CONTRACTOR TO TAKE MEASURES TO ENSURE THAT THE WATER IS NOT CONVEYED THROUGH UTILITY TRENCHES AND THE NATURAL FLOW PATH OF THE SPRING IS ALTERED AS LITTLE AS PRACTICABLE. THE PROJECT ENGINEER SHALL SUBMIT A REPORT SUMMARIZING THE FINDINGS TO THE CITY. IMPACTS AND MITIGATION SHALL BE ADDRESSED FOR CITY APPROVAL.

13. THE CONTRACTOR SHALL POTHOLE AND VERIFY LOCATION AND DEPTH OF ALL EXISTING UTILITIES PRIOR TO THE START OF CONSTRUCTION. THE CONTRACTOR SHALL TAKE ALL NECESSARY FIELD MEASUREMENTS AND OTHERWISE VERIFY ALL DIMENSIONS AND EXISTING CONSTRUCTION CONDITIONS INDICATED AND/ OR SHOWN ON THE PLANS. SHOULD ANY ERROR OR INCONSISTENCY EXIST, THE CONTRACTOR SHALL NOT PROCEED WITH THE WORK AFFECTED UNTIL REPORTED TO THE PROJECT ENGINEER FOR CLARIFICATION OR CORRECTION.

14. ANY INSPECTION BY THE CITY, COUNTY, STATE, FEDERAL AGENCY, OR PROJECT ENGINEER SHALL NOT, IN ANY WAY RELIVE THE CONTRACTOR FROM ANY OBLIGATION TO PERFORM THE WORK IN COMPLIANCE WITH THE APPLICABLE CODES AND REGULATIONS, CITY STANDARDS, AND PROJECT DOCUMENTS.

15. THE CONTRACTOR SHALL VERIFY CENTERLINE AND TOP OF CURB ELEVATIONS PRIOR TO CONSTRUCTION TO INSURE COMPLIANCE WITH THE CONSTRUCTION DRAWINGS AND REPORT ANY DISCREPANCIES IMMEDIATELY TO THE PROJECT ENGINEER.

16. THE CONTRACTOR SHALL SUBMIT A TRAFFIC CONTROL PLAN FOR APPROVAL PRIOR TO THE START OF CONSTRUCTION IN ACCORDANCE WITH THE SPECIFICATIONS, CITY STANDARDS, AND THE CURRENT EDITION OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES. ALL FLAGGERS SHALL BE CERTIFIED BY THE STATE OF OREGON.

17. THE CONTRACTOR SHALL PROVIDE THE CITY AND PROJECT ENGINEER A TWENTY-FOUR (24) HOUR CONTACT PERSON AND NUMBER.

18. THE CONTRACTOR SHALL VERIFY TEMPORARY CONSTRUCTION EASEMENTS PRIOR TO CONSTRUCTION.

19. THE CONTRACTOR SHALL RECORD ALL CHANGES TO THE CONSTRUCTION PLANS. CHANGES SHALL INCLUDE REFERENCE MEASUREMENTS, MATERIALS TYPE, AND UTILITIES NOT PREVIOUSLY SHOWN ON THE PLANS. INFORMATION SHALL BE SUBMITTED TO THE PROJECT ENGINEER FOR THE COMPLETION OF RECORD DRAWINGS.

20. ALL SURVEY MONUMENTS ON THE PROJECT'S SITE OR THAT MAY BE SUBJECT TO DISTURBANCE WITHIN THE CONSTRUCTION AREA, OR THE CONSTRUCTION OF ANY OFF SITE IMPROVEMENTS SHALL BE ADEQUATELY REFERENCED AND PROTECTED PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION ACTIVITY. IF THE SURVEY MONUMENTS ARE DISTURBED, MOVED, RELOCATED, OR DESTROYED AS A RESULT OF ANY CONSTRUCTION, THE CONTRACTOR SHALL, AT THEIR COST, RETAIN THE SERVICES OF A REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF OREGON TO RESTORE THE MONUMENT TO ITS ORIGINAL CONDITION AND FILE THE NECESSARY SURVEYS AS REQUIRED BY OREGON STATE LAW. A COPY OF ANY RECORDED SURVEY SHALL BE SUBMITTED TO THE CITY PUBLIC WORKS DIRECTOR OR AUTHORIZED REPRESENTATIVE.

21. THE CONTRACTOR IS REQUIRED TO METER CONSTRUCTION WATER THROUGH A CITY BULK WATER METER. CONTACT THE SILVERTON WASTEWATER PLANT AT 503-873-5439.

22. ANY ROOTS ENCOUNTERED OVER 2 INCHES SHALL BE CUT WITH SAW PERPENDICULAR TO TRENCH.

EROSION AND SEDIMENT CONTROL NOTES:

1. THE CONTRACTOR SHALL PROVIDE EFFECTIVE EROSION CONTROL PROTECTION TO INCLUDE, BUT NOT LIMITED TO, GRADING, DITCHING, HAY BALES, SILT FENCING, AND SEDIMENT BARRIERS TO MINIMIZE EROSION AND IMPACT TO ADJACENT PROPERTY.

2. APPROVAL OF THE EROSION AND SEDIMENT CONTROL PLAN DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT ROAD OR DRAINAGE DESIGN (E.G. SIZE AND LOCATION OF ROADS, PIPES, STRUCTURES, CHANNELS, DETENTION FACILITIES, UTILITIES, ETC.)

3. THE EROSION AND SEDIMENT CONTROL MEASURES MUST BE CONSTRUCTED IN CONJUNCTION WITH ALL CLEARING AND GRADING ACTIVITIES, AND IN SUCH A MANNER AS TO INSURE THAT SEDIMENT AND SEDIMENT LADEN WATER DOES NOT ENTER THE STORM DRAINAGE SYSTEM, STREETS, OR VIOLATE APPLICABLE WATER STANDARDS.

4. THE CONTRACTOR SHALL CALL FOR INITIAL AND FINAL EROSION AND SEDIMENT CONTROL INSPECTION. EROSION AND SEDIMENT CONTROL INSPECTION SHALL BE APPROVED PRIOR TO THE START OF CONSTRUCTION ACTIVITIES. CONTRACTOR SHALL REMOVE TRASH AND SEDIMENT DEPOSITS PRIOR TO FINAL PROJECT INSPECTION.

5. THE EROSION AND SEDIMENT CONTROL MEASURES SHALL BE INSPECTED AND MAINTAINED DAILY BY THE APPLICANT/CONTRACTOR. INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH OR WITHIN 24 HOURS FOLLOWING A STORM EVENT.

6. GRAVEL CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES, SUCH AS A WHEEL WASH, MAY BE REQUIRED TO INSURE THAT ALL PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT. WHEEL WASH BASINS SHALL BE PERIODICALLY (OR AS DIRECTED BY CITY INSPECTORS) DRAINED, CLEANED OF SEDIMENT, AND REFILLED WITH CLEAN WATER. AT NO TIME SHALL VEHICLES EXIT THE SITE WITHOUT USING WHEEL WASH STATION INCLUDING DURING MAINTENANCE OF WHEEL WASH BASIN.

7. STORM DRAIN INLETS, BASINS, AND AREA DRAINS SHALL BE PROTECTED UNTIL THE COMPLETION OF THE PROJECT. SILT SACK INSERTS WITH BIO-BAGS ALONG CURB INLETS IS THE PREFERRED MEASURE FOR INLET PROTECTION WHERE APPLICABLE. CONTRACTOR SHALL PROVIDE AND MAINTAIN SILT SACK PROTECTION AT THE NEAREST CATCH BASIN INLET(S) DOWNSTREAM OF THE PROJECTS SITE. INSTALL INLET PROTECTION TO NEW INLETS AS INSTALLED.

8. AT NO TIME SHALL SEDIMENT BE ALLOWED TO ACCUMULATE WITHIN A TRAPPED CATCH BASIN. ALL SILT SACKS SHALL BE INSPECTED DAILY AND CLEANED OR REPLACED AS NECESSARY. ALL CATCH BASINS AND CONVEYANCE LINES SHALL BE CLEANED PRIOR TO PAVING. THE CLEANING OPERATION SHALL NOT FLUSH SEDIMENT LADEN WATER INTO THE DOWNSTREAM STORM SYSTEM.

9. THE CONTRACTOR SHALL INSTALL, OPERATE AND MAINTAIN ADEQUATE EROSION CONTROL MEASURES IN CONFORMANCE WITH THE STANDARDS ADOPTED BY THE CITY OF SILVERTON DURING THE CONSTRUCTION OF ANY PUBLIC UTILITIES AND BUILDING IMPROVEMENTS UNTIL SUCH TIME AS APPROVED PERMANENT VEGETATIVE MATERIALS HAVE BEEN INSTALLED.

10. AT THE COMPLETION OF CONSTRUCTION, ALL EXPOSED SOILS MUST BE HYDROSEEDED AND/OR COVERED WITH STRAW AND TACIFIER. IF GROUND COVER IS NOT ESTABLISHED BY OCTOBER 15, THE OPEN AREAS SHALL BE PROTECTED THROUGH THE WINTER WITH MULCH, EROSION BLANKETS, OR OTHER METHOD(S) APPROVED BY THE CITY. SEEDING SHALL BE PERFORMED NO LATER THAN SEPTEMBER 31 FOR EACH PHASE OF CONSTRUCTION.

11. STOCKPILES OF SOIL OR OTHER EROSION PRONE MATERIALS FOR EXTENDED PERIODS MUST BE COVERED WITH TEMPORARY EROSION CONTROL MEASURES AND PROTECTED WITH SILT FENCING.

12. DURING ALL PHASES OF WORK THE CONTRACTOR SHALL TAKE PRECAUTIONS TO ABATE ANY DUST NUISANCE. DUST SHALL BE MINIMIZED TO THE EXTENT PRACTICABLE AND PREVENTION MEASURES SHALL BE CONTINUOUS UNTIL FINAL INSPECTION BY THE CITY.

13. NO PERSON SHALL CREATE PHYSICAL EROSION BY DRAGGING, DROPPING, TRACKING, OR OTHERWISE PLACING OR DEPOSITING, OR PERMITTING TO BE DEPOSITED, MUD, DIRT, ROCK, OR OTHER DEBRIS ON A PUBLIC STREET, OR INTO ANY PART OF THE PUBLIC STORM WATER SYSTEM AND SURFACE WATER SYSTEM, OR INTO ANY PART OF A PRIVATE STORM WATER OR SURFACE WATER SYSTEM THAT DRAINS OR CONNECTS TO THE PUBLIC STORM WATER AND SURFACE WATER SYSTEM. ANY SUCH DEPOSITED MATERIAL SHALL BE IMMEDIATELY REMOVED BY HAND LABOR OR MECHANICAL MEANS. NO MATERIAL SHALL BE WASHED OR FLUSHED INTO ANY PART OF THE STORM WATER OR SURFACE WATER SYSTEM UNTIL ALL MECHANICAL MEANS TO REMOVE THE DEBRIS ARE EXHAUSTED AND PREVENTATIVE SEDIMENT FILTRATION IS IN PLACE.

14. ALL SEDIMENT FENCE SHALL BE INSTALLED PER MANUFACTURER'S RECOMMENDATIONS AND COMPLY WITH THE RECENT EDITION OF THE OREGON CHAPTER APWA STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION EXCEPT AS MODIFIED BY THE CONSTRUCTION REQUIREMENTS OF THE CITY OF SILVERTON.

STREET NOTES:

1. THE CONTRACTOR SHALL SUBMIT A TRAFFIC CONTROL PLAN FOR APPROVAL PRIOR TO THE START OF CONSTRUCTION IN ACCORDANCE WITH THE SPECIFICATIONS, CITY STANDARDS, AND THE CURRENT EDITION OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES. APPROVAL OF PLAN REQUIRED PRIOR TO ANY WORK PERFORMED IN EXISTING PUBLIC RIGHT-OF WAY. ALL FLAGGERS SHALL BE CERTIFIED BY THE STATE OF OREGON.

2. CONTRACTOR TO PROVIDE STATE CERTIFIED INDEPENDENT TESTING AGENCY FOR ALL TESTING OF SUB-GRADE, BASE ROCK, CONCRETE CURB AND DRIVEWAY, ASPHALT PAVEMENT, AND CONCRETE PAVEMENT. CITY RESERVES THE RIGHT TO DIRECT TESTING AGENCY ON FREQUENCY OF TESTING. TESTING AGENCY SHALL SUBMIT ONE COPY OF ALL TESTING REPORTS TO CITY'S AUTHORIZED REPRESENTATIVE.

3. NO FILLS ARE TO BE PLACED PRIOR TO CITY APPROVAL OF STRIPING. SUB-GRADE SHALL BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY, AS DETERMINED BY AASHTO T-180. ALONG WITH TESTING USING A NUCLEAR DENSITY GAUGE, A PROOF ROLL SHALL BE CONDUCTED BY THE CONTRACTOR AND ACCEPTED BY CITY PRIOR TO PLACEMENT OF BASE ROCK. ALL SOFT AREAS SHALL BE OVER-EXCAVATED TO A DEPTH SATISFACTORY TO THE GEOTECHNICAL ENGINEER AND CITY REPRESENTATIVE, BACKFILLED WITH CRUSHED 3/4"-0 AND COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY, AS DETERMINED BY AASHTO T-180.

4. BASE ROCK SHALL BE FROM AN APPROVED SOURCE. CITY MUST RECEIVE AND APPROVE A COPY OF A STATE MIX DESIGN AT LEAST SEVEN (7) DAYS PRIOR TO THE PLACEMENT OF BASE ROCK. BASE ROCK SHALL CONFORM TO THE RECENT EDITION OF THE OREGON CHAPTER APWA STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION AND THE CONSTRUCTION REQUIREMENTS OF THE CITY OF SILVERTON.

5. BASE ROCK SHALL BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY, AS DETERMINED BY AASHTO T-180. ALONG WITH TESTING USING A NUCLEAR DENSITY GAUGE, A PROOF ROLL SHALL BE CONDUCTED BY THE CONTRACTOR AND ACCEPTED BY CITY PRIOR TO PAVING TAKING PLACE.

6. NO PAVING SHALL TAKE PLACE UNTIL ALL TESTING OF UNDERGROUND UTILITIES (INCLUDING TONE TESTING BY CITY), SUB-GRADE, AND BASE ROCK IS COMPLETED AND APPROVED BY THE CITY.

7. ASPHALT PAVEMENT SHALL BE FROM AN APPROVED SOURCE. CITY MUST RECEIVE AND APPROVE A COPY OF A STATE MIX DESIGN AT LEAST SEVEN (7) DAYS PRIOR TO THE PLACEMENT OF PAVEMENT. PAVEMENT SHALL CONFORM TO THE RECENT EDITION OF THE OREGON CHAPTER APWA STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION AND THE CONSTRUCTION REQUIREMENTS OF THE CITY OF SILVERTON.

8. ASPHALT PAVEMENT SHALL BE COMPACTED TO A MINIMUM OF 92% OF RELATIVE DENSITY BASED ON RICE GRAVITY.

9. UTILITY CUTS ACROSS EXISTING STREETS SHALL BE T-CUT, CONFORMING TO CITY DETAIL. STREETS CONSTRUCTED OR OVERLAYED WITHIN FIVE (5) OF CONSTRUCTION OF THIS PROJECT SHALL BE SUBJECT TO AN ADDITION MILL AND OVERLAY REQUIREMENT. MILL AND OVERLAY SHALL BE HALF TO FULL STREET WIDTH, DEPENDING ON THE EXTENT OF THE TRENCH CUT, AND EXTEND NO LESS THAN FIVE (5) FEET BEYOND WIDEST PORTION OF T-CUT.

10. ALL CONSTRUCTION STAKING OF PUBLIC STREETS SHALL BE PERFORMED BY OR UNDER THE DIRECTION OF A PROFESSIONAL LAND SURVEYOR REGISTERED IN THE STATE OF OREGON. STAKES SHALL, AT A MINIMUM, LOCATE ALL HORIZONTAL POINTS OF CURVATURE (BEGINNING, MIDPOINT, AND ENDING), VERTICAL POINTS OF CURVATURE (BEGINNING, LOW/HIGH POINT, AND ENDING), CURB RETURNS (BEGINNING, MIDPOINT, AND ENDING), AND CENTERLINE FOR OFFSET CROWNS. MAXIMUM SPACING FOR REFERENCE STAKES IS 50 FEET. CONSTRUCTION SHALL NOT BE ALLOWED BEFORE STAKING IS PERFORMED.

11. NEWLY CONSTRUCTED CURBS SHALL BE STAMPED WITH THE CAPITOL LETTER "D" FOR STORM, "S" FOR SANITARY, OR "w" FOR WATER AT THE LOCATION OF EACH UNDERGROUND SERVICE CROSSING. LETTERS SHALL BE 3 INCHES IN HEIGHT AND EMBOSSED A MINIMUM OF (1/4) INCH DEEP. ALL WEEP HOLES SHALL BE INSTALLED DURING INITIAL CURB AND GUTTER POUR. INSTALLATION OF WEEP HOLES AFTER INITIAL POUR SHALL BE CORE DRILLED ONLY. USE OF SAW CUT AND KNOCK OUT BY HAMMER IS PROHIBITED.

12. ALL DRIVEWAY APRONS AND CURB AND GUTTER SHALL HAVE CYLINDER SAMPLES TAKEN BY A STATE CERTIFIED INDEPENDENT TESTING AGENCY. REPORT OF BREAK RESULT SHALL BE PROVIDED TO THE CITY'S AUTHORIZED REPRESENTATIVE.

13. ALL STREET SIGNAGE, STRIPING, AND REFLECTORS SHALL BE INSTALLED BY APPLICANT/CONTRACTOR PRIOR TO PROJECT CORRECTION LIST WALK-THROUGH. ALL CROSSWALK STRIPING AND ROADWAY EMBLEMS SHALL BE THERMOPLASTIC. ALL SIGNAGE AND STRIPING SHALL COMPLY WITH CITY STANDARDS, AND THE CURRENT EDITION OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES.

14. SEE NOTES FOR STREET LIGHTING, DRY UTILITIES, STREET TREES, LANDSCAPING AND IRRIGATION.

STORM NOTES:

1. ALL STORM MANHOLE LIDS SHALL BE SIXTEEN (16) HOLE TYPE. MANHOLES IN PLANTER AREAS SHALL BE A MINIMUM OF SIX (6) INCHES ABOVE FINISHED GRADE.

2. ALL CONNECTIONS TO EXISTING MANHOLES SHALL BE CORE DRILLED. USE OF CUT-OFF SAW AND KNOCK OUT BY HAMMER IS PROHIBITED. REVISIONS TO DESIGN WILL NOT CONSTITUTE A VARIANCE TO CORE DRILL REQUIREMENT AND MAY, AT CITY DISCRETION, REQUIRE MANUFACTURE AND INSTALLATION OF NEW MANHOLE MATCHING DESIGN REVISION.

3. STORM LATERALS SHALL BE A MINIMUM OF SIX (6) INCHES DIAMETER AND HAVE LOCATING WIRE (SOLID 14 GAGE WHITE INSULATION) INSTALLED BESIDE THE PIPE AND PLASTIC CAUTION TAPE INSTALLED 1-FOOT ABOVE THE PIPE CROWN. SURFACE LOCATING WIRE AT RIGHT-OF-WAY CLEANOUTS; TAPE SHALL BE TIED OFF TO THE 2 X 4 MARKER PAINTED WHITE. TONE TESTING BY CITY TO PASS PRIOR TO PAVING.

4. NEWLY CONSTRUCTED CURBS OR REPLACED CURBS SHALL BE STAMPED WITH THE CAPITOL LETTER "D" AT THE LOCATION OF EACH UNDERGROUND STORM LATERAL CROSSING. LETTERS SHALL BE 3 INCHES IN HEIGHT AND EMBOSSED A MINIMUM OF (1/4) INCH DEEP.

5. ALL WEEP HOLES SHALL BE INSTALLED DURING INITIAL CURB AND GUTTER POUR. INSTALLATION OF WEEP HOLES AFTER INITIAL POUR SHALL BE CORE DRILLED ONLY. USE OF SAW CUT AND KNOCK OUT BY HAMMER IS PROHIBITED.

6. ALL STORM LINES SHALL BE FLUSHED AND CLEANED PRIOR TO TESTING. ALL STORM LINES SHALL BE VIDEO INSPECTED. IN ADDITION, STORM LINES CONSTRUCTED OF FLEXIBLE PIPE SHALL BE MANDREL TESTED (5%). CONTRACTOR TO FURNISH ALL NECESSARY TEST EQUIPMENT AND PERFORM THE TESTS IN A MANNER SATISFACTORY TO THE CITY. CITY INSPECTOR SHALL BE PRESENT DURING TESTING (24-HR NOTIFICATION).

7. STORM WATER FACILITIES SHALL NOT BE ACTIVATED AND/OR CONNECTED TO PUBLIC STORM SYSTEMS OR WATERWAYS UNLESS FACILITY HAS BEEN TESTED AND APPROVED BY CITY STAFF.

8. CONTRACTOR TO PROVIDE INDEPENDENT TESTING AGENCY FOR ALL TESTING OF TRENCH BACKFILL. TESTING OF BACKFILL LIFTS SHALL NOT EXCEED THREE (3) FEET IN DEPTH AND TESTS OF LIFTS SHALL BE STAGGERED ALONG TRENCH LINE. CITY RESERVES THE RIGHT TO DIRECT TESTING AGENCY ON FREQUENCY OF TESTING. TESTING AGENCY SHALL SUBMIT ONE COPY OF ALL TESTING REPORTS TO CITY'S AUTHORIZED REPRESENTATIVE.

9. ALL CONSTRUCTION STAKING OF PUBLIC STORM LINES SHALL BE PERFORMED BY OR UNDER THE DIRECTION OF A PROFESSIONAL LAND SURVEYOR REGISTERED IN THE STATE OF OREGON. STAKES SHALL, AT A MINIMUM, LOCATE ALL TEES, CLEANOUTS, MANHOLES, CATCH BASINS, DITCH INLETS, AND OUTFALLS. MAXIMUM SPACING FOR REFERENCE STAKES IS 50 FEET. CONSTRUCTION SHALL NOT BE ALLOWED BEFORE STAKING IS PERFORMED.

SANITARY NOTES:

1. ALL SANITARY MANHOLE LIDS SHALL BE TWO (2) HOLE TYPE UNLESS OTHERWISE SPECIFIED. MANHOLES IN PLANTER AREAS SHALL BE A MINIMUM OF SIX (6) INCHES ABOVE FINISHED GRADE.

2. ALL CONNECTIONS TO EXISTING MANHOLES SHALL BE CORE DRILLED. USE OF CUT-OFF SAW AND KNOCK OUT BY HAMMER IS PROHIBITED. REVISIONS TO DESIGN WILL NOT CONSTITUTE A VARIANCE TO CORE DRILL REQUIREMENT AND MAY, AT CITY DISCRETION, REQUIRE MANUFACTURE AND INSTALLATION OF NEW MANHOLE MATCHING DESIGN REVISION.

3. SANITARY LATERALS SHALL BE A MINIMUM OF FOUR (4) INCHES DIAMETER, UNLESS MULTI-FAMILY/COMMERCIAL/INDUSTRIAL ZONING, AND HAVE LOCATING WIRE (SOLID 14 GAGE GREEN INSULATION) INSTALLED BESIDE THE PIPE AND PLASTIC CAUTION TAPE INSTALLED 1-FOOT ABOVE THE PIPE CROWN. SURFACE LOCATING WIRE AT RIGHT-OF-WAY CLEANOUTS; TAPE SHALL BE TIED OFF TO THE 2 X 4 MARKER PAINTED GREEN. TONE TESTING BY CITY TO PASS PRIOR TO PAVING.

4. NEWLY CONSTRUCTED CURBS OR REPLACED CURBS SHALL BE STAMPED WITH THE CAPITOL LETTER "S" AT THE LOCATION OF EACH SANITARY LATERAL CROSSING. LETTERS SHALL BE 3 INCHES IN HEIGHT AND EMBOSSED A MINIMUM OF ONE-QUARTER (1/4) INCH DEEP.

5. ALL PUBLIC SEWER LINES SHALL BE FLUSHED AND CLEANED PRIOR TO TESTING. ALL PUBLIC SEWER LINES SHALL BE PRESSURE TESTED, AND VIDEO INSPECTED. IN ADDITION, SEWERS CONSTRUCTED OF FLEXIBLE PIPE SHALL BE MANDREL TESTED (5%). CONTRACTOR TO FURNISH ALL NECESSARY TEST EQUIPMENT AND PERFORM THE TESTS IN A MANNER SATISFACTORY TO THE CITY. CITY INSPECTOR SHALL BE PRESENT DURING TESTING (24-HR NOTIFICATION).

6. PUBLIC SANITARY SEWER MANHOLES SHALL BE VACUUM TESTED AFTER THE STREET PAVING IS COMPLETED. CONTRACTOR TO FURNISH ALL NECESSARY TEST EQUIPMENT AND PERFORM THE TESTS IN A MANNER SATISFACTORY TO THE CITY. CITY INSPECTOR SHALL BE PRESENT DURING TESTING (24-HR NOTIFICATION).

7. FOR ALL PUBLIC SANITARY MANHOLES, THE CONTRACTOR SHALL SUPPLY THE CITY WITH MANHOLE COVER INSERTS. FOR PUBLIC MANHOLES LOCATED IN NATURAL OR LANDSCAPED AREAS OR IN RESIDENTIAL STREETS, THE CONTRACTOR SHALL SUPPLY MANHOLE COVER INSERTS MADE OF DURABLE PLASTIC. FOR PUBLIC MANHOLES LOCATED IN ARTERIAL AND COLLECTOR STREETS, THE CONTRACTOR SHALL SUPPLY MANHOLE COVER INSERTS MADE OF STAINLESS STEEL.

8. CONTRACTOR TO PROVIDE INDEPENDENT TESTING AGENCY FOR ALL TESTING OF TRENCH BACKFILL. TESTING OF BACKFILL LIFTS SHALL NOT EXCEED THREE (3) FEET IN DEPTH AND TESTS OF LIFTS SHALL BE STAGGERED ALONG TRENCH LINE. CITY RESERVES THE RIGHT TO DIRECT TESTING AGENCY ON FREQUENCY OF TESTING. TESTING AGENCY SHALL SUBMIT ONE COPY OF ALL TESTING REPORTS TO CITY'S AUTHORIZED REPRESENTATIVE.

9. ALL CONSTRUCTION STAKING OF PUBLIC SANITARY LINES SHALL BE PERFORMED BY OR UNDER THE DIRECTION OF A PROFESSIONAL LAND SURVEYOR REGISTERED IN THE STATE OF OREGON. STAKES SHALL, AT A MINIMUM, LOCATE ALL TEES, CLEAN-OUTS, MANHOLES, WATER LINE CROSSINGS, AND PUMP STATIONS. MAXIMUM SPACING FOR REFERENCE STAKES IS 50 FEET. CONSTRUCTION SHALL NOT BE ALLOWED BEFORE STAKING IS PERFORMED.

WATER NOTES:

1. CITY WILL OPERATE ALL EXISTING VALVES TO ISOLATE WATERLINES FOR WORK REQUIRED AND FOR ALL FLUSHING AND FILLING ACTIVITIES. CONTACT THE PUBLIC WORKS MAINTENANCE DIVISION AT 503-873-6359 A MINIMUM OF TWENTY-FOUR (24) HOURS IN ADVANCE.

2. CITY WILL PROVIDE NOTIFICATION TO AFFECTED WATER USERS FOR PLANNED SERVICE DISRUPTIONS. CONTACT THE PUBLIC WORKS MAINTENANCE DIVISION AT 503-873-6359 A MINIMUM OF SEVENTY-TWO (72) HOURS IN ADVANCE.

3. PUBLIC WATER LINES SHALL CONFORM TO MATERIALS AND INSTALLATION REQUIREMENTS AS MAY BE REQUIRED BY THE CITY OF SILVERTON AND AMERICAN WATER WORKS ASSOCIATION.

4. ALL WATER LINE CROSSINGS SHALL BE IN CONFORMANCE WITH OAR CHAPTER 333. THE CITY MAY REQUIRE MORE STRINGENT STANDARDS.

5. ALL WATER LINES SHALL BE C-900 OR CLASS 50 DUCTILE IRON. ALL FITTINGS SHALL BE PUSH-ON GASKETED UNLESS OTHERWISE SPECIFIED. TEES AND CROSSES SHALL BE FLANGED EXCEPT TEES TO FIRE HYDRANTS WHICH WILL BE MJ BY FLANGED. ALL VALVES JOINED TO TEES AND CROSSES SHALL BE FLANGED BY MECHANICAL JOINT.

6. ALL PUBLIC WATER LINES SHALL BE INSTALLED WITH LOCATING WIRE (SOLID 14-GAGE BLUE INSULATION) INSTALLED BESIDE THE PIPE AND PLASTIC CAUTION TAPE INSTALLED 1-FOOT ABOVE THE PIPE CROWN. WIRE SHALL BE BROUGHT TO THE SURFACE AT ALL SERVICE METER STOPS, FIRE HYDRANTS, VALVE BOXES, AIR RELIEF'S, AND BLOW-OFFS. TONE TESTING BY CITY TO PASS PRIOR TO PAVING.

7. ALL PUBLIC WATER LINES SHALL HAVE A MINIMUM OF 30 INCHES OF COVER.

8. SEE CITY OF SILVERTON DETAILS FOR THRUST BLOCKS AND FIRE HYDRANT ASSEMBLIES.

9. ALL WATER VALVES AND BOXES SHALL BE DESIGNED AND CONSTRUCTED A MINIMUM OF EIGHTEEN (18) INCHES FROM FACE OF CURB UNLESS OTHERWISE APPROVED BY CITY'S AUTHORIZED REPRESENTATIVE.

10. CONTRACTOR TO PROVIDE INDEPENDENT TESTING AGENCY FOR ALL TESTING OF TRENCH BACKFILL. TESTING OF BACKFILL LIFTS SHALL NOT EXCEED THREE (3) FEET IN DEPTH AND TESTS OF LIFTS SHALL BE STAGGERED ALONG TRENCH LINE. CITY RESERVES THE RIGHT TO DIRECT TESTING AGENCY ON FREQUENCY OF TESTING. TESTING AGENCY SHALL SUBMIT ONE COPY OF ALL TESTING REPORTS TO CITY'S AUTHORIZED REPRESENTATIVE.

11. ALL CONSTRUCTION STAKING OF PUBLIC WATER LINES SHALL BE PERFORMED BY OR UNDER THE DIRECTION OF A PROFESSIONAL LAND SURVEYOR REGISTERED IN THE STATE OF OREGON. STAKES SHALL, AT A MINIMUM, LOCATE ALL BENDS, TEES, CROSSES, FIRE HYDRANTS, BLOW-OFFS, ISOLATION VALVES, VAULTS, AND BOOSTER PUMP STATIONS. MAXIMUM SPACING FOR REFERENCE STAKES IS 50 FEET. CONSTRUCTION SHALL NOT BE ALLOWED BEFORE STAKING IS PERFORMED.

12. AFTER WATER VALVE CANS ARE ADJUSTED TO FINISH GRADE FOR ALL NEW AND EXISTING VALVES, WHERE THE DEPTH OF THE OPERATION NUT IS GREATER THAN THREE (3) FEET, OPERATING EXTENSIONS SHALL BE PROVIDED TO BRING THE OPERATING NUT TO A POINT FOURTEEN (14) INCHES BELOW THE SURFACE OF THE GROUND OR PAVEMENT.

13. HYDROSTATIC TESTS: THE TEST SHALL CONFORM WITH AWWA C 600, SECTION 4 WITH THE FOLLOWING MODIFICATIONS. THE TEST PRESSURE SHALL BE 150 PSI AT THE HIGHEST POINT OF ELEVATION IN ANY SECTION. THE DURATION SHALL BE 120 MINUTES AND SHALL BE MONITORED BY THE CITY OF SILVERTON PUBLIC WORKS DEPARTMENT. DISINFECTION OF THE LINE SHALL TAKE PLACE PRIOR TO PERFORMING HYDROSTATIC TESTING.

14. DISINFECTION: PIPELINES SHALL BE FLUSHED AND DISINFECTED BEFORE PLACING INTO SERVICE. DISINFECTION SHALL CONFORM TO AWWA C 651. DISCHARGING OF THE HIGHLY CHLORINATED WATER USED FOR DISINFECTION SHALL NOT BE DISCHARGED INTO SURFACE WATERS. APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS CONCERNING DISCHARGE SHALL BE FOLLOWED. OREGON STATE HEALTH DIVISION BACTERIOLOGICAL TESTS SHALL BE TAKEN BY AN OUTSIDE TESTING FACILITY AND RESULTS OF THE TEST SHALL BE REPORTED TO THE CITY PRIOR TO HYDROSTATIC TESTS.

STREET LIGHTING AND DRY UTILITY NOTES:

1. ALL LIGHT POLES, CONDUIT AND JUNCTION BOXES SHALL CONFORM TO THE REQUIREMENTS OF PORTLAND GENERAL ELECTRIC AND THE CITY OF SILVERTON. POLE SHROUDS AND JUNCTION BOXES SHALL BE SET TO FINISHED GRADE. ALL JUNCTION BOXES AND LIDS SHALL BE H-20 LOADING.

2. ALL LIGHTING SHALL BE ENERGIZED AND APPROVED BY PORTLAND GENERAL ELECTRIC PRIOR TO PROJECT CORRECTION LIST WALK-THROUGH

3. ALL FRANCHISE UTILITY CONDUITS SHALL RUN ALONG A COMMON TRENCH WITHIN THE PUBLIC UTILITY EASEMENT. ALL PUBLIC RIGHT-OF-WAY CROSSINGS SHALL BE AT RIGHT ANGLES TO STREET CENTERLINE AND BE LOCATED IN COMMON TRENCH AT INTERSECTIONS OR MID-BLOCK LOCATIONS.

4. ALL PUBLIC RIGHT-OF-WAY CROSSINGS OR SLEEVES SHALL BE INSTALLED AND APPROVED PRIOR TO PROOF ROLL OF STREET BASE ROCK.

5. THE CONTRACTOR SHALL GRADE PUBLIC UTILITY EASEMENTS SO THAT ALL FRANCHISE UTILITY PEDESTALS AND VAULTS CAN BE SET TO FINISHED GRADE AS MEASURED FROM BACK OF PUBLIC SIDEWALK. FINISHED GRADES WITHIN PUBLIC RIGHT-OF-WAY SHALL BE AT TWO (2) PERCENT AND OUTSIDE OF PUBLIC RIGHT-OF-WAY SHALL NOT EXCEED 2H : 1V UNLESS APPROVED BY CITY'S AUTHORIZED REPRESENTATIVE.

6. ALL EXISTING OVERHEAD UTILITIES SHALL BE RELOCATED UNDERGROUND AT APPLICANT/CONTRACTORS EXPENSE PRIOR TO PROOF ROLL OF STREET BASE ROCK.

STREET TREES, LANDSCAPING, AND IRRIGATION NOTES:

1. ALL STREET TREES AND LANDSCAPING SHALL NOT CONFLICT WITH SIGHT DISTANCE REQUIREMENTS. STREET TREES SHALL MAINTAIN THE FOLLOWING CLEARANCE DISTANCES:
- MINIMUM OF FIVE (5) FEET FROM ALL SANITARY, STORM, AND WATER SERVICE CROSSINGS.
- MINIMUM OF TEN (10) FEET OF CLEARANCE FROM ALL FIRE HYDRANTS.
- MINIMUM OF TWENTY (20) FEET OF CLEARANCE FROM ALL CATCH BASINS/GUTTER INLETS AND STREET LIGHTS.
- MINIMUM OF FORTY (40) FEET OF CLEARANCE FROM NEAR CURB LINE OF INTERSECTING STREET.

2. ALL LANDSCAPE PLANTINGS SHALL MAINTAIN THREE (3) FEET OF CLEARANCE FROM FIRE HYDRANTS AS MEASURED FROM CENTER NUT TO EDGE OF MATURE GROWTH.

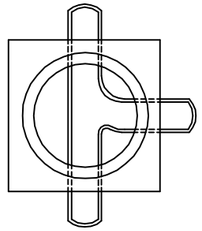
3. ALL IRRIGATION SYSTEMS SHALL HAVE BACKFLOW PROTECTION AS REQUIRED BY PLUMBING CODE AND THE CITY OF SILVERTON.

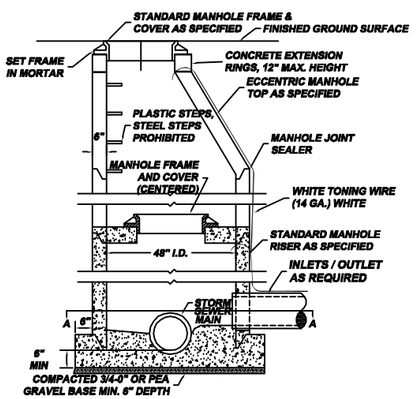
DATE	REVISIONS

CITY OF SILVERTON

STANDARD CONSTRUCTION NOTES

DATE	DRAWN BY	APPROVED BY	SHEET	PROJECT NO.
03/01/07	GCF	RJB	G-1	
SCALE	CHK'D BY	FIELD BOOK		DRAWING NO.
NOTED	RJB			

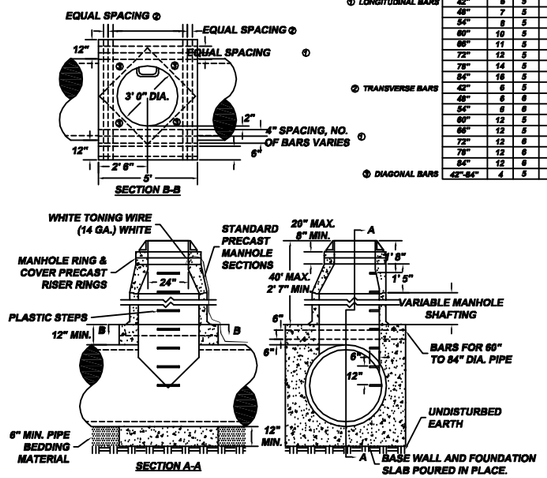




CONE & FLAT TOP MANHOLE STORM SEWER

PIPE SIZE TO 18"

1 / ST-1



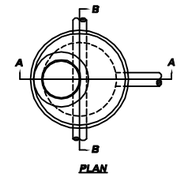
NOTES:
1. UNIT, AS SHOWN IS A CASE-IN-PLACE BASE SECTION ABOVE WHICH CONSTRUCTION MAY BE PRECAST RISER RINGS OR CAST-IN-PLACE CONSTRUCTION.
2. ECCENTRIC CONES SHALL BE USED WHEN THE DEPTH EXCEEDS 6 FT.
3. CONSTRUCT MANHOLES IN ACCORDANCE WITH THE STANDARD SPECIFICATIONS.
4. REINFORCING STEEL SHALL HAVE A MIN. CONER OF 2".
5. ALL LIFT HOLES AND JOINTS TO BE FILLED WITH MORTAR.

MANHOLE FOR 42" TO 84" PIPE

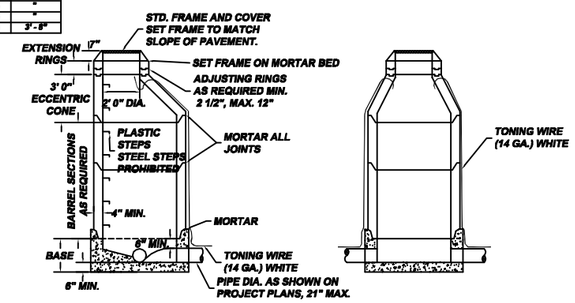
2 / ST-1

BAR LIST

	PIPE DIA.	NO.	SIZE	LENGTH
① LONGITUDINAL BARS	42"	6	5	4' - 8"
	48"	7	5	"
	54"	8	5	"
	60"	10	5	"
	66"	11	5	"
	72"	12	5	"
	78"	14	5	"
	84"	16	5	"
② TRANSVERSE BARS	42"	6	6	2' - 8"
	48"	6	6	"
	54"	6	6	"
	60"	12	5	"
	66"	12	5	"
	72"	12	6	"
	78"	12	6	"
	84"	12	6	"
③ DIAGONAL BARS	42"-84"	4	5	3' - 8"

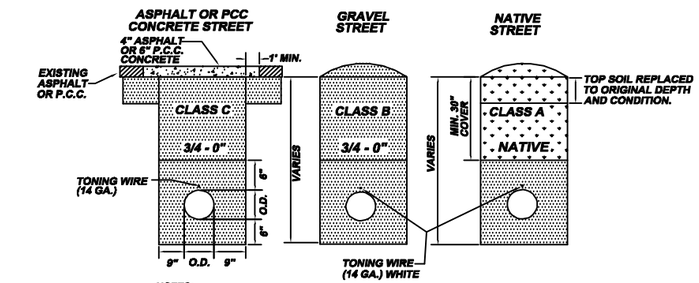


NOTES
1. PRECAST BARREL, CONE, AND EXTENSION RINGS SHALL BE REINFORCED CONCRETE MANHOLE SECTIONS CONFORMING TO ASTM C 478. AASHO M 199.
2. CONCRETE FOR MANHOLE BASE SHALL BE CLASS 3000 PSI.
3. INSIDE JOINTS SHALL NOT EXCEED 3/8" IN THICKNESS.
4. FORM CHANNELS IN MANHOLE BASE AS SHOWN.



STORM DRAIN PRECAST MANHOLE

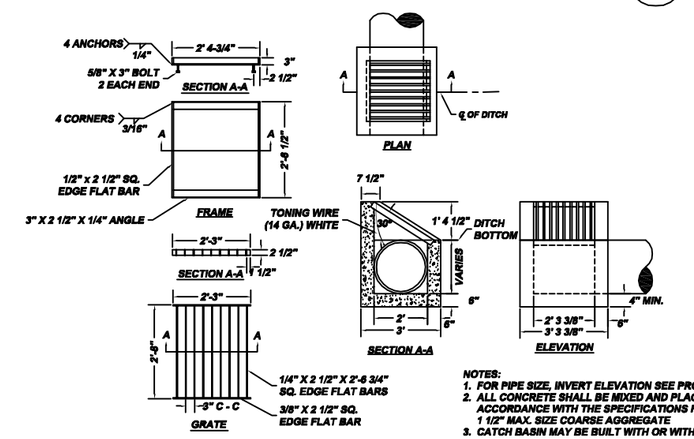
3 / ST-1



NOTES:
1. PIPE ZONE MATERIAL SHALL BE 3/4-0".
2. A/C/ PAVING TO BE DONE IN TWO SEPARATE 2" LIFTS.
3. WHERE PIPE GRADIENT >5% CLAY DAMS SHALL BE USED FOR EACH 50' OF ELEVATION DROP.

TYPICAL TRENCH SECTION

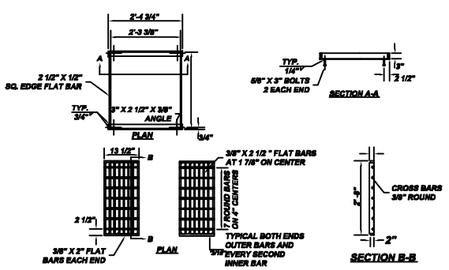
4 / ST-1



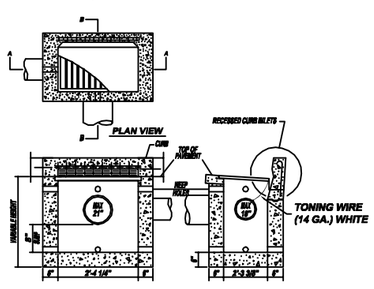
NOTES:
1. FOR PIPE SIZE, INVERT ELEVATION SEE PROJECT PLANS
2. ALL CONCRETE SHALL BE MIXED AND PLACED IN ACCORDANCE WITH THE SPECIFICATIONS FOR 3000 PSI 1 1/2" MAX. SIZE COARSE AGGREGATE
3. CATCH BASIN MAY BE BUILT WITH OR WITHOUT A SUMP AS THE ENGINEER MAY DIRECT.
4. FRAME AND GRATE MATERIAL SHALL BE STEEL (A.S.T.M. A-36) AND BE GALVANIZED IN ACCORDANCE WITH (A.S.T.M. A-123)

TYPE 3 CATCH BASIN

5 / ST-1



NOTE:
FRAME AND GRATE MATERIAL SHALL BE FLAT BAR STEEL OR APPROVED EQUAL. ADDITIONAL THICKNESS AND REINFORCEMENT SHALL BE REQUIRED FOR STATE HIGHWAY APPLICATIONS.

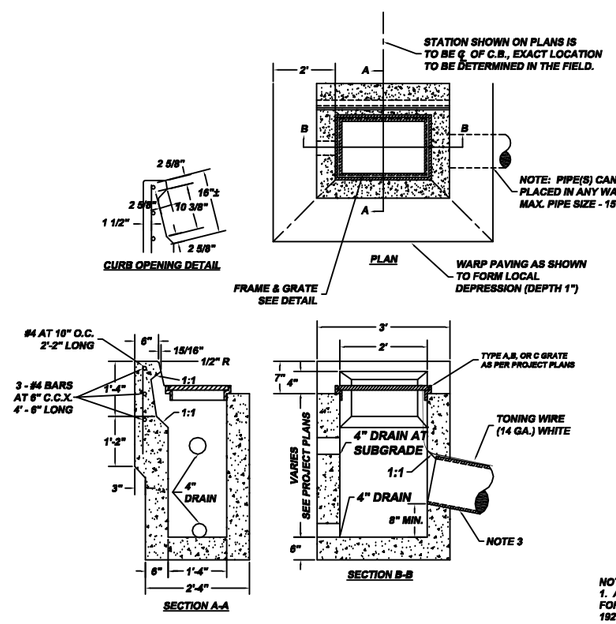


NOTES:
1. CATCH BASIN TO BE CONSTRUCTED IN ACCORDANCE WITH ASTM C-478
2. ALL CONCRETE SHALL BE CLASS 3000 PSI
3. SUBGRADE DRAINS SHALL BE 4" DIAMETER
4. BED CATCH BASIN IN MIN. OF 8" OF 3/4"-0 COMPACTED BASE MATERIAL

PRECAST CATCH BASIN:
5. MINIMUM WALL THICKNESS TO BE 5" REINFORCEMENT TO BE REBAR MEETING ASTM A615 GRADE 60 OR WELDED WIRE MEETING ASTM A497

TYPE CG-2 (CURB INLET) CATCH BASIN

8 / ST-1

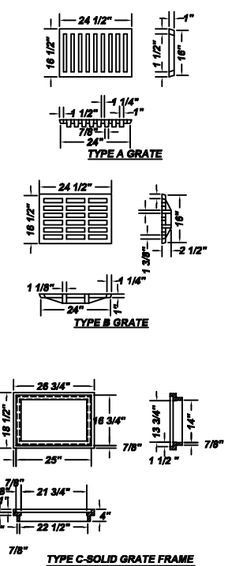


NOTES:
1. ALL CONCRETE SHALL BE CLASS 3000 PSI
2. SUBGRADE DRAINS SHALL BE 4"
3. FOR OUTLET PIPE SIZE, LOCATION, AND INVERT ELEVATION SEE PROJECT PLANS.

BASIN

TYPE 2 (CURB INLET) CATCH BASIN

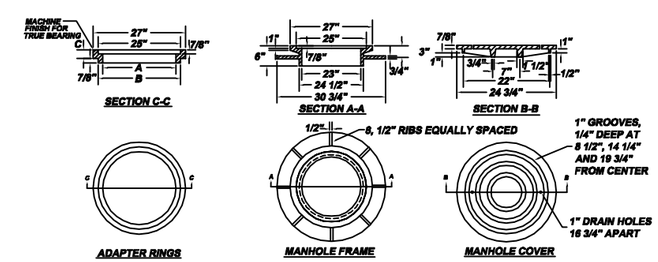
7 / ST-1



NOTES:
1. ALL CASTINGS SHALL CONFORM TO ASTM A-48 (AASHTO M 105) FOR GRAY IRON CASTINGS, CLASS 30, OR (AASHO M 192 x 70) FOR CAST STEEL
2. ROUNDS, FILLETS, TAPERS AND OTHER MINOR MODIFICATIONS TO THE DIMENSIONS SHOWN FOR CASTINGS MAY BE MADE TO CONFORM TO COMMON SHOP PRACTICES.

GRATES & FRAME

(CAST IRON OR CAST STEEL)



COVER & FRAME TO BE MACHINED FOR TRUE BEARING
MATERIAL: ASTM A-48 CASS 30 CAST IRON

STANDARD MANHOLE CASTING DETAILS

6 / ST-1

DATE	REVISIONS

CITY OF SILVERTON

STANDARD DETAILS FOR STORM SEWER CONST.

DATE	DRAWN BY	APPROVED BY	SHEET	PROJECT NO.
01/01/07	SRD	RJB	ST-1	
NOT TO SCALE	CHK'D BY GCF	FIELD BOOK		DRAWING NO.

Appendix F

opinion of probable cost master plan

KELLER associates

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CITY OF SILVERTON
Storm Water Master Plan
Capital Improvement Plan

Item #	Item Description	Opinion of Probable Cost*	Percent SDC Eligible	SDC Improvement Amount	City Amount
Priority 1 Improvements (by 2022)					
1	Utility and SDC Rate Study	$20,000	50%	$10,000	$10,000
1A	Olson's Ditch Improvements	$536,000	30%	$160,800	$375,200
1B	North Second Street and Mills Addition Improvements	$2,061,000	20%	$412,200	$1,648,800
1C	West Main, Welch, and Cherry Street Storm Water	$691,000	10%	$69,100	$621,900
1D	High Street to East Main Street Storm Water	$1,013,000	5%	$50,700	$962,300
1E	Jersey Street Storm Water	$453,000	5%	$22,700	$430,300
	Total Priority 1 Improvements	***$4,774,000***		**$725,500**	**$4,048,500**
	Priority 1 Annual Payment (20yr, 4%)	***$351,279***			***$297,896***
Priority 2 Improvements (2017 - 2027)					
2	Update Storm Water Master Plan	$150,000	50%	$75,000	$75,000
2A	Hwy 214 Detention Facility	$1,061,000	10%	$106,100	$954,900
2B	North James Street and Pine Street Storm Water	$238,000	0%	$0	$238,000
2C	Sheridan Street and Pine Street Storm Water	$288,000	10%	$28,800	$259,200
2D	Rock Street to South 3rd Street Connection	$218,000	10%	$21,800	$196,200
2E	McClaine Street Improvements	$236,000	5%	$11,800	$224,200
2F	Koons Street Improvements	$265,000	0%	$0	$265,000
2G	James Street Improvements	$185,000	5%	$9,300	$175,700
	Total Priority 2 Improvements	***$2,641,000***		**$252,800**	**$2,388,200**
	Priority 2 Annual Payment (20yr, 4%)	***$194,329***			***$175,728***
Priority 3 Improvements (2022 - 2032)					
3A	Oak Street Improvements	$197,000	35%	$69,000	$128,000
3B	Monson Road Improvements	$161,000	40%	$64,400	$96,600
3C	Grant Street Improvements	$128,000	10%	$12,800	$115,200
3D	West McClain Street Improvements	$94,000	0%	$0	$94,000
3E	Monitor Road Improvements	$61,000	55%	$33,600	$27,400
	Total Priority 3 Improvements	***$641,000***		**$179,800**	**$461,200**
	Priority 3 Annual Payment (20yr, 4%)	***$47,166***			***$33,936***
	TOTAL (rounded)	**$8,056,000**		**$1,158,100**	**$6,897,900**

* All costs in 2012 Dollars. Costs include engineering and contingencies.

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs atbased on historical costs provided by the City. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Unit Price Summary Table

ITEM	UNIT	UNIT PRICE
Concrete Detention Outlet Control Structure	EA	$6,000.00
Concrete Inlet Structure	EA	$3,000.00
Storm Water Manhole	EA	$3,750.00
Storm Water Quality Manhole (CDS or equal)	EA	$17,000.00
Catch Basin - Standard WQ Features	EA	$2,300.00
10" Pipe - Excavation and Backfill	LF	$55.00
12" Pipe - Excavation and Backfill	LF	$60.00
15" Pipe - Excavation and Backfill	LF	$65.00
18" Pipe - Excavation and Backfill	LF	$70.00
21" Pipe - Excavation and Backfill	LF	$105.00
24" Pipe - Excavation and Backfill	LF	$120.00
30" Pipe - Excavation and Backfill	LF	$160.00
36" Pipe - Excavation and Backfill	LF	$200.00
Control Density Backfill - additional cost	LF	$55.00
1/2 Lane Pavement Repair (5 ft. wide)	LF	$35.00
Full Lane Pavement Repair (8 ft. wide)	LF	$50.00
Curb and Gutter	LF	$20.00
Traffic Control	LF	$2.00
Utilities	LF	$6.00
Detention Pond Excavation	CY	$18.00
Open Channel Excavation	CY	$60.00
Landscaping	SF	$1.00
Abandon Existing Storm Lines	EA	$450
30" Directional Bore	LF	$700
Mobilization - % of Item Cost Sum	%	6%
Contingency - % of Construction Costs - Pipes	%	30%
Contingency - % of Construction Costs - Detention Sites	%	15%
Engineering, Legal, & CMS* - % of Construction Costs	%	20%

*CMS: Construction Management Services

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Silverton, Oregon
2012 Storm Water Master Plan: Capital Improvement Project Details

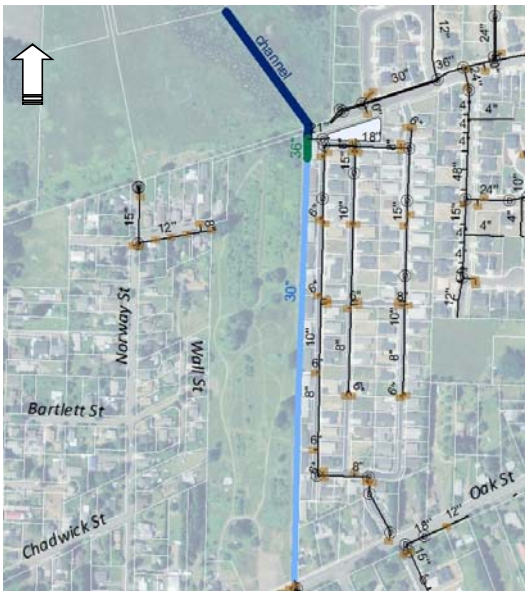
Storm Water Master Plan Project:
Olson's Ditch Improvements

Project Identifier:
1A (replacement)

Objective: Eliminate erosion in Olson's Ditch and mitigate flooding upstream and downstream of the Silver Cliff Estates detention pond by constructing a pipeline in place of the ditch and widening/deepening the downstream channel.

Key Issues: Install enery dissipater at pipeline discharge

Project Location: Olson's Ditch



General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
30" Pipe - Excavation and Backfill	LF	160	1,643	$ 262,957
36" Pipe - Excavation and Backfill	LF	200	81	$ 16,148
Open Channel Excavation	CY	60	237	$ 14,247
Storm Water Manhole	EA	3,750	5	$ 18,750
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Energy Dissipation	LS	4,000	1	$ 4,000
Landscaping	SF	1	3,448	$ 3,448
Subtotal				$ 336,550
Mobilization - % of Item Cost Sum	%	6%		$ 20,193
Total Construction Costs				$ 356,743
Contingency - % of Construction Costs - Pipes	%	30%		$ 107,023
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 71,349
Total Project Cost	$536,000			

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*CMS: Construction Management Services

Storm Water Master Plan Project:

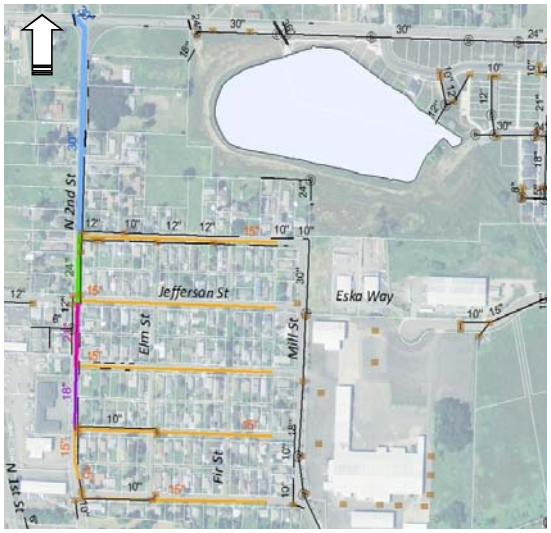
North Second Street and Mills Addition Improvements

Project Identifier:
1B (new lines)

Objective: Increase the conveyance capacity of the North Second Street and upstream conveyance system by upsizing sections of pipeline and constructing new storm pipeline in areas currently without a storm water collection system.

Key Issues: Pipeline in North Second Street may possibly be located outside of existing pavement. Curb and gutter, as well as some additional paving is necessary along some streets currently without curb.

Project Location: 2nd, Lincoln, Jefferson, Washington, Chester, and Whittier Streets



General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
15" Pipe - Excavation and Backfill	LF	65	5,344	$ 347,360
18" Pipe - Excavation and Backfill	LF	70	275	$ 19,254
21" Pipe - Excavation and Backfill	LF	105	308	$ 32,337
24" Pipe - Excavation and Backfill	LF	120	278	$ 33,311
30" Pipe - Excavation and Backfill	LF	160	1,046	$ 167,368
Storm Water Manhole	EA	3,750	19	$ 71,250
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Catch Basin - Standard WQ Features	EA	2,300	36	$ 82,800
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	5,619	$ 196,667
Full Lane Pavement Repair (8 ft. wide)	LF	50	1,632	$ 81,581
Curb and Gutter	LF	18	10,501	$ 189,024
Traffic Control	LF	2	7,251	$ 14,501
Utilities	LF	6	7,251	$ 43,504
Subtotal				$ 1,295,956
Mobilization - % of Item Cost Sum	%	6%		$ 77,757
Total Construction Costs				$ 1,373,713
Contingency - % of Construction Costs - Pipes	%	30%		$ 412,114
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 274,743
Total Project Cost	$2,061,000			

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Silverton, Oregon

2012 Storm Water Master Plan: Capital Improvement Project Details

Storm Water Master Plan Project:

West Main, Welch, and Cherry Street Storm Water

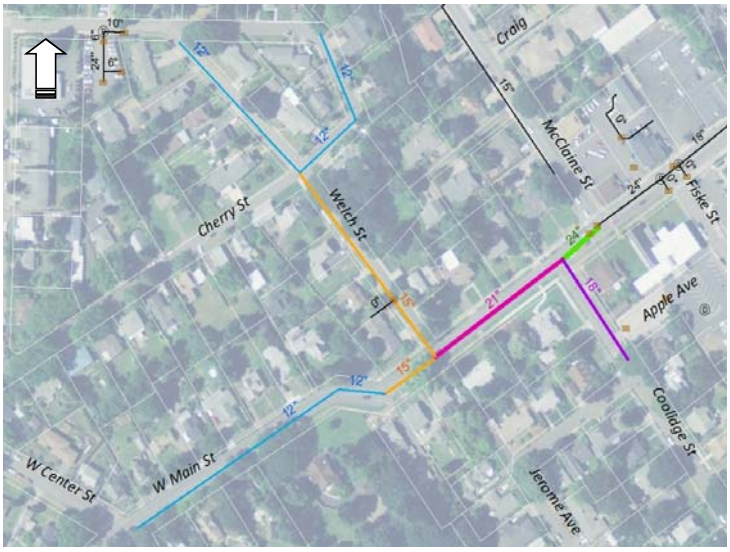
Project Identifier:

1C (new lines)

Objective: Construct new storm pipelines along West Main Street, Welch Street, and Cherry Street. This area currently does not have a storm water collection system.

Key Issues: Cherry Street east of Welch Street needs existing low curb replaced with curb and gutter.

Project Location: West Main, Welch, Cherry and Coolidge Streets



General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
12" Pipe - Excavation and Backfill	LF	60	1,273	$ 76,373
15" Pipe - Excavation and Backfill	LF	65	561	$ 36,477
18" Pipe - Excavation and Backfill	LF	70	271	$ 18,950
21" Pipe - Excavation and Backfill	LF	105	304	$ 31,940
24" Pipe - Excavation and Backfill	LF	120	99	$ 11,924
Storm Water Manhole	EA	3,750	13	$ 48,750
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Catch Basin - Standard WQ Features	EA	2,300	28	$ 64,400
Curb and Gutter	LF	20	720	$ 14,400
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	2,105	$ 73,668
Full Lane Pavement Repair (8 ft. wide)	LF	50	404	$ 20,178
Traffic Control	LF	2	2,508	$ 5,017
Utilities	LF	6	2,508	$ 15,050
Subtotal				$ 434,127
Mobilization - % of Item Cost Sum	%	6%		$ 26,048
Total Construction Costs				$ 460,175
Contingency - % of Construction Costs - Pipes	%	30%		$ 138,052
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 92,035
Total Project Cost	$691,000			

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Silverton, Oregon
2012 Storm Water Master Plan: Capital Improvement Project Details

Storm Water Master Plan Project:
High Street to East Main Street Storm Water

Project Identifier:
1D (new lines)

Objective: Construct new storm pipelines along either High Street or Park Street, N. 3rd Avenue, and East Main Street. This improvement will alleviate flooding along Mill Street by taking on some of the flow from Oak Street via a flow split in a manhole.

Key Issues: Manhole flow split at intersection of Oak Street and Mill Street. Curb and gutter, as well as some additional paving is needed along East Main Street and a portion of North 3rd Street. Existing pipe heading east from manhole at intersection of South 3rd Street and East Main Street should be plugged and abandoned. Easements will need to be obtained near new outfall to Silver Creek.

Project Location: High Street, North 3rd Street, and East Main Street

General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
12" Pipe - Excavation and Backfill	LF	60	781	$ 46,860
15" Pipe - Excavation and Backfill	LF	65	251	$ 16,322
24" Pipe - Excavation and Backfill	LF	120	386	$ 46,320
30" Pipe - Excavation and Backfill	LF	160	1,394	$ 223,040
Storm Water Manhole	EA	3,750	14	$ 52,500
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Catch Basin - Standard WQ Features	EA	2,300	28	$ 64,400
Curb and Gutter	LF	20	1,000	$ 20,000
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	1,032	$ 36,124
Full Lane Pavement Repair (8 ft. wide)	LF	50	1,780	$ 89,000
Traffic Control	LF	2	2,812	$ 5,624
Utilities	LF	6	2,812	$ 16,873
Abandon Existing Storm Lines	EA	450	6	$ 2,700
Subtotal				$ 636,762
Mobilization - % of Item Cost Sum	%	6%		$ 38,206
Total Construction Costs				$ 674,968
Contingency - % of Construction Costs - Pipes	%	30%		$ 202,490
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 134,994
Total Project Cost	$1,013,000			

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Storm Water Master Plan Project:
Jersey Street Storm Water

Project Identifier:
1E (new lines)

Objective: Construct a new storm pipeline along Jersey St that will intercept storm water that currently discharges into Silver Creek near the C St Bridge. The new pipeline will also alleviate flooding in Mill St and drain areas of downtown that currently do not have a storm water collection system.

Key Issues: Utilize existing outfall to Silver Creek. Last section of pipeline discharging into Silver Creek assumes steep slope. Existing pipeline between South 3rd Street and South 2nd Street along Jersey Street is to be abandoned. Pipelines flowing north on South 3rd Street should be plugged at the intersection of South 3rd Street and Jersey Street.

Project Location: Jersey Street

General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
30" Pipe - Excavation and Backfill	LF	160	1,003	$ 160,480
Storm Water Manhole	EA	3,750	6	$ 22,500
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Catch Basin - Standard WQ Features	EA	2,300	11	$ 25,300
Full Lane Pavement Repair (8 ft. wide)	LF	50	1,003	$ 50,150
Traffic Control	LF	2	940	$ 1,880
Utilities	LF	6	1,005	$ 6,030
Abandon Existing Storm Lines	EA	450	3	$ 1,350
Subtotal				$ 284,690
Mobilization - % of Item Cost Sum	%	6%		$ 17,081
Total Construction Costs				$ 301,771
Contingency - % of Construction Costs - Pipes	%	30%		$ 90,531
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 60,354
Total Project Cost	$453,000			

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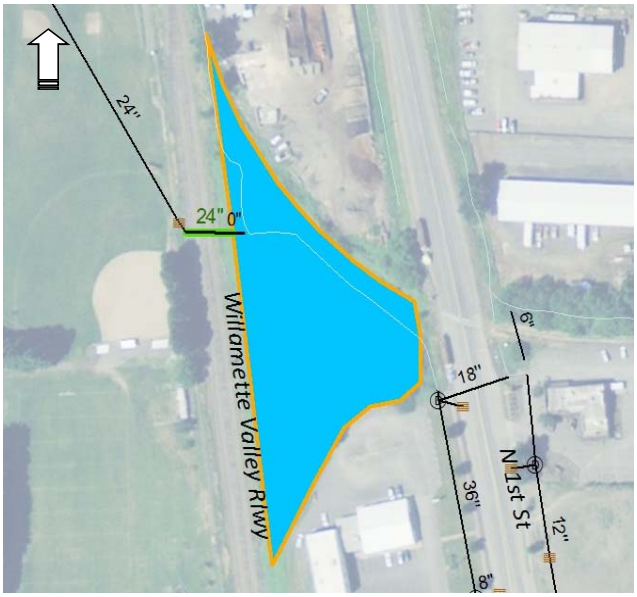
Storm Water Master Plan Project:
Hwy 214 Detention Facility

Project Identifier:
2A (replace culvert and new detention pond)

Objective: Construct a regional detention facility between Highway 214 and the Union Pacific railroad to alleviate downstream flooding. This detention facility should provide a minimum storage of 9.5 ac-ft and be designed to also provide water quality treatment. This 2.4 acre property is currently listed for sale at $600,000.

Potential Issues: A 30" bore for a new 24" pipeline will be required to cross the railroad tracks. This new 24" pipeline will take the place of the existing wooden culverts. The rim elevation for the manhole downstream of the new railroad crossing should be equal to or greater than the finish grade of the railroad. This required rim elevation will keep the manhole from surcharging higher than the rim elevation and flooding the area.

Project Location: Hwy 214



General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
Detention Pond Excavation	CY	18	13,000	$ 234,000
30" Directional Bore	LF	700	60	$ 42,000
Storm Water Manhole	EA	3,750	1	$ 3,750
Concrete Inlet Structure	EA	3,000	2	$ 6,000
Concrete Detention Outlet Control Structure	EA	6,000	1	$ 6,000
Wetland Landscaping	LS	30,000	1	$ 30,000
Subtotal				$ 321,750
Mobilization - % of Item Cost Sum	%	6%		$ 19,305
Total Construction Costs				$ 341,055
Contingency - % of Construction Costs - Detention Sites	%	15%		$ 51,158
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 68,211
Land Acquisition	LS	$ 600,000	1	$ 600,000
Total Project Cost	$1,061,000			

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Storm Water Master Plan Project:

North James Street and Pine Street Storm Water

Project Identifier:
2B (new lines)

Objective: Construct new storm pipelines along North James Street and Pine Street to drain standing storm water along Pine Street. This area currently does not have a storm water collection system.

Key Issues: Utilize existing outfall to Silver Creek.

Project Location: North James Street and Pine Street

General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
12" Pipe - Excavation and Backfill	LF	60	916	$ 54,979
Storm Water Manhole	EA	3,750	4	$ 15,000
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Catch Basin - Standard WQ Features	EA	2,300	10	$ 23,000
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	916	$ 32,060
Traffic Control	LF	2	916	$ 1,832
Utilities	LF	6	916	$ 5,496
Subtotal				$ 149,367
Mobilization - % of Item Cost Sum	%	6%		$ 8,962
Total Construction Costs				$ 158,329
Contingency - % of Construction Costs - Pipes	%	30%		$ 47,499
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 31,666
Total Project Cost	$238,000			

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Storm Water Master Plan Project:

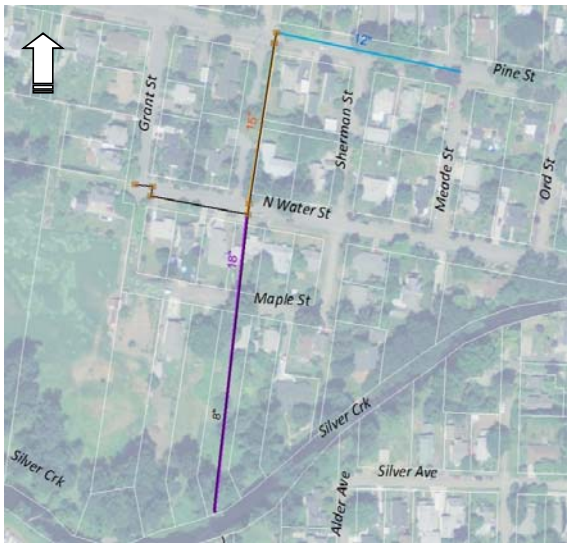
Sheridan Street and Pine Street Storm Water

Project Identifier:
2C (new lines)

Objective: Construct new storm pipelines along Pine Street and upsize an existing pipeline along Sheridan Street to drain standing storm water in Pine Street. This section of Pine Street currently does not have a storm water collection system.

Key Issues: Utilize existing outfall to Silver Creek.

Project Location: Sheridan Street and Pine Street



General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
12" Pipe - Excavation and Backfill	LF	60	384	$ 23,018
15" Pipe - Excavation and Backfill	LF	65	327	$ 21,255
18" Pipe - Excavation and Backfill	LF	70	555	$ 38,842
Storm Water Manhole	EA	3,750	4	$ 15,000
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Catch Basin - Standard WQ Features	EA	2,300	12	$ 27,600
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	861	$ 30,122
Traffic Control	LF	2	861	$ 1,721
Utilities	LF	6	861	$ 5,164
Landscaping	SF	3	405	$ 1,215
Subtotal				$ 180,937
Mobilization - % of Item Cost Sum	%	6%		$ 10,856
Total Construction Costs				$ 191,793
Contingency - % of Construction Costs - Pipes	%	30%		$ 57,538
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 38,359
Total Project Cost	$288,000			

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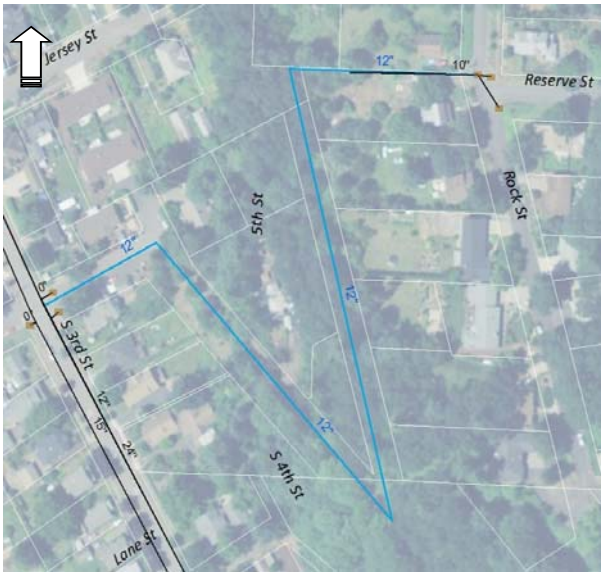
Storm Water Master Plan Project:
Rock Street to South 3rd Street Connection

Project Identifier:
2D (new lines)

Objective: Construct new storm pipeline from Rock Street down the hillside to South 3rd Street. This improvement will redirect concentrated storm water runoff currently discharging into residential backyards.

Key Issues: 4th Street and 5th Street are steep terrain and are currently unimproved right-of-way. Easements will need to be obtained.

Project Location: Drake Street, South 4th Street, 5th Street, and Rock Street



General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
12" Pipe - Excavation and Backfill	LF	60	1,570	$ 94,200
Storm Water Manhole	EA	3,750	5	$ 18,750
Catch Basin - Standard WQ Features	EA	2,300	6	$ 13,800
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	190	$ 6,650
Traffic Control	LF	2	190	$ 380
Utilities	LF	6	190	$ 1,140
Landscaping	SF	1	1,570	$ 1,570
Subtotal				$ 136,490
Mobilization - % of Item Cost Sum	%	6%		$ 8,189
Total Construction Costs				$ 144,679
Contingency - % of Construction Costs - Pipes	%	30%		$ 43,404
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 28,936
Total Project Cost	$218,000			

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Silverton, Oregon
2012 Storm Water Master Plan: Capital Improvement Project Details

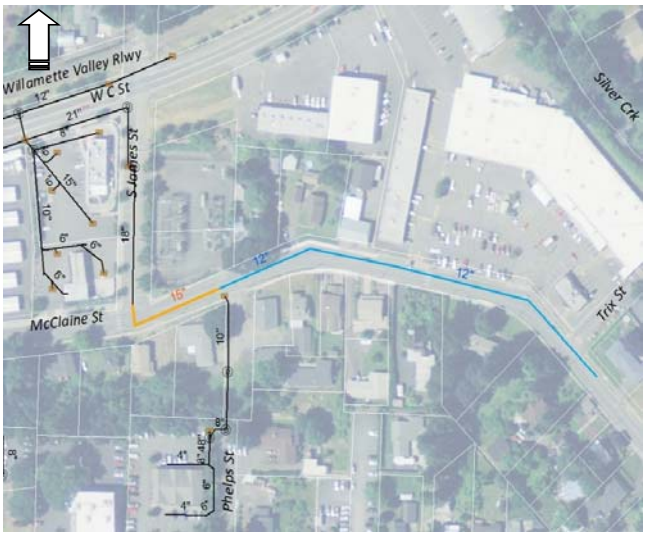
Storm Water Master Plan Project:
McClaine Street Improvements

Project Identifier:
2E (new lines)

Objective: Construct new storm pipelines along McClaine Street and connect to existing storm at South James Street. This area currently does not have a storm water collection system.

Key Issues: Connect existing pipeline from Phelps Street to new pipeline.

Project Location: McClaine Street



General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
12" Pipe - Excavation and Backfill	LF	60	747	$ 44,820
15" Pipe - Excavation and Backfill	LF	65	198	$ 12,870
Storm Water Manhole	EA	3,750	6	$ 22,500
Catch Basin - Standard WQ Features	EA	2,300	12	$ 27,600
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	945	$ 33,075
Traffic Control	LF	2	945	$ 1,890
Utilities	LF	6	945	$ 5,670
Subtotal				$ 148,425
Mobilization - % of Item Cost Sum	%	6%		$ 8,906
Total Construction Costs				$ 157,331
Contingency - % of Construction Costs - Pipes	%	30%		$ 47,199
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 31,466
Total Project Cost	$236,000			

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Silverton, Oregon
2012 Storm Water Master Plan: Capital Improvement Project Details

Storm Water Master Plan Project:
Koons Street Improvements

Project Identifier:
2F (replacement)

Objective: Increase the conveyance capacity in Koons Street by upsizing sections of pipeline. Curb and gutter, as well as some additional paving is necessary along this street.

Key Issues: Existing storm pipeline appears to be close to the edge of existing right-of-way line.

Project Location: Koons Street

General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
12" Pipe - Excavation and Backfill	LF	60	211	$ 12,680
18" Pipe - Excavation and Backfill	LF	70	734	$ 51,414
Storm Water Manhole	EA	3,750	3	$ 11,250
Catch Basin - Standard WQ Features	EA	2,300	10	$ 23,000
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	946	$ 33,104
Curb and Gutter	LF	20	1,360	$ 27,200
Traffic Control	LF	2	946	$ 1,892
Utilities	LF	6	946	$ 5,675
Subtotal				$ 166,214
Mobilization - % of Item Cost Sum	%	6%		$ 9,973
Total Construction Costs				$ 176,187
Contingency - % of Construction Costs - Pipes	%	30%		$ 52,856
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 35,237
Total Project Cost	$265,000			

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Storm Water Master Plan Project:
James Street Improvements

Project Identifier:
2G (replacement)

Objective: Increase the conveyance capacity in North James Street by upsizing sections of bottlenecked pipe and installing a parallel pipeline.

Key Issues: Location of parallel pipeline is close to edge of right-of-way line.

Project Location: North James Street

General Line Items	Unit	Unit Price	Estimated Quantity	2012 Cost
18" Pipe - Excavation and Backfill	LF	70	544	$ 38,080
24" Pipe - Excavation and Backfill	LF	120	180	$ 21,552
Storm Water Manhole	EA	3,750	1	$ 3,750
Catch Basin - Standard WQ Features	EA	2,300	2	$ 4,600
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	544	$ 19,040
Full Lane Pavement Repair (8 ft. wide)	LF	50	180	$ 8,980
Curb and Gutter	LF	20	724	$ 14,472
Traffic Control	LF	2	724	$ 1,447
Utilities	LF	6	724	$ 4,342
Subtotal				$ 116,263
Mobilization - % of Item Cost Sum	%	6%		$ 6,976
Total Construction Costs				$ 123,239
Contingency - % of Construction Costs - Pipes	%	30%		$ 36,972
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 24,648
Total Project Cost	$185,000			

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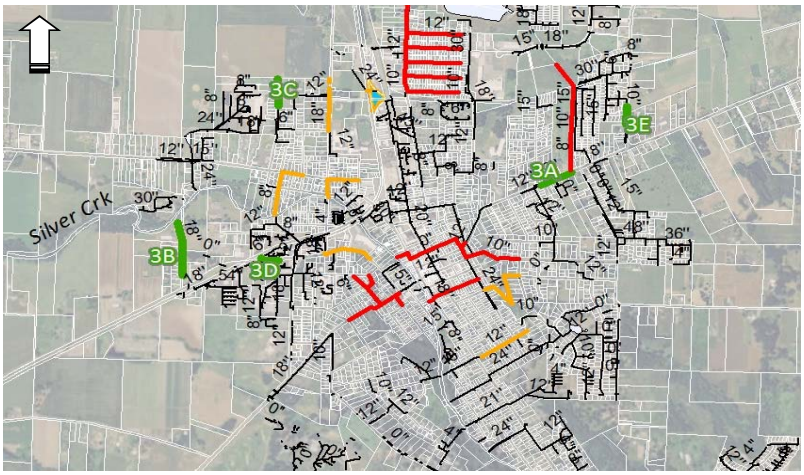
Silverton, Oregon
2012 Storm Water Master Plan: Capital Improvement Project Details

Storm Water Master Plan Project:
Priority 3 Improvements

Project Location: West Silver Creek, North Central and Webb Lake Basins



3A: Oak Street Improvements	Unit	Unit Price	Estimated Quantity	2012 Cost
24" Pipe - Excavation and Backfill	LF	120	606	$ 72,768
Storm Water Manhole	EA	3,750	3	$ 11,250
Catch Basin - Standard WQ Features	EA	2,300	2	$ 4,600
Full Lane Pavement Repair (8 ft. wide)	LF	50	606	$ 30,320
Traffic Control	LF	2	606	$ 1,213
Utilities	LF	6	606	$ 3,638
Subtotal				$ 123,789
Mobilization - % of Item Cost Sum	%	6%		$ 7,427
Total Construction Costs				$ 131,217
Contingency - % of Construction Costs - Pipes	%	30%		$ 39,365
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 26,243
Total Project Cost (rounded)				$ 197,000

3B: Monson Road Improvements	Unit	Unit Price	Estimated Quantity	2012 Cost
Open Channel Excavation	CY	60	40	$ 2,400
30" Pipe - Excavation and Backfill	LF	160	444	$ 71,114
Storm Water Quality Manhole (CDS or equal)	EA	17,000	1	$ 17,000
Full Lane Pavement Repair (8 ft. wide)	LF	50	150	$ 7,500
Traffic Control	LF	2	850	$ 1,700
Utilities	LF	6	150	$ 900
Landscaping	SF	1	300	$ 300
Subtotal				$ 100,914
Mobilization - % of Item Cost Sum	%	6%		$ 6,055
Total Construction Costs				$ 106,968
Contingency - % of Construction Costs - Pipes	%	30%		$ 32,091
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 21,394
Total Project Cost (rounded)				$ 161,000

Silverton, Oregon
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3C: Grant Street Improvements	Unit	Unit Price	Estimated Quantity	2012 Cost
15" Pipe - Excavation and Backfill	LF	65	545	$ 35,425
Storm Water Manhole	EA	3,750	2	$ 7,500
Catch Basin - Standard WQ Features	EA	2,300	6	$ 13,800
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	545	$ 19,075
Traffic Control	LF	2	545	$ 1,090
Utilities	LF	6	545	$ 3,270
Subtotal				$ 80,160
Mobilization - % of Item Cost Sum	%	6%		$ 4,810
Total Construction Costs				$ 84,970
Contingency - % of Construction Costs - Pipes	%	30%		$ 25,491
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 16,994
Total Project Cost (rounded)				$ 128,000
3D: West McClain Street Improvements	**Unit**	**Unit Price**	**Estimated Quantity**	**2012 Cost**
18" Pipe - Excavation and Backfill	LF	70	309	$ 21,610
Catch Basin - Standard WQ Features	EA	2,300	3	$ 6,900
1/2 Lane Pavement Repair (5 ft. wide)	LF	35	309	$ 10,805
Control Density Backfill - additional cost	LF	55	309	$ 16,980
Traffic Control	LF	2	309	$ 617
Utilities	LF	6	309	$ 1,852
Subtotal				$ 58,765
Mobilization - % of Item Cost Sum	%	6%		$ 3,526
Total Construction Costs				$ 62,291
Contingency - % of Construction Costs - Pipes	%	30%		$ 18,687
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 12,458
Total Project Cost (rounded)				$ 94,000
3E: Monitor Road Improvements	**Unit**	**Unit Price**	**Estimated Quantity**	**2012 Cost**
21" Pipe - Excavation and Backfill	LF	105	291	$ 30,555
Concrete Inlet Structure	EA	3,000	1	$ 3,000
Storm Water Manhole	EA	3,750	1	$ 3,750
Traffic Control	LF	2	291	$ 582
Landscaping	SF	1	291	$ 291
Subtotal				$ 38,178
Mobilization - % of Item Cost Sum	%	6%		$ 2,291
Total Construction Costs				$ 40,469
Contingency - % of Construction Costs - Pipes	%	30%		$ 12,141
Engineering, Legal, & CMS* - % of Construction Costs	%	20%		$ 8,094
Total Project Cost (rounded)				$ 61,000

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Appendix G

funding sources ▪ master plan

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Program Name	Overview	Potential Application to Silverton's Storm Water Master Plan
Access & Habitat Program, Oregon Department of Fish & Wildlife	To qualify for Access & Habitat funding, a project must improve wildlife habitat and/or increase public hunting access to private land. Access & Habitat activities are designed to be grassroots in nature and encourage cooperative working relationships.	This funding could be used for wetland protection or creation if it can be shown to improve wildlife habitat
Bonneville Environmental Foundation Watershed Program	The Bonneville Environmental Foundation's Watershed Program strives to support and build the community, scientific, and monitoring infrastructure that is essential to successful watershed restoration. BEF's Watershed Program seeks to restore natural watershed processes and functions in watersheds located in Oregon, Washington, Idaho, and Montana.	Can be used to fund water quality monitoring (for TMDL) and BMP implementation because it is part of the Willamette Basin Restoration
Clean Water State Revolving Fund Loan Program - Oregon	The Clean Water State Revolving Fund (CWSRF) Loan Program provides low-cost loans for the planning, design and construction of water pollution control facilities and activities. Oregon's DEQ is committed to working with Oregon communities to attain or maintain water quality standards, which are necessary to protect beneficial uses such as wildlife, farming, recreation and drinking water.	Can be used to fund non-pointsource pollution reduction strategies in the capital improvement plan.
Drinking Water Protection Loan Fund (DWPLF) - Oregon	The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water systems to finance infrastructure improvements. The program also emphasizes providing funds to small and disadvantaged communities and to programs that encourage pollution prevention as a tool for ensuring safe drinking water. Each federal fiscal year, US EPA makes funds (as grants) available to states.	This loan might be applicable to storm water activities that reduce pollutant loading to surface or ground water used for drinking water.
Flood Mitigation Assistance (FMA) Program	This program provides federal funding to assist States and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP).	Can be used for general capital improvement funding that mitigates flooding risks.
General Purpose Grants - M.J. Murdock Charitable Trust	The Trust's mission is to enrich the quality of life in the Pacific Northwest by providing grants to organizations that seek to strengthen the region's educational and cultural base in creative and sustainable ways.	Projects shown to enhance the quality of life, especially for youth
Jubitz Family Foundation Grant	AREAS OF INTEREST: Early childhood development and education, with an emphasis on children at-risk. Environmental stewardship, with an emphasis on rivers and their watershed ecosystems.	River and watershed ecosystem projects such as wetlands, erosion prevention, riparian management, etc.
Land and Water Conservation Fund - Oregon	Land and Water Conservation Fund grant funds may be used for the acquisition and development of state and local facilities that provide recreational opportunities. Recreation enhancement may be accomplished throughout the preservation of open space, forests, wildlife and natural resource areas.	Could be used for detention facilities that double as recreational facilities.
Lawrence Foundation, The	The Lawrence Foundation makes contributions and grants to organizations that are working to solve pressing educational, environmental, and health issues.	General applicability to storm water improvements funding
Nonpoint Source Implementation Grant (319) Program - Oregon	Section 319 of the 1987 Clean Water Act authorizes grants for implementation of nonpoint source pollution control programs and projects to help protect or improve water quality. The Department of Environmental Quality, the state agency authorized to carry out this program, offers funding to implement key elements of watershed protection through locally developed watershed projects.	Non-point source BMP funding

Source: Boise State University Environmental Finance Center http://efc.boisestate.edu/watershed/

Silverton, OR
Storm Water Master Plan
Potential Funding Sources

Program Name	Overview	Potential Application to Silverton's Storm Water Master Plan
Oregon Wildlife Heritage Foundation	The mission of the Oregon Wildlife Heritage Foundation is to initiate, organize, and support projects through public and private partnerships that benefit Oregon's Fish and Wildlife.	Projects shown to enhance fish and wildlife habitats
PGE Foundation	The Foundation's giving interests include art and humanities, civic and public affairs, education, the environment, health and social services. The Foundation seeks to preserve and enhance environmental quality throughout Oregon. We support a variety of groups working to keep Oregon clean and preserve its natural resources.	General applicability to storm water improvements funding
Plum Creek Foundation	The Plum Creek Foundation is the major channel of philanthropy for Plum Creek Timber Company, Inc. and its subsidiaries. The Plum Creek Foundation has been established to provide a philanthropic contribution program to support and improve the general welfare and quality of life in the communities we serve.	Applies to community development, parks and recration facilities, and public education.
RCAC - Technical Assistance, Training and Loan Fund	Technical assistance and training to build local management, financial and technical capacity. Areas include, but are not limited to: Financial management, project financing, hiring consultants, board training, strategic and comprehensive planning. RCAC also is a certified Community Devlopment Financial Institution (CDFI) by the U.S. Treasury. The RCAC loan fund can provide resources for planning, engineering, construction and bridge financing.	Can help with the financing of consultants for implementing proposed improvements
RCAC Loan Fund	The Rural Community Assistance Corporation (RCAC) Loan Fund is a valuable resource for rural communities. RCAC fills financing gaps and serves those traditionally neglected by conventional markets. As a certified Community Development Financial Institution (CDFI), RCAC's loan fund offers a comprehensive array of products for affordable housing development, environmental infrastructure and community facilities in rural communities.	Funding for rural communities
Safe Drinking Water Revolving Loan Fund (SDWRLF)- Oregon	The Safe Drinking Water Act, as amended in 1996, established the Drinking Water State Revolving Fund (DWSRF) to make funds available to drinking water systems to finance infrastructure improvements. The program also emphasizes providing funds to small and disadvantaged communities and to programs that encourage pollution prevention as a tool for ensuring safe drinking water. Each federal fiscal year, US EPA makes funds (as grants) available to states.	Applies to water quality devices
Special Public Works Fund, Oregon	The Special Public Works Fund program provides financial assistance to eligible public entities for the purpose of studying, designing and building public infrastructure.	Applies to infrastructure improvements
Water Development Loan Fund, Oregon Water Resources Department	Oregon Water Resources Department provides loans for water development and watershed enhancement projects. Funds to finance a water development project are obtained through the issuance and sale of self-liquidating bonds. The bonds are repaid by participants in the program and at no cost to the state or the Oregon taxpayer.	Applies to drainage systems that remove excess water to improve soil
Watershed Restoration Grant Program, OWEB	OWEB focuses on projects that approach natural resources management from a whole-watershed perspective. OWEB encourages projects that foster interagency cooperation, include other sources of funding, provide for local stakeholder involvement, include youth and volunteers and promote learning about watershed concepts.	Applies generally to the storm water master plan

Source: Boise State University Environmental Finance Center http://efc.boisestate.edu/watershed/