Section 5—SWM Capital Needs

Introduction

Section 5 of the City's Comprehensive Stormwater Management Plan presents the capital improvement project development methodologies, including information sources, stormwater hydrologic and hydraulic modeling results, and rating and ranking criteria for drainage concerns. This Section concludes with a Capital Improvement Program with project descriptions, costs and implementation priorities.

Section 5.1 provides the results of a City-wide hydraulic analysis conducted to identify stormwater pipes that are under capacity and will allow the City to set criteria for upstream future development.

Section 5.2 provides a summary of the process used to identify, evaluate, and select the proposed CIP projects and estimate costs, including a schematic diagram identifying the highlights of the CIP planning process.

Section 5.3 presents the recommended CIP Program, including project designs, project costs, and implementation priorities.

Little Bear Creek at 132nd Avenue NE

Introduction

The City requested that an analysis be performed of major portions of the City's stormwater conveyance system to assess current capacity. This information is needed by the City to determine if the system has adequate capacity for the additional runoff from new development and redevelopment. If additional capacity is not available, then the City would request that the developer perform a detailed downstream analysis to more accurately assess current capacity and/or size and locate additional detention/infiltration facilities on-site.

Brief History of Stormwater Conveyance Design Criteria

King County has been a leader in Stormwater Design Criteria. King County values its surface water features and believes they are a significant part of the natural beauty and rich heritage of the Puget Sound region. Since 1990, when King County published its first Surface Water Design Manual, the criteria have become more and more stringent for water quality treatment, flow control and conveyance. Below is a brief history of the evolution of conveyance design criteria in the manual starting with the 1998 KCSWDM.

In the 1998 KCSWDM, the following criteria applied to culverts larger than 18-inches:

- New culverts shall be designed with sufficient capacity to meet the headwater requirements in Section 4.3.1 and convey (at minimum) the 25-year peak flow, assuming developed conditions for onsite tributary areas and existing conditions for any offsite tributary areas.
- New culverts must also convey as much of the 100-year peak flow as is necessary to preclude creating or aggravating a severe flooding problem or severe erosion problem as described in Core Requirement #2, Section 1.2.2 (p. 1-36). Any overflow occurring onsite for runoff events up to and including the 100-year event must discharge at the natural location for the project site. In residential subdivisions, this overflow must be contained within an onsite drainage easement, tract, covenant, or public right-of-way.
- New culverts proposed in streams with salmonids shall be designed to provide for fish passage as detailed in Section 4.3.2. Note: The County's critical areas regulations (KCC 21A.24) or the state Department of Fish and Wildlife may require a bridge to facilitate fish passage.
- For culverts larger than 18-inch diameter, the maximum allowable design flow headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter or arch-culvert-rise at design flow (i.e., the 10-year or 25-year peak flow rate as specified in Core Requirement #4, Section 1.2.4).

The design criteria for conveyance systems and culverts did not change from the 1998 to the 2009 KCSWDM.

Table 5.1-1 Conveyance Design Criteria Summary	
King County Stormwater Design Criteria (2009 KCSWDM)	Consideration for Woodinville Stormwater Design Criteria
	Little Bear Creek Culverts:
• New culverts shall be designed with sufficient capacity to meet the headwater requirements in Section 4.3.1 and convey (at minimum) the 25-year peak flow, assuming developed conditions for onsite tributary areas and existing conditions for any offsite tributary areas.	• New culverts shall be designed with sufficient capacity to meet the headwater requirements in Section 4.3.1 and convey (at minimum) the 100-year peak flow, assuming developed conditions for onsite tributary areas and existing conditions for any offsite tributary areas.
• New culverts must also convey as much of the 100-year peak flow as is necessary to preclude creating or aggravating a severe flooding problem or severe erosion problem as described in Core Requirement #2, Section 1.2.2 (p. 1-36). Any overflow occurring onsite for runoff events up to and including the 100-year event must discharge at the natural location for the project site. In residential subdivisions, this overflow must be contained within an onsite drainage easement, tract, covenant, or public right-of-way.	• Same as King County Design Criteria
• New culverts proposed in streams with salmonids shall be designed to provide for fish passage as detailed in Section 4.3.2. Note: The County's critical areas regulations (KCC 21A.24) or the state Department of Fish and Wildlife may require a bridge to facilitate fish passage.	• Same as King County Design Criteria
• For culverts larger than 18-inch diameter, the maximum allowable design flow headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter or arch-culvert-rise at design flow. (i.e., the 10-year or 25-year peak flow rate as specified in Core Requirement #4, Section 1.2.4).	• For culverts larger than 18-inch diameter The maximum allowable design flow headwater elevation (measured from the inlet invert) shall not exceed 1 time the pipe diameter or arch-culvert-rise at the 100-year event flow. No backwater flow is allowed; the culvert must pass the entire 100-year event flow.

Table 5.1-1 Conveyance Design Criteria Summary	
• Bridges shall be design to convey flows and pass sediment debris for runoff events up to and including the 100-year event in a manner that does not increase the potential for flooding or erosion to properties and structures near or adjacent to the bridge, or cause bridge failure. The bridge and approach roads must pass the 100-year flow without creating hydraulic restrictions that cause or increase flooding.	**Woodinville Trestle:** • Bridges shall be design to convey flows and pass sediment debris for runoff events up to and including the 500-year event in a manner that does not increase the potential for flooding or erosion to properties and structures near or adjacent to the bridge, or cause bridge failure. The bridge and approach roads must pass the 500-year flow without creating hydraulic restrictions that cause or increase flooding.
• For culverts larger than 18-inch diameter, the maximum allowable design flow headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter or arch-culvert-rise at design flow. (i.e., the 10-year or 25-year peak flow rate as specified in Core Requirement #4, Section 1.2.4). • New pipe systems shall be designed with sufficient capacity to convey and contain (at minimum) the 25-year peak flow, assuming developed conditions for onsite tributary areas and existing conditions for any offsite tributary areas. • Pipe system structures may overtop for runoff events that exceed the 25-year design capacity, provided the overflow from a 100-year runoff event does not create or aggravate a severe flooding problem or severe erosion problem as described in Core Requirement #2, Section 1.2.2 (p. 1-36). Any overflow occurring onsite for runoff events up to and including the 100-year event must discharge at the natural location for the project site. In residential subdivisions, this overflow must be contained within an onsite drainage easement, tract, covenant, or public right-of-way.	**Lower Woodin Creek Conveyance and Culverts**: • For culverts larger than 18-inch diameter the maximum allowable design flow headwater elevation (measured from the inlet invert) shall not exceed 1 time the pipe diameter or arch-culvert-rise at the 100-year event flow. No backwater flow is allowed; the culvert must pass the entire 100-year event flow. • New pipe systems shall be designed with sufficient capacity to convey and contain (at minimum) the 100-year peak flow, assuming developed conditions for onsite tributary areas and existing conditions for any offsite tributary areas. • Pipe system structures may overtop for runoff events that exceed the 100-year design capacity, provided the overflow from a 100-year runoff event does not create or aggravate a severe flooding problem or severe erosion problem as described in Core Requirement #2, Section 1.2.2 (p. 1-36). Any overflow occurring onsite for runoff events up to and including the 100-year event must discharge at the natural location for the project site. In residential subdivisions, this overflow must be contained within an onsite drainage easement, tract, covenant, or public right-of-way.

City-Wide Hydraulic Analysis

A city-wide hydraulic analysis has been conducted for the City of Woodinville. The analysis will help the City identify stormwater pipes that are potentially undersized, to identify existing capacity deficiencies in the existing stormwater system and allow the City to set criteria for upstream future development. The hydrologic and hydraulic modeling methodology, supporting calculations, and detailed modeling results are included in the Citywide Hydraulic Analysis Technical Memorandum included in Appendix B.

Hydrologic Analysis

The peak discharge from the various subbasins tributary to the City's storm drainage system was analyzed using the Santa Barbara Urban Hydrograph (SBUH) methodology. The SBUH method was selected for the hydrologic model because it is widely used; it is an accepted method for conveyance sizing in the 2009 KCSWDM, which is the City's standard for stormwater management; and it does not require a specialized computer program for updates. SBUH is a single event hydrologic model that computes peak discharge based on 24-hour storm events. The SBUH method produces a runoff hydrograph that predicts the total flow over a period of time, or a rainfall event.

Input for the SBUH method is based on the following:

- Precipitation
- Drainage Basin Area
- Curve Number
- Time of Concentration

Precipitation

Precipitation maps for Washington State were updated for Ecology and WSDOT by MGS Engineering Consultants and Oregon Climate Service in January 2006. Table 5.1-2 presents the minimum, maximum, and average 24-hour precipitation depths throughout the City of Woodinville. Average precipitation depths were used for the city-wide hydraulic analysis.

Table 5.1-2
24-Hour Precipitation Depths

Recurrence Interval	24-hr Precipitation Depths within the City Limits of Woodinville (in)		
	Minimum	Maximum	Average
6-month	1.41	1.56	1.5
2-year	2.0	2.2	2.1
10- year	2.7	2.9	2.8
25- year	3.2	3.4	3.3
100- year	3.9	4.1	4.0

Drainage Basin Delineation

The City of Woodinville had divided the city into seven major basins including: Little Bear Creek, Sammamish River, Juanita Creek, Woodin Creek, Lake Leota, and School Creek Basins. Based on the areas of interest to this city-wide hydraulic analysis, three of these basins were spilt (Little Bear into East and West; Sammamish River into North, West, and East; and School into North and South). These major basins were then subdivided into a total of 99 subbasins to calculate peak flows at critical points of interest.

Subbasin delineation was completed by use of aerial photos, the City's topographic map, King County LIDAR data, the City's stormwater pipe and open channel GIS mapping, and field reconnaissance at locations of apparent mapping conflicts. Data collected during site visits was updated into the City's stormwater GIS database.

In areas without complete storm drainage mapping (i.e., outside the City limits), basin boundaries were delineated using only available topographic information. The GIS drainage data available for areas outside of the City limits was not used because it was not consistent with field observations. The basin boundaries may change if new information about the underground storm drainage system is acquired.

Curve Number

The curve number method was developed by the Soil Conservation Service (SCS) for predicting runoff from a drainage basin based on land use and cover the underlying soil and its hydrologic condition, and antecedent moisture condition. In general, the higher the curve number the higher the runoff from the basin will be. Table 5.1-3 shows the curve number based on land cover and soil type used in this analysis.

Composite curve numbers were estimated for each subbasin according to a combination of land cover and hydrologic soil group.

Table 5.1-3
Curve Numbers

Hydrologic Soil Group	Impervious CN	Forest CN	Grass CN	Bare ground CN	1990 Develop-ment	1998 Develop-ment
A	98	30	49	72	60	60
B	98	55	69	82	65	60
C	98	70	79	87	70	60
D	98	77	84	89	80	60

Land Use

Land cover was indirectly estimated by use of present land use data for existing conditions and zoning data for future conditions. For existing conditions, the present land use data was obtained from three separate sources:

- City of Woodinville Transportation Analysis Zones data (2009)
- King County Tax Assessor Data by Aerial Express (May 2006)
- Snohomish Tax Assessor Data by Aerial Express (May 2006)

For future conditions, zoning data was obtained from three separate sources:

- City of Woodinville Zoning (September 9, 2009)
- King County Tax Assessor Data by Aerial Express (May 2006)
- Snohomish Tax Assessor Data by Aerial Express (May 2006)

The land uses for both present and future scenarios were consolidated into 13 categories including:

- Open space
- Agriculture
- Park/recreation
- Public institution
- Greenhouse
- Single family residential (SFR) rural (parcel size >2 acres)
- SFR low (parcel size 0.5 to 2 acres)
- SFR med (parcel size 7,500 square feet to 0.5 acres)
- SFR high (parcel size <7,500 square feet)
- Multi-family
- Commercial
- Industrial
- Right-of-way

After these consolidated land uses were assigned, they were mapped and compared to the 2007 aerial photography. The land uses initially assigned to several locations were modified to reflect the land uses visible in the aerial photograph.

The land uses assigned to some areas within the City were adjusted to account for the runoff control facilities within those areas. The city-wide hydraulic analysis did not attempt to model individual retention and detention facilities, because the City did not consider the effort required to obtain data on each of these facilities and the effort to model each of these facilities compatible with the objectives of the city-wide analysis. A technical memorandum by Otak dated November 12, 2009 provided a method for approximating the attenuation effects of detention ponds associated with newer developments. It showed that curve numbers can be adjusted to near pre-developed values in order to cost effectively estimate detention. For this city-wide hydraulic analysis, land use was adjusted based upon the date of development. New developments between 1990 and 1998 and new development after 1998

were considered separately because of the drainage standards in effect during those periods, and land uses assigned to these areas were adjusted accordingly. These newer developments were identified using aerial photographs including:

- 1990 USGS Orthoquad Imagery
- 2007 City of Woodinville aerial photograph
- 2005 images from Aerial Express for drainage basins outside the City of Woodinville

Future land use was not further analyzed for peak discharge or pipe capacity. It is assumed that any future development will provide the detention required to maintain existing discharge conditions from the developed site and not result in significant changes in peak discharge downstream.

Time of Concentration

The time of concentration (Tc) is defined as the time required for a drop of water to travel the furthest distance in the subcatchment to the point of collection. The Tc is based on ground slope, ground roughness, and distance of flow. In general, the longer the flow path, the higher the Tc, the lower the flow rate.

Time of concentration was estimated for each subbasin using drainage basin lengths measured in GIS. The time of concentration assumes an initial 30 minutes for sheet flow followed by concentrated flow at a velocity of 2.5 feet per second for the distance of the measured basin length.

Hydraulic Analysis

The hydraulic analysis conducts a comparison between the estimated pipe capacity and the calculated peak discharge for the 25-year and 100-year, 24 hour storm events at approximately 300 pipe locations within the City's drainage system. The analysis provides an overview of the existing stormwater infrastructure at significant locations, but does not include a detailed analysis of pipe connectivity or backwater effects.

The city-wide hydraulic analysis shows that approximately 75% of the analyzed pipes have sufficient capacity for the 24-hour, 25-year rainfall event and 63% of the City's pipes have enough capacity for the 24-hour, 100-year rainfall event. The areas of insufficient capacity are located throughout the City. Some of the more significant problem areas are within the Woodin Creek basin and in areas upstream of Lake Leota. Figures 5-11 in Appendix B show the areas where existing pipes are under capacity.

The city-wide hydraulic analysis was conducted to identify where the existing stormwater system is currently under capacity and to allow the City of Woodinville to set criteria for upstream future development. The impact of changes upstream may have a significant impact on the City of Woodinville. The impact may be larger than what is currently being anticipated. The City's current stormwater infrastructure is designed to handle a 25-year storm event for the existing conditions at the time of construction. The system is not

designed to convey larger than the 25-year event or additional flow in the system as a result of urbanization.

The major capacity problem locations identified in the city-wide hydraulic analysis (defined as 150% or more over capacity during the 25-year event) are listed in Table 5.1-4 and shown on the "City-Wide Hydraulic" Map in Appendix B.

Table 5.1-4 Capacity Problem Locations		
Location	Size/Capacity	Pipe ID
Little Bear Creek Basin		
Basin Little Bear Creek East (LBE)		
LBE05	12 inch pipe at 198% capacity	IO1843IO2640
Basin LBE11+	Two 18 inch pipes at 291% capacity	CB3142IO1089 IO1090CB3142
Basin LBE15+	18 inch pipe at 335% capacity	IO1097IO1096
Basin LBE17+	12 inch pipe at 510% capacity	CB20316CB2028
Basin LBE17+	18 inch pipe at 183% capacity	CB21110IO1151
Basin LBE18	12 inch pipe at 213% capacity	CB3253CB21115
Basin LBE40+	Two 18 inch pipes at 263% capacity	CB3181IO1122 CB3180CB3181
Basin Little Bear Creek West (LBW)		
Basin LBW 40+	12 inch pipe at 242% capacity	CB3016IO1003
Basin LBW45	12 inch pipe at 156% capacity	CB20748IO2724
Basin LBW65	12 inch pipe at 726% capacity	CB2610IO1646
Basin LBW65	18 inch pipe at 250% capacity	CB20331CB2076
Lake Leota Basin (LL)		
Basin LL10+	Two 24 inch pipes at 150% capacity	CB20919CB20899 CB20900CB20919
Basin LL30+	24 inch pipe at 169% capacity	IO2151CB21147
Basin LL40+	Two 24 inch pipes at 158% capacity	CB20763IO2667 IO1837CB20763
Basin LL60	Two 12 inch pipes at 361% capacity	CB2990IO2924 CB2990IO2924
Basin LL70	12 inch pipe at 191% capacity	IO2429IO2925
School Creek Basin (SS)		
School Creek South Basin SS 10+	18 inch pipe at 323% capacity	IO2115CB0822
Woodin Creek Basin (WC)		
Basin WC 13.5	Three 12 inch pipes at 166% capacity	CB0546CB0547 CB0545CB0546 CB0544CB0545
Basin WC15+	Three 18 inch pipes at 163% capacity	CB3239CB21097 CB21098CB3239 CB21099CB21098
Basin WC15+	12 inch pipe at 474% capacity	IO1135CB21099

Table 5.1-4 Capacity Problem Locations		
Location	Size/Capacity	Pipe ID
Basin WC16+	12 inch pipe at 191% capacity	CB20792IO2788
Basin WC18+	18 inch pipe at 180% capacity	CB1853CB3236
Sammamish River Basin (SRW)		
Basin SRW 10+	Three 12 inch pipes at 150% capacity	CB1489CB1499 CB1488CB1489 CB20115CB1465
Basin SRW13+	12 inch pipe at 242% capacity	IO1385IO1662
Basin SRW14+	12 inch pipe at 182% capacity	CB20631IO1475

Little Bear Creek Culvert Analysis

Following significant flooding in December 2007, the City conducted a separate hydrologic and hydraulic analysis of the culverts along Little Bear Creek. The results of that study are documented in a separate technical memorandum (Otak, July 11, 2008; included in Appendix B). The analysis shows that nearly all the Little Bear Creek culverts are undersized to carry the projected flows from a major storm event. Of the five culverts analyzed, including those at NE 205th Street, NE 195th Street, SR-522, 134th Avenue NE, and SR-202, all were near or exceeded their design capacity. The three at NE 195th Street, SR-522, and SR-202 each exceeded their design capacities during the December 3, 2007 storm/runoff event by 167%, 158%, and 132%, respectively. Table 5.1-5 show a comparison between the statistical peak discharge to culvert capacity, as presented in the findings of the technical memorandum (Otak, July 11, 2008; included in Appendix B).

Table 5.1-5 Comparison of Statistical Peak Discharges to Culvert Capacity						
	25-yr			100-yr		
Location	Statistical Peak Discharge (cfs)	Design Capacity (cfs)	Percent of Design Capacity	Statistical Peak Discharge (cfs)	Design Capacity (cfs)	Percent of Design Capacity
NE 205th Street	486	520	93%	658	830	79%
NE 195th Street	525	420	**125%**	710	460	**154%**
SR-522	540	460	**117%**	732	500	**146%**
134th Avenue NE	548	510	**107%**	742	820	90%
SR-202	559	520	**108%**	756	620	**122%**

The results of both of these culvert analyses have been included in Appendix B.

Recommendations

The results of both of these culvert studies suggest that some areas of the City's existing drainage system may have capacity to accommodate some increased flows from new development. However, it would be prudent for all major future development/redevelopment projects within the City to conduct a detailed downstream analysis to ensure that drainage facilities are adequately sized onsite and that there are no significant downstream impacts to the City's existing drainage system.

The city-wide hydraulic analysis identifies where the existing stormwater system is under capacity and allows the City of Woodinville to set criteria for upstream future development. The impact of changes upstream may have a significant impact on the City of Woodinville. The impact may be larger than what is currently being anticipated.

CIP Development Process

A major component in the development of this CSWM Plan is the compilation of an updated SWM Capital Improvement Program projects list. The CIP Plan will include projects to address localized flooding, while also addressing infrastructure capacity and habitat concerns.

This Section describes the methodologies used to develop the updated list of SWM Capital Improvement Projects, including collection and mapping of drainage problem areas, conducting citywide hydrologic and hydraulic modeling to assess capacity, rating and ranking of problem areas, and selection of top ranked drainage problem areas. Based on this rating/ranking process, capital projects were developed to address the highest ranked priority problem areas.

The CIP planning process used to update the City's CSWM Plan is shown in the CIP Development Process Flow Chart, Figure 5.2-1 below. It consists of the following four steps:

- Step 1: Locating, documenting and mapping drainage problems areas.
- Step 2: Rating and ranking problems areas and setting priorities for new projects.
- Step 3: Analyzing drainage concerns and evaluating feasibility of potential CIP approaches and designs.
- Step 4: Selecting priority problems and identifying designs and costs for recommended CIP projects.

Following this process, this Section concludes with the selection and development of ten CIP projects that address the City's top ranked drainage problems. Resulting CIP project priorities, their costs and the City's overall CIP Plan funding needs are presented in Section 5.3. The grouping of these prioritized capital projects and their associated costs into a master list, creates the updated SWM CIP Plan for the City, and identifies the funding needed for the City's future SWM Capital Improvement Program.

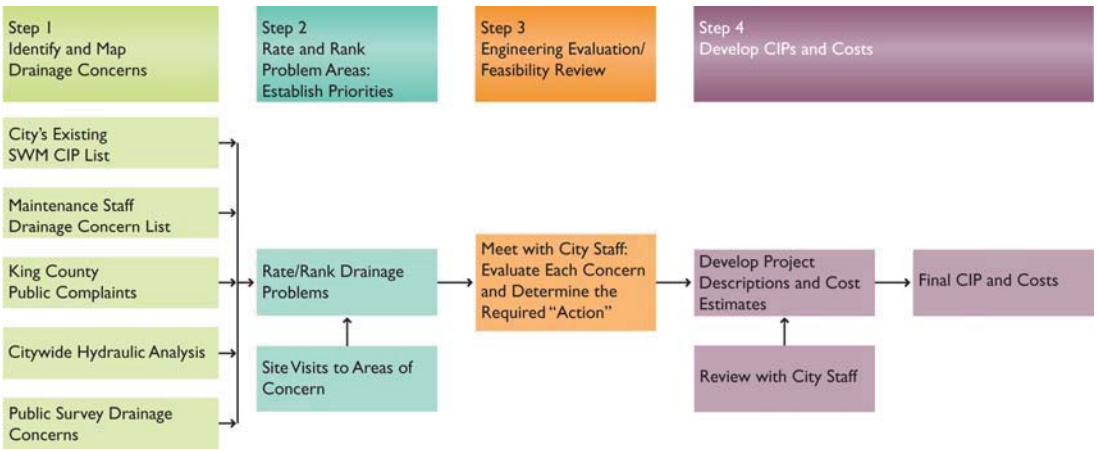


Figure 5.2-1 CIP Development Process Flow Chart

Step 1: Problem Identification and Mapping

Problem Identification

The first step in developing the CIP projects was to identify existing drainage concerns and problem areas throughout the City. Data was collected from the five different sources listed below. Table 5.2-1 provides a summary of the number of drainage problem areas identified from each of the five sources of drainage information. Identified drainage concerns ranged from minor flooding problems due to clogged structures to more serious capacity issues involving sedimentation and/or culvert and stream channel capacity. Descriptions of each of the drainage concerns and problem areas are summarized in Appendix C.

Table 5.2-1
Number of Drainage Problem Reports by Source

Source of Drainage Problem Reports	Number of Problems
Woodinville Public Survey	34
King County Complaints (2001-2008)	11
City Staff	25
Citywide Hydraulic Analysis	24
City's Previous Stormwater CIP List	10
Total	**104**

The drainage complaints are located in numerous drainage basins throughout the City. Table 5.2-2 provides a summary of where drainage complaints are located throughout the City by basin.

Table 5.2-2
Number of Reported Drainage Problems by Basin

Basin Name	Total Number of Drainage Problems
Cottage Lake Basin	2
Juanita Creek Basin	5
Little Bear Creek Basin	4
Little Bear Creek East Basin	12
Little Bear Creek West Basin	7
Lake Leota Basin	7
Sammamish River Basin	5

Table 5.2-2 Number of Reported Drainage Problems by Basin	
Basin Name	Total Number of Drainage Problems
Sammamish River East Basin	3
Sammamish River North Basin	2
Sammamish River West Basin	15
School Creek Basin	2
Woodin Creek Basin	6
Total	**70**

From December 2007 to June 2010 the City had a total of 31 reported drainage complaints, 27 of which have been addressed and closed. The City staff is timely and responsive to addressing drainage complaints. Appendix C provides more information about the nature of the complaints and the response time.

Sources of Drainage Information

The approach used to identify the City's current drainage problems was to collect drainage complaint and problem area information from the five sources listed below. The identified drainage problems were then reviewed, organized and located on a drainage base map for further engineering assessment.

- **Woodinville Public Survey** – In the summer of 2009, the City mailed a survey to all Woodinville residents and businesses asking for information regarding observed stormwater problems. Citizens were asked to provide the location of the problem, a brief description of the problem, frequency of the problem, impacts and damages, and general public safety concerns. The 34 returned surveys identified a number of localized drainage problems that included several clogged and/or blocked pipes, and several water quality concerns. Each of the reported public survey concerns were considered for a CIP project during the project evaluation and rating/ranking processes.
- **King County Complaints** – King County operates a drainage complaint hotline and documents calls based on mapped locations. The County provided a list of all complaints reported within the City boundaries for this study. The resulting eleven drainage complaints, reported between 2001 and 2008, were included on the map of the City's problem areas.
- **City Staff** – City of Woodinville Public Works staff compiled a list of an additional 25 known drainage problems and areas requiring frequent maintenance.
- **Citywide Hydraulic Analysis** – At the request of the City, a hydraulic analysis was conducted of the City's existing drainage system. Results confirmed that some pipes were undersized. When the results of the conveyance capacity analysis showed that the

modeled 25-year flow exceeded the calculated pipe capacity by 50% or more, the pipe location was added to the problem area list. Using this criteria, 24 pipes were determined to be under capacity and were added to the list of drainage problems.

Total Reported Drainage Problem Areas

In total, compiling and reviewing the drainage complaints from the five sources, resulted in the identification of 104 drainage problems areas located in various areas throughout the City. The identified problem areas are summarized in the evaluation matrix presented in Appendix C.

Mapping of Problem Areas

As part of this initial step to located, list and evaluate drainage problem areas, a GIS database was established from the compiled list of drainage concerns and a map of the drainage problem areas was created. Figure 5.2-2 shows the location of the identified drainage concerns and problem areas. Color coded symbols indicate the source of the drainage problem information.

Step 2: Evaluation of Problem Areas/Drainage Concerns

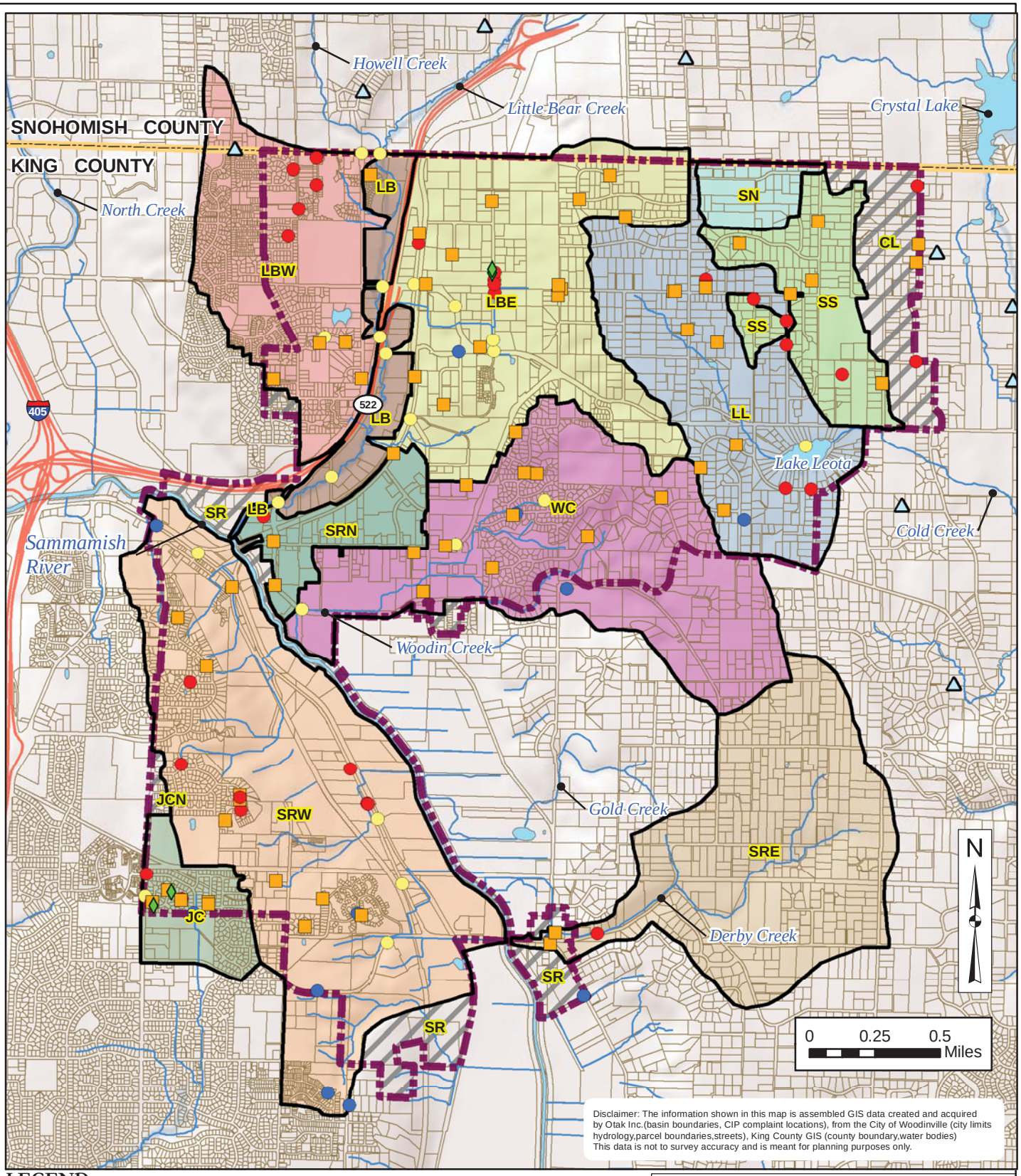
Rating/Ranking Approach and Methodology

After compiling the drainage concerns into a database, developing the location map, and completing the site reconnaissance, each drainage problem area/concern was evaluated for severity using a weighted scoring system.

The rating/ranking process consisted of the application of 12 criteria, grouped according to the three major concerns of the City: flood reduction hazard, community considerations, and environmental impacts, as shown on page 1 of Appendix C. Each of the 12 criteria was weighted according to the City local priorities and concerns.

The ranting/ranking criteria consisted of the following 12 criteria. The relative weighting factors are shown in parenthesis. Each criterion was given a score of 0 to 5, with a total possible weighted score of 115 points.

- *Flood Reduction (60 points)*
    - Flood location (weight of 3)
    - Flood source (weight of 3)
    - Flood frequency (weight of 3)
    - Flood magnitude (weight of 3)



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LEGEND

CITY OF WOODINVILLE PUBLIC SURVEY COMPLAINTS

- City Response Completed
- Mainteneance Needed
- Outside City Limits
- Potential Project Needed
- King County Drainage Complaints(2001 to 2008)
- City of Woodinville Public Works Complaints
- LL Basin Boundary in Hydraulic Analysis
- Area Not Draining to City's Storm System
- City Limits
- County Boundary
- Parcel Boundary
- Streams

STORMWATER MANAGEMENT PLAN

FIGURE 5.2-1

DRAINAGE COMPLAINTS LOCATION MAP

CITY OF WOODINVILLE

OCTOBER 2010

- *Community Priorities/Concerns (35 points)*
  - Aesthetics(weight of 1)
  - Economic impact (weight of 2)
  - Complaint history (weight of 2)
  - City responsibility (weight of 2)
- *Environmental Considerations (20 points)*
  - Stream bank erosion(weight of 1)
  - Hillside erosion (weight of 1)
  - Water quality (weight of 1)
  - Habitat (weight of 1)
- *Total Possible Points (115)*

An example of scoring a drainage complaint is provided in Table 5.2-3 for problem PCIP1.

Table 5.2-3
Ranking Criteria for CIP Projects

Criteria Number	General	Specific	Score Range	Weight	Score	Weighted Score
1	Flood Hazard Reduction	Flood Location	0 = no impact, 3 = impacts private property 5 = impacts publics streets in terms of traffic, infrastructure and public safety.	3	3	9
2		Flood Source	0 = no flooding. 3 = Private Water 5 = Public Water	3	5	15
3		Flood Frequency	0 = 100 -yr storm, 3 = 25-yr storm, 5 = 6-month storm.	3	3	9
4		Stream Bank Erosion	1 = flood condition lasts less than 8 hours, 3 = flood condition lasts more than 8 hours, 5 = flood condition lasts more than 24 hours.	3	3	9

Table 5.2-3 Ranking Criteria for CIP Projects						
Criteria Number	General	Specific	Score Range	Weight	Score	Weighted Score
5	Environmental	Stream Bank Erosion	0 = No stream bank erosion, 3 = visible stream bank erosion in stream 5 = downstream deposition causing aggraded streambed.	1	3	3
6		Hillside Erosion	0 = No hillside erosion, 3 = visible hillside erosion, 5 = hillside erosion with impacts to stream channel.	1	3	3
7		Water Quality	0 = No water quality concerns, 3 = minor water quality concerns, 5 = measurable water quality concerns.	1	0	0
8		Habitat	0 = No habitat impact, 3 = Impact of habits of 1 to 2 species, 5 = Impacts of 3 or more species.	1	3	3
9	Community Considerations	Aesthetics	0 = No aesthetic impacts (appearance or smell), 3 = occasional aesthetic impacts (appearance or smell), 5 = constant aesthetic impacts (appearance or smell)	1	3	3

Table 5.2-3 Ranking Criteria for CIP Projects						
Criteria Number	General	Specific	Score Range	Weight	Score	Weighted Score
10		Economic Impact	0 = No economic impacts, 3 = Minor economic impacts to public or private property, 5 = High economic impacts, such as commercial and high use areas.	2	3	6
11		Complaint History	0 = No previous citizen complaints, 3 = 1 or 2 other citizen complaints, 5 = more than 3 citizen complaints.	2	5	10
12		City Responsibility	0 = No public perception this is a problem. 3 = Public Perception of the problem, 5 = Public perception of the problem and covered by legal responsibilities	2	5	10
Total						**80**

Based on direction from the City, problem areas were assigned a relative cost category. Projects of low cost that could be built for less than $250K, projects of medium cost that could be built for $250K-$1M, and projects of high cost that would require more than $1M for design and construction. Results of applying these initial cost estimates to each of the identified problem areas are presented in Appendix C.

Although the relative costs of potential solutions were estimated, project cost was not used in the ranking and rating of the problem areas. Also not included in the rating/ranking process was any consideration of project opportunities resulting from coordination with other projects, efficiencies of sequencing and timing, common funding opportunities or any economies of scale in doing a number of similar projects concurrently.

Results of Rating/Ranking Process

The results of the rating/ranking process are presented in Appendix C, where the 104 drainage problems have been grouped by source/origin of the problem information, and a composite master listing of all drainage problem areas is presented. The ratings of the 104 drainage problem areas ranged from a low of 17 to a high of 100 points; with the average score being about 68 points. This allowed a relative comparison of the severity of each problem area to all the other reported problem areas.

As shown in the table presented in Appendix C, ten problems that were clear maintenance issues were noted as such on the problem list and referred to City maintenance staff for further action. Five other problem area complaints were not surface water related or had previously been addressed by City staff and were removed from further consideration.

The remaining 89 drainage problem areas were prioritized and evaluated for future CIP projects using the weighted scoring system shown in Table 5.2-3 and Appendix C.

Based on prior direction from the City the top ranked 24 problem areas were identified to be addressed by the development of capital projects, with the remaining problem areas to be addressed by the City at a later date.

Table 5.2-4 provides a summary of the number drainage problem areas from each of the five sources of drainage problem areas that were investigated for potential CIP projects. This table shows that of the drainage concerns reviewed, 24 were prioritized for CIP project development.

Table 5.2-4
Summary of Drainage Problems that are CIP Projects

Source of Drainage Problems	Number of Drainage Problems/Complaints	Number of CIP Projects
Woodinville Public Survey	34	7
King County Complaints (2001-2008)	11	0
City Staff	25	9
Citywide Hydraulic Analysis	24	3
City's Previous Stormwater CIP List	10	5
Total	**104**	**24**

Step 3: Detailed Evaluation and Review

In the third step of CIP development, conceptual solutions were developed for the top scoring problem areas. A meeting was held with City staff to review the proposed solutions. Using the experience of staff and knowledge of the City's drainage infrastructure and reoccurring problem areas, the scoring and ranking was finalized and a solution/project was identified. The consultant team met with City staff to review and prioritize problem areas, discuss and evaluate design options and identify those projects that would be further developed into CIP projects. This meeting was also used to refine the project concepts and group problem areas into larger projects that would address the long term needs of the City's drainage infrastructure.

Step 4: Development of Capital SWM Projects

In the final step of the CIP development, the top 24 priority drainage concerns were further developed into CIP projects. Many of these reported drainage problems/complaints were related to similar issues or problem areas, so the ten proposed CIP projects were developed to address the top 24 ranked drainage problems/concerns.

Projects were developed to approximately a preliminary engineering design level to address each of the problem areas and estimated costs. Projects include adding and upsizing inlets, replacing damaged pipes, and installing new or retrofitting existing stormwater infrastructure (pipes, ditches, etc.). Preliminary calculations were performed to establish runoff rates and evaluate the capacity of the existing drainage systems. Project sketches and planning level quantity/cost estimates were developed using available GIS data, existing as-builts, and information documented during the field visits. More detailed project survey will be needed to develop full solutions and construction drawings for each CIP.

Section 5.3: Capital Improvement Program

The following SWM CIP Plan describes the stormwater CIP projects that need to be designed and constructed to address the major drainage problems identified throughout the City. The proposed CIP Plan documents costs and allows future revenues to be obtained to support an annual SWM Capital Improvement Program.

Historically, the City's CIP projects have been funded by the City's stormwater utility, as annual funding has allowed. The City will use their annual budgeting process to update priorities and select projects for design and construction. This Section provides a cost estimate in 2010 dollars for the planning, design, permitting and construction of each of the ten proposed CIP project.

SWM Capital Improvement Program

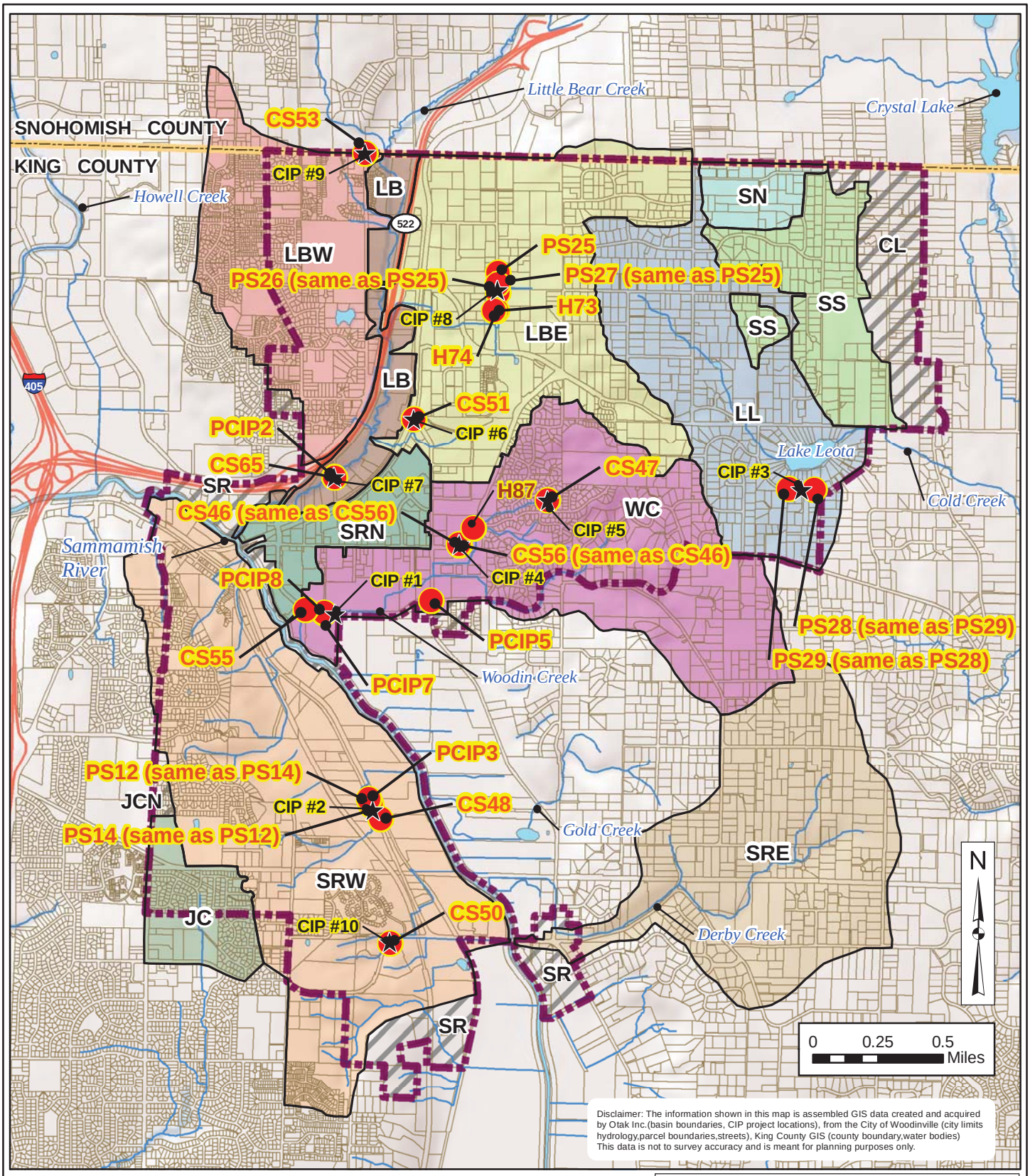
In the final phase of CIP development, the top 24 ranked drainage problems, with scores of 85 or higher, were assessed, a possible solution was proposed and the scope and cost estimate were created. Many of the reported problems were related to each other, resulting in a total of ten new stormwater CIP projects. Each CIP project has been developed to a preliminary level of design in order to define preliminary design and construction costs. The project sheets include location maps, problem descriptions, proposed project summaries, cost estimates, photos and project sketches for 15 percent planning level design. The cost estimates were developed using average bid item costs from recent construction projects[1] and the engineering judgment and construction experience of the consultant team. CIP project sheets and cost estimates are included in Appendix D.

The total cost for the ten new CIP projects is $6.4M. Table 5.3-1 shows the ten new CIP projects, their costs and initial prioritization; each project is described below. Figure 5.3-1 shows the location of each new CIP project.

Capital Improvement Program Project Prioritization

The prioritization process used to rank the new CIP projects was based on three basic criteria: public safety concerns; flood hazard reduction; community consideration and environmental impacts to habitat, water quality and stream banks, as described in Section 5.2. In general, the results of the prioritization process are reflected in the listing of the CIP projects presented in Table 5.3-1. A brief description of the drainage problem and cost for each project ranking is provided below.

[1] From 2008 Snohomish County Construction Bid Items. Adjusted for 2010 dollars.



K:/project/31324/GIS/mxds/SWM Plan June 2010/FinalPlanFigures_Oct2010

LEGEND

- CIP#10 — CIP Project Locations
- Top 24 Ranked Drainage Complaints
- Streams
- LL — Basin Boundary in Hydraulic Analysis
- City Limits
- County Boundary
- Parcel Boundary

STORMWATER MANAGEMENT PLAN

FIGURE 5.3-1

CIP PROJECT LOCATION MAP

CITY OF WOODINVILLE

OCTOBER 2010

Table 5.3-1 provides the list of prioritized CIP projects and their associated costs. City Staff will use this list to identify the capital project priorities and related cost for future budgeting and implementation.

Table 5.3-1
Summary of CIP Projects

Project Problem Area	Project ID	Cost (1)
1	Woodin Creek CIP	$2,633,000
2	Chateau Reach CIP	$608,000
3	Lake Leota and NE 180th Street CIP	$947,000
4	NE Woodinville Duvall Road Stormwater Conveyance CIP	$102,000
5	147th Place NE CIP	$40,000
6	Cottonwood Trees at 14300 NE Woodinville Duvall Road CIP	$57,000
7	Little Bear Creek Culvert at 134th Avenue NE CIP	$1,691,155
8	144th Avenue NE CIP	$153,000
9	136th Avenue NE and NE 205th Street CIP	$153,000
10	137th Place NE CIP	$48,000
	Total	**$6,432,155**

(1) The above cost opinion is in 2010 dollars and does not include future escalation, financing, or O&M costs.

Project sketches and quantity/cost estimates were developed using available GIS data provided by City staff and collected during field visits to each of the potential project locations. More detailed field survey may be needed for some projects to develop full solutions and construction drawings. A short summary of each stormwater CIP project is included below. Appendix D provides the CIP project sheets and preliminary cost estimates.

Capital Improvement Project Descriptions and Costs

The Capital Improvement Project descriptions and costs are described in the pages to follow (one CIP per page).

CIP #1: Woodin Creek CIP

Drainage Problem: Along Woodin Creek between 133rd Avenue NE to 140th Avenue NE, and along NE 171st Street, sedimentation has blocked culverts and conveyances causing localized flooding along NE 171st Street. The area along NE 171st Street and the southern downtown area does not have water quality treatment prior to discharge to Woodin Creek. The City has not been able to identify the source of the sediment; however the creek is very flat along the stretch identified in the project sketch which could cause sediment to settle and accumulate. The City often experiences lane closures for short periods of time on NE 171st Street, during the 5- to 10-year storm event due to flooding of the roadway from Woodin Creek.

Limited conveyance capacity and sediment accumulation in Woodin Creek

Project Description: Complete a detailed survey of the stormwater system that drains to Woodin Creek in the study area along NE 171st Street. Solution 1: Elevate NE 171st Street one foot higher in the area near Woodin Creek and construct a separate storm system (1,000 linear feet (LF) of 42-inch stormwater pipe and 2,000 LF of 24-inch stormwater pipe) to convey the roadway drainage to and outlet within Woodin Park. Add a water quality vault in Woodin Park. Solution 2: Add berms between the creek and the roadway at critical locations. Add a high flow diversion system within the roadway.

Note: If redevelopment occurs north of NE 171st Street (existing Mobile Home Park) some issues on Woodin Creek may be addressed during the redevelopment.

Project Cost: **$2,633,000 (for Solution #1)**

CIP #2: Chateau Reach CIP

Drainage Problem: Erosion and excess sedimentation problems in the channel cause flooding of SR-202 and a nearby commercial area. This is a recurring problem that has been on the City's CIP list for several years. A previous project concept was contingent on a private property owner granting the City an easement during redevelopment of the surrounding property.

Project Description: Identify the sources of sediment and install erosion control measures where City has right-of-way. Retrofit the existing sediment facility upstream of SR-202. This facility is currently on private property. This project would require obtaining a stormwater easement. Upsize the driveway culverts along SR-202 (12-inch upsize to 18-inch) to the SR-202 crossing (24-inch); upsize the SR-202 culvert crossing to 42-inch (or as determined by the designer). The new 42-inch pipe will require boring under SR202.

Project Cost: **$608,000**

CIP #3: Lake Leota and NE 180th Street CIP

Drainage Problem: Stormwater runoff from NE 180th Street and private property on the upstream (south) hillside of NE 180th Street is not being treated before entering Lake Leota. During storm events there are an insufficient number of inlets to collect stormwater from the roadway and water flows toward private residences.

Project Description: Install 5 additional catch basin inlets, 3 new manholes and 500 LF stormwater conveyance pipe on NE 180th Street. Install two bioretention stormwater quality treatment facilities (120 LF and 60 LF) within the right-of-way of NE 180th Street to treat the stormwater before it enters Lake Leota. Retrofit the existing ditch. Install a water quality treatment vault in the City's right-of-way. In addition design and construction of a five Bioretention/Rain Gardens and a water quality vault with media filters throughout the Lake Leota Basin.

Project Cost: **$947,000**

CIP #4: NE Woodinville Duvall Road Stormwater Conveyance CIP

Drainage Problem: A primary conveyance line (12-inch) along NE Woodinville Duvall Road takes a 90 degree direction change in a catch basin and then crosses to the center of the road as an 8-inch stormwater pipe. At this point it turns 90 degrees in a second structure and continues as a 12-inch stormwater pipe. The lid of the catch basin upstream of the 8-inch pipe blows off during heavy rainfall. Water flows along the gutter to the intersection at 140th Avenue NE and 175th Street NE where it temporarily ponds due to the lack of inlet capacity. This causes traffic disruption.

Project Description: Upsize approximately 40 LF of 8-inch stormwater pipe to a 12-inch stormwater pipe and replace the existing catch basin(s) to decrease the angle of the 90 degree transition when the new pipe is installed. Add curb cut inlet frames and grates on upstream structures along NE Woodinville Duvall Road to minimize clogging due to street tree leaf litter.

Project Cost: **$102,000**

CIP #5: 147th Place NE CIP

Drainage Problem: There are an insufficient number of catch basin inlets at the low point of 147th Place NE. As a result, flooding of a nearby electrical vault occurs along with standing water in the roadway.

Project Description: Install a new curb inlet in the right-of-way at the low point in front of the existing electrical vault. Install approximately 20 LF of 12-inch stormwater pipe to connect the new catch basin with the existing stormwater conveyance system. Add another flanking catch basin and 20 LF of 12-inch stormwater pipe to the northeast of the low point. All grates should be vane grates. To accommodate new pipe and angle of existing pipes, the existing catch basin may need to be replaced with a larger structure.

Project Cost: **$40,000**

Existing low point and electrical vault on 147th Place NE

CIP #6: Cottonwood Trees at 14300 NE Woodinville Duvall Road CIP

Drainage Problem: There are two large cottonwood trees whose root systems are intruding on a nearby Type 2 catch basin and conveyance pipe. The roots have caused extensive stormwater infrastructure damage and require frequent maintenance.

Project Description: Remove two cottonwood trees per WMC 2.24.170. Replace existing Type 2 catch basin and approximately 100 feet of stormwater conveyance pipe that has been damaged by the tree roots. Regrade 50 feet of roadside ditch and replant area with appropriate street trees per the City's Tree Ordinance No. 478.

Project Cost: **$57,000**

CIP #7: Little Bear Creek Culvert at 134th Avenue NE CIP

Drainage Problem: Downstream sections of three 60-inch pipes were damaged during December 3, 2007 flood. The culverts are perched, creating a fish barrier, and there is a continued risk of erosion and potential roadway failure. The creek alignment also shifted, eroding the upstream roadway embankment. The middle culvert is currently plugged with sediment and debris.

Project Description: Replace four 60-inch culverts with a bridge that is one lane, 14-feet wide and has a 70-foot span. Deep foundations for the abutments will be necessary. Likely either drilled shaft or pile abutments will be needed. Note: The City is currently working on a small temporary solution to address the damaged culverts and fish passage issues, but the larger bridge project is needed to address ongoing capacity issues.

Project Cost: **$1,691,155**

Most southern of the three 60-inch culverts under 134th Avenue NE on Little Bear Creek

CIP #8: 144th Avenue NE CIP

Drainage Problem: There have been reported problems of flooding of local businesses along 144th Avenue NE. The City installed an additional catch basin to alleviate this problem; however, degraded, undersized pipes still cause problems. The ditch along 144th Avenue NE needs frequent maintenance and causes surrounding ground to become saturated. The capacity analysis shows pipes in this area may be significantly undersized.

Project Description: Upsize 100 LF of existing 12-inch stormwater conveyance line on 144th Avenue NE to provide capacity for the 25-year storm event. Replace 215 LF of ditch that runs along 144th Avenue NE with a closed pipe system. Replace 110 LF existing 12-inch pipe and 235 LF of 18-inch pipe.

Project Cost: **$153,000**

CIP #9: 136th Avenue NE and NE 205th Street CIP

Drainage Problem: An existing 12-inch culvert along NE 205th Street under 136th Avenue NE becomes plugged and causes roadside flooding. The side slope of the ditch along NE 205th Street is too steep and gravel continues to cave into the culvert entrance.

Project Description: Replace 100 LF of existing 12-inch culvert with a new 12-inch culvert. Add two additional catch basins. Extend closed pipe system an additional 130 LF west along NE 205th Street. Install 100 LF of new stormwater conveyance and two new catch basins along 136th Avenue NE. Install new shoulder and sidewalk while making stormwater improvements.

***Project* Cost: $153,000**

CIP #10: 137th Place NE CIP

Drainage Problem: Runoff from private property overtops an existing culvert (also on private property) and causes overflow into a public road. Runoff comes from a conveyance ditch and from seeps from adjacent steep hillside. In the winter, water on the roadway has caused icy conditions in this location where the road has a steep grade at a curve.

Project Description: Abandon access road and extend the roadside ditch 220 LF through the existing access road to collect stormwater runoff before it hits the public roadway. This project will also include installing 100 LF of 12-inch culvert.

Project Cost: **$48,000**

137th Place NE where new road ditch will be constructed